INTERNATIONAL CONFERENCE ON ENERGY WATER & ENVIRONMENT ICEWE-2021

ICEWE - 21

BOOK OF ABSTRACTS

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DEPARTMENT OF MECHANICAL MECHATRONICS & MANUFACTURING ENGINEERING

(NEW CAMPUS) UNIVERSITY OF ENGINEERING & TECHNOLOGY LAHORE, PAKISTAN

ISBN: 978-969-23447-1-5 Book of Abstracts of the International Conference on Energy, Water and Environment (ICEWE-2021).

Published By: Department of Mechanical Engineering, New Campus (KSK), University of Engineering & Technology Lahore, Pakistan.

BOOK OF ABSTRACTS

INTERNATIONAL CONFERENCE ON ENERGY, WATER AND ENVIRONMENT (ICEWE-21)

ORGANIZED BY

Department of Mechanical Engineering (New Campus – KSK)

University of Engineering and Technology (UET) Lahore, Pakistan

31 March 2021

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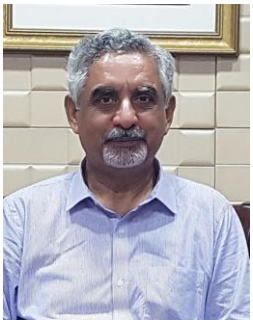

The Department of Mechanical Engineering, New Campus of the University of Engineering and Technology, has taken this important initiative of hosting an International Conference on Energy, Water and Environment (ICEWE-21). As Patron in Chief of ICEWE-21, I believe that the nexus between energy, water and environment is of global relevance and is extremely important in Pakistan's national perspective. The solutions to the problems related to these fields are going to impact the future of generations to come. The material that is intended to be presented in the conference shall analyze the existing state of affairs and propose a roadmap for the sustainable development of the solution to the problems related to energy, water and environment. University of Engineering and Technology (UET) Lahore is a premier and the oldest Engineering University of Pakistan. Established in 1921, the University is celebrating 100 years of excellence. We contribute the highest share in terms of technical human resource to sustain the economic growth and industrial production. The UET LAHORE has always been a center of excellence in terms of hatching and harboring solutions to the national problem. This year, the Department of Mechanical Engineering, New Campus of UET, has taken an important initiative of hosting an International Conference on Energy, Water and Environment (ICEWE-21). As Patron in Chief of ICEWE-21, I believe that the nexus between energy, water and environment is of global relevance and is extremely important in Pakistan's national perspective. The solutions to the problems related to these fields are going to impact the future of generations to come. The material that is intended to be presented in the conference shall analyze the existing state of affairs, and propose a roadmap for the sustainable development of the solution to the problems related to energy, water and environment.

Prof. Dr. Syed Mansoor Sarwar
Patron in Cheif, ICEWE-21
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FOREWORD

International Conference on Energy, Water and Environment (ICEWE-21) is a multi-module, multi-track double blind peer-reviewed International Conference, which will be held on March 31, 2021 at University of Engineering and Technology, New Campus, Kala Shah Kaku, Pakistan.

This conference will showcase Research/Policy/Industry Papers, Posters and Projects, Industrial Products Exhibition, Students Professional development from disciplines of Energy Conversation in Domestic, Industrial and Commercial Sector, Energy Efficient Heating and Cooling, Energy Efficient Lighting, Energy System Modeling, Waste Water Management and Training, Water Quality and Production, Water Resources and Sustainable Development, Air Pollution and Treatment, Environment Sustainability and Development, Impact of Industrialization on Environment and Nanotechnology Impacts on Environment.

Following are **4 modules** of the conference.

Module 1:	**Invited Sessions** by the renewed national and international experts from academia and industry leaders on issues related to national importance.
Module 2:	**Research Presentations** by researchers, experts, Academics and Industry Staff focusing state of the art research findings in theory and applications.
Module 3:	**Posters/ Projects Exhibition** by researchers, experts, Academics and Industry Staff focusing state of the art research findings in theory and applications.
Module 4:	**Exhibition:** Industrial products by various industries showcasing their products and technologies.

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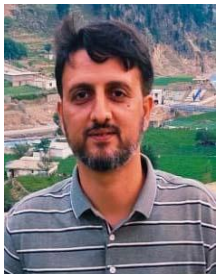

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Punjab Higher Education Commission (PHEC) aims to improve the quality of higher education in Punjab. Since our inception in January 2015, we have been focusing on enhancing accessibility and affordability of opportunities in higher education for students of Punjab across all socio-economic segments. We firmly believe that equipping the students of Higher Education Institutes (HEIs) with adequate facilities and by incubating a market-oriented and skilled workforce through proposed skill-development projects would eventually pave the path for students to excel within their respective areas of profession.

PHEC has been establishing educational benchmarks compatible with the imperatives of modern-day knowledge economy and developing a culture of rigorous pursuance thereof. In this regard, our organization has been adopting proactive measures including technology commercialization, industry-academia linkages, and international collaboration to ensure meaningful reform in higher education sector in Punjab. Moreover, we have been initiating several faculty development programs through which foreign scholarships and post-doctoral fellowships are awarded to the deserving and competent faculty members of public sector HEIs in Punjab. The PHEC endeavors to strengthen existing assets and introduce new initiatives to stay competitive in the modern-day economy as well as improving governance and management in HEIs for more efficient functioning. Our top priority is increasing equitable access along with bringing improvement in academic standards, emphasizing focus on research relevant to the socio-economic needs of the province and introducing mandatory faculty development programs to improve teaching standards.

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Our team focuses all its efforts toward achieving six major goals - in the areas of Forests, Oceans, Wildlife, Food, Climate & Energy, and Water. Since our presence for over 50 years in the country, our organization has been aiming to stop the degradation of the planet's natural environment and to build a future in which people and nature could thrive by conserving the world's biological diversity, ensuring the use of renewable natural resources being sustainable and promoting the reduction of pollution and wasteful consumption.

With a head office in Lahore, 6 regional offices including Gilgit, Peshawar, Muzaffarabad, Islamabad, Karachi, Quetta, and more than 20 project offices and information centers, WWF-Pakistan has a presence in all the provincial capitals and considerable outreach in field sites and protected areas across Pakistan. Through a diversified team which includes, but is not limited to, biologists, zoologists, foresters, natural resource managers, sociologists, policy experts, GIS experts, freshwater ecologists, and environmental economists, we are currently implementing over 30 projects, with an annual budget of about USD 6 million – including work on forests, freshwater, species, marine and coastal areas, climate change, education and awareness, poverty-environment linkages, and policy research and advocacy – and employ holistic approaches that mesh conservation and sustainable development initiatives.

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INVITED SPEAKER ABSTRACTS

EXPERIMENTAL DEVELOPMENT OF A BUBBLING FLUIDIZED-BED GASIFICATION SYSTEM FOR POWER GENERATION FROM WASTE BIOMASS

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ABSTRACT

Power generation from biomass is one of the most relevant pathways to meet the goal of the European Union to become the first carbon-neutral continent by 2050. Differently from non-programmable wind and solar energy, biomass is a renewable energy source that can be managed and regulated on the basis of the specific needs of the electric grid. In this context, waste biomass – residues from forest management, agriculture and food industry – represents a renewable fuel cheap, widely available and characterized by a significant energy content.
One of the most promising, flexible and effective technologies for energy conversion from waste fuels is represented by gasification processes. They thermochemically convert low rank primary fuels in a fuel gas (called synthesis gas or, more generally, syngas) that can be used for power generation (*e.g.* by means of internal combustion engines), but also for the synthesis of other products, including hydrogen. And these systems can be easily integrated with CO_2 separation units, with the additional benefit of making the carbon balance negative.
This work summarizes the results of a combined bench- and pilot-scale experimental development of a bubbling fluidized-bed gasification technology for power generation from waste biomass. The lab-scale BFB gasification unit is designed to study the influence of gasification parameters (*e.g.* equivalence ratio, composition of the gasification agents and temperature) on syngas composition and tar production. It provides cost-effective testing capabilities to augment the more complex and expensive experimental tests in the pilot-scale unit. In parallel, the pilot scale gasifier, called FABER (Fluidized Air Blown Experimental Reactor), is characterized by a thermal output of about 400 kW and a feedstock capacity of about 100 kg/h. Its internal diameter (0.489 m) is large enough to exclude any further change of the scale-up parameters.

Keywords: Waste biomass, Bubbling fluidized-bed gasification, Experimental assessment

METALLOTHERMIC REDUCTION-BASED PROCESSES: A LOW ENERGY REQUIRED ALTERNATIVE TO CONVENTIONAL METAL AND CERAMIC PRODUCTION

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Metallothermic reduction-based metal production has been in use since the end of the 19th century. Goldschmidt reaction which is used for railway welding application was the first developed application area of these techniques. Despite its practical use in such areas, its mechanism and theoretical background were explained in the middle of 60s by the studies of Prof Merzhanov et al. in the USSR. Moreover, Merzhanov's research team developed the implementation of metallothermic reduction-based processes to advanced ceramic (and derivatives) field. Those inventions made Prof Merzhanov to be called the father of self-propagating high-temperature synthesis (SHS) process which is one of the sub-groups of combustion synthesis for ceramic synthesis.

Metallothermic reduction-based processes have a wide application area from the production of metals and their alloys such as Mg, Sb, Ti, FeMo, low carbon FeCr, iron-nickel-chromium-based alloys, high entropy alloys to ceramic synthesis (borides, nitrides, carbides etc.) and to welding applications e.g. hard-metal coatings and railway welding. The common points of those processes are the use of a metal reductant (e.g. Mg, Al, Si) instead of carbon in conventional processes and low additional energy requirement of the processes because of the highly exothermic characteristics of the reactions. Thus, the processes have very low or zero CO_2 emissions too.

In the present study, characteristics, mechanism, thermochemical features of those processes will be shared with laboratory, pilot and industrial scale examples which have been studied in our laboratories in Turkey. Prof Yucel's team (MtNT at ITU) is the first research group where those processes have been comprehensively investigated in Turkey. The researchers, who formerly worked and graduated from MtNT research group, extended these studies in their current laboratories and in their institutions. In this presentation, various experimental studies from different laboratories in Turkey (ITU, Yalova Uni., Dokuz Eylül Uni.) will be shared for the use of the method for metal production (V, Cr, B, Mg, Sr, Sb, FeB, FeV, FeW, FeCr, FeMn, FeMo, CrNi, AlTiB etc.) and for advanced ceramic synthesis (TiB_2, B_4C, W_xB_y, ZrB_2 etc.).

HYDROGEN ADSORPTION PROPERTIES OF HEMIFULLERENE BUCKYBOWL

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ABSTRACT

In this study, hydrogen adsorption properties of $C_{30}H_{12}$ buckybowl (hemifullerene) have been investigated computationally, applying the first-principles calculations. The study encompassed calculations of binding energies, identification of noncovalent interaction, and identification of interaction energy's essential components. Adsorption of hydrogen from both concave and convex sides of hemifullerene has been studied. Calculations show that hemifullerene might adsorb hydrogen molecules, with binding energies higher than those calculated for corannulene and sumanene (best-known representatives of buckybowls). In terms of binding energy, the importance of hemifullerene's curvature has been addressed through comparison with hydrogen adsorption properties of coronene (a flat relative of buckybowls).

Key words: Buckybowls, hydrogen, adsorption, DFT, SAPT

Introduction

The development of efficient green energy sources is one of the most challenging tasks in front of humankind. This task cannot be achieved without collaboration between the academy and industry. In this area, hydrogen holds one of the central roles, as it provides more chemical energy than conventional fossil fuels without producing polluting substances [1]. To be used as an energy source, it is necessary to have a material that can adsorb, store and release hydrogen under reasonable experimental conditions. While there have been synthesized numerous materials for hydrogen storage, there is a necessity for constant improvements to cut the costs and make this technology available everywhere. But, the challenge is not only to develop materials that can bind hydrogen. It is also necessary to release it under easily achievable conditions (for example, by simple heating). If hydrogen adsorption is too strong, its release may be too difficult and require too high temperatures.

Buckybowl molecules are bowl-shaped structures that attract scientists' attention thanks to their specific structural and reactive properties. Structurally, they are characterized by the bowl-depth, while from the aspect of reactivity, they are characterized by two surfaces with different adsorption properties. Studies have shown that these molecules significantly interact with hydrogen molecules, providing possibilities for hydrogen storage materials [2,3]. They can be regarded as fragments of fullerenes and nanotubes. Not only that calculations indicate that they adsorb hydrogen molecules with significant binding energies, but their other properties, such as bowl-to-bowl inversion, might be used for the efficient release of hydrogen.

This study aimed to apply first-principles calculations (DFT and SAPT approaches) to understand the interactions between hydrogen molecules and $C_{30}H_{12}$ buckybowl, also known as hemifullerene. Density functional theory (DFT) and symmetry-adapted perturbation theory (SAPT) calculations have been used to analyze a set of quantities that resemble molecules' ability to bind, store and release hydrogen molecules.

Methodology

DFT calculations have been performed for geometrical optimizations, the calculation of binding energies, and the identification of noncovalent interactions. The dispersion corrected B3LYP-D3 functional was used for all DFT calculations, in combination with 6-31G(d,p) basis set. All DFT calculations have been performed with Jaguar program [4], as implemented in Schrodinger Materials Science Suite 2021-1. SAPT calculations, namely the SAPT0 scheme with jun-cc-pVDZ basis set, have been performed with PSI4 modeling program [5].

Results and Analysis

DFT calculations indicated that the hemifullerene binds hydrogen molecule with binding energies higher than those obtained with coranulene and sumanene. Calculations involving the counterpoise method for treatment of the basis superposition error have shown that the binding energy of hydrogen adsorption from the concave side of hemifullerene is equal to -2.88 kcal/mol, while the binding energy of hydrogen adsorption from the convex side of hemifullerene is equal to -0.74 kcal/mol. Further, DFT calculations showed that the two noncovalent interactions characterize the adsorption of hydrogen from the concave side compared to only one noncovalent interaction in the hydrogen's adsorption from the convex side of hemifullerene (Figure 1). The interaction energy between hydrogen and hemifullerene molecules has been decomposed into components via the SAPT0 approach, showing that the most substantial attractive component is the dispersion one.

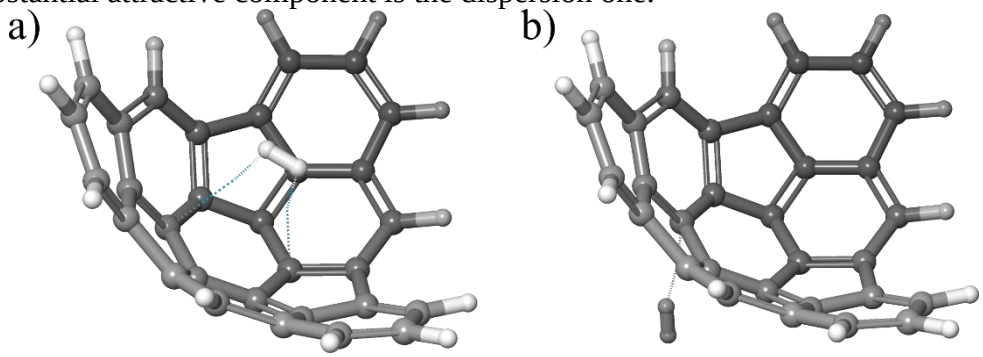

Figure 1. Adsorption of hydrogen from a) concave and b) convex side hemifullerene (dotted lines indicate noncovalent interactions between hydrogen and hemifullerene)

Conclusions

The computational study of interactions between hydrogen and hemifullerene molecules have been performed by the first-principles calculations. DFT calculations of binding energies indicated that the much stronger binding energy characterizes hydrogen's adsorption from the concave side of the hemifullerene. Adsorption of hydrogen from the concave side is also characterized by a higher number of noncovalent interactions than the convex side's adsorption. The SAPT0 calculations show that the most significant contribution to the attraction between hydrogen and hemifullerene is the dispersion one.

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APPLICATION OF TIO_2 NANOMATERIALS FOR WATER PURIFICATION BASED ON PHOTOCATALYSIS

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ABSTRACT

In this work, environmental aspects of the application of TiO_2 have been considered. The photocatalytic application of TiO_2 for removing organic compounds that accumulate in the water resources has provided highly efficient results. The motivation for the application of TiO_2 has been found because this material possesses a suitable combination of physical and chemical properties, some of them being: stability, insolubility, and non-toxicity. In this study, the commercial forms of TiO_2 (Degussa P25 and Wackherr) were used as photocatalysts for the degradation of metoprolol in water. Kinetics of photodegradation, including the influence of temperature and pH, have been studied in detail to evaluate the efficiency of these materials for removing this frequently prescribed beta-blocker. It has been established that the more efficient degradation of metoprolol was achieved with Wackherr.

Key words: Environmental pollution, Metoprolol, β-blocker, Photocatalytic degradation

Introduction

As soon as it was determined that semiconductors can be efficiently used to obtain products such as H_2 and O_2, they were also recognized as efficient photocatalysts for the degradation of toxic materials. Titanium dioxide (TiO_2) has shown to be a very good photocatalyst and therefore, it is widely used due to its great photocatalytic activity, chemical and biological stability, insolubility in water, acid, and base environment, resistivity towards corrosion, non-toxicity, low price and availability in comparison to oxide, sulfide and other materials [1-3]. Heterogeneous photocatalytic oxidation of organic compounds in aqueous solution in the presence of TiO_2 as photocatalyst and irradiation provides the opportunity for efficient treatment of wastewaters, drinking water, surface water, and groundwater as well as for obtaining the ultraclean water suitable for the pharmaceutical industry and microelectronics [4]. Many organic substances and their intermediates are in this way completely mineralized. Suitable physical and chemical properties, the possibility for modifications using inexpensive methods, applicability to a wide range of compounds, low price, commercial availability, and finally, its outstanding photocatalytic properties have contributed that this oxide compound becomes one of the most frequently used and studied nanomaterial.

The aim of this work was to compare the kinetics of photodegradation of metoprolol by TiO_2 Degussa P25 and Wackherr in an aqueous solution under UV irradiation with special attention on the influence of initial temperature and pH solution value on stability of the investigated compound.

Methodology

All chemicals were of reagent grade and were used without further purification. The drug (±)-Metoprolol (+)-tartrate salt, ≥99%, was purchased from Sigma–Aldrich. All solutions were made using ultra-pure water. The TiO_2 Degussa P25 and Wackherr [5] were used as photocatalysts. In experiments, the initial metoprolol concentration was 0.05 mM and the TiO_2 loading (Degussa P25 or Wackherr) was 1.0 mg/mL. The temperature which observed were: 298, 303, 308 and 318 K. Further, the initial pH values were: 3, 5, 7, 9, and 11.

Results and Analysis

The specific surface plays a significant role when it comes to the photocatalytic properties of nanostructured and porous TiO_2. The photocatalytic activity of Wackherr was compared with the most commonly used form of TiO_2, Degussa P25, under the influence of UV radiation. Experiments were performed at four different temperatures (298, 303, 308, and 318 K) and five different initial pH values (3, 5, 7, 9, and 11). It was found that the efficiency of photocatalytic degradation differs depending on the catalyst used, at the same temperature and pH. Faster decomposition of metoprolol was established when the Wackherr form was used, compared with Degussa P25. The Wackherr form has much larger particles than Degussa P25, which results in six times smaller specific surface area. However, the higher degree of radiation scattering in the Degussa P25 catalyst compared to the Wackherr is why the Degussa P25 is a less efficient catalyst at each temperature and pH value of the solution. Higher temperatures than 25 °C contribute to increased degradation efficiency in both cases (Fig. 1). Metoprolol photocatalytic degradation efficiency was higher for pH values higher than natural (*ca*. 7).

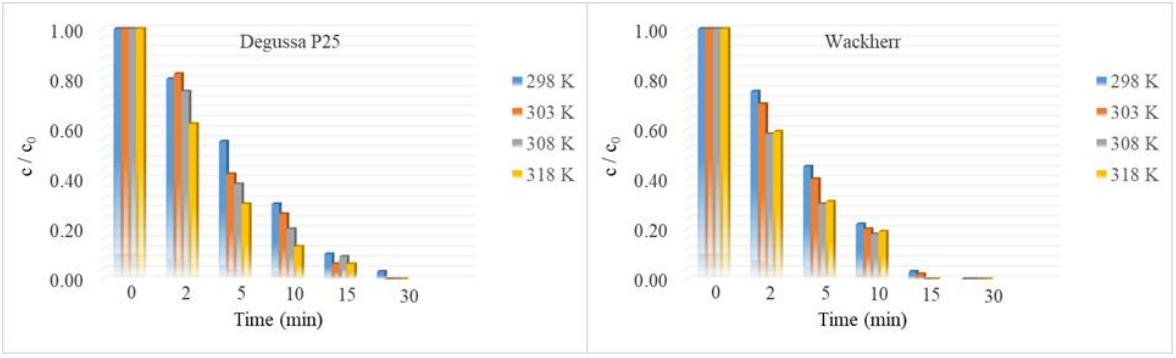

Fig. 1 Influence of temperature on the kinetics of the photocatalytic degradation of metoprolol in the presence of TiO_2 at natural pH value

Conclusions

The study of photocatalytic degradation of metoprolol in the presence of commercially available forms of TiO_2 (Degussa P25 and Wackherr) has been performed. The study aimed to evaluate these materials' efficiency for removing metoprolol from water through analysis of the kinetics of photocatalytic degradation. This study also encompassed the investigation of the influence of temperature. It has been found that the Wackherr form of TiO_2 performs better when it comes to the photocatalytic removal of metoprolol from water. In cases of both photocatalysts, the higher temperature contributed to the faster degradation of metoprolol.

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UNLOCKING THE DESALINATION PROCESSES FUTURE ROADMAP

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ABSTRACT

For future sustainable seawater desalination, the importance of achieving better energy efficiency of the existing 20,000 commercial-scale desalination plants cannot be over emphasized. The major concern of desalination industry is the inadequate approach for energy efficiency evaluation of diverse seawater desalination processes by omitting the grade of energy supplied. These conventional approaches would suffice if the efficacy comparison were to be conducted for the same energy input processes. The misconception of considering all derived energies as equivalent in desalination industry has severe economic and environmental consequences.

We proposed a standard primary energy based thermodynamic framework to addresses the energy efficacy fairly and accurately. It clearly shows that all desalination processes performance varies from 10-13% of thermodynamic limit. To achieve 2030 sustainability goals, innovative processes are required to meet 25-30% of thermodynamic limit. This can only be achieved by developing innovative materials for membrane modules or hybrid thermally driven processes.

We also proposed a hybrid Multi Effect Desalination and Adsorption (MEDAD) cycle to overcome the conventional MED system operational limitations. The hybrid cycles gave two salient advantages: Firstly, an increase in the available operational temperature differences between the top to bottom brine temperatures. On the other hand, a green-field design allows around 15 MED stages as compared to 6-8 conventional system stages. Secondly, the hybrid operation of the MEDAD plant lowers the saturation temperatures in the last few stages to below ambient temperature, boost water production by additional flashing effect. A solar driven hybrid MEDAD pilot of capacity 10 m^3/day is successfully tested at KAUST, Saudi Arabia. The bottom brine temperature was achieved as low as 7ºC as compared to 40ºC in conventional system. The water production was boosted to 2-3 folds as compared to conventional MED system at same energy input. The proposed hybrid system achieved performance level of 20%, one of the highest reported in the desalination industry.
Keywords: Hybrid desalination, sustainability, standard primary energy




CHEMICAL CONVERSION: A PROMISING METHOD FOR RECYCLING PLASTIC WASTES

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Background

Plastic is popularly branded as "one of the greatest innovations of the 20th century" due to its durability, low cost, safe usage and light weight and other specific properties. The worlds' plastic consumption has been increasing since 1950 from around 2 million tonnes per year to about 245 million tonnes per year in 2010 with a projection of reaching 400 million tonnes by 2025.

Methods established for recycling Municipal Solid Wastes, particularly plastics include mechanical, biological and .chemical recycling methods. Plastic waste resists natural degradation, which makes landfill an unattractive option for its management while incineration releases harmful emissions into the environment. Hence, there is a serious need for a sustainable method of recycling plastic waste back into chemicals and/or fuels. Chemical recycling, which comprises of thermal and catalytic has been proved the most promising recycling method. However, thermal conversion typically results in non-selectivity and requires high temperatures. Thus, catalytic recycling, which is highly selective towards desired products and requires less energy has been suggested as an excellent recycling method. This method converts plastic waste to liquid hydrocarbons that could be used as fuels and or as raw materials. Catalytic recycling of plastic has been reported to have a potential for recovering valuable hydrocarbons from the waste.

Method

This work reports the conversion of High Density Polyethylene (HDPE) plastic into different hydrocarbon valuable products in the presence of a modified sulphated zirconia catalyst using a simple designed laboratory fixed-bed reactor (Figure 1).

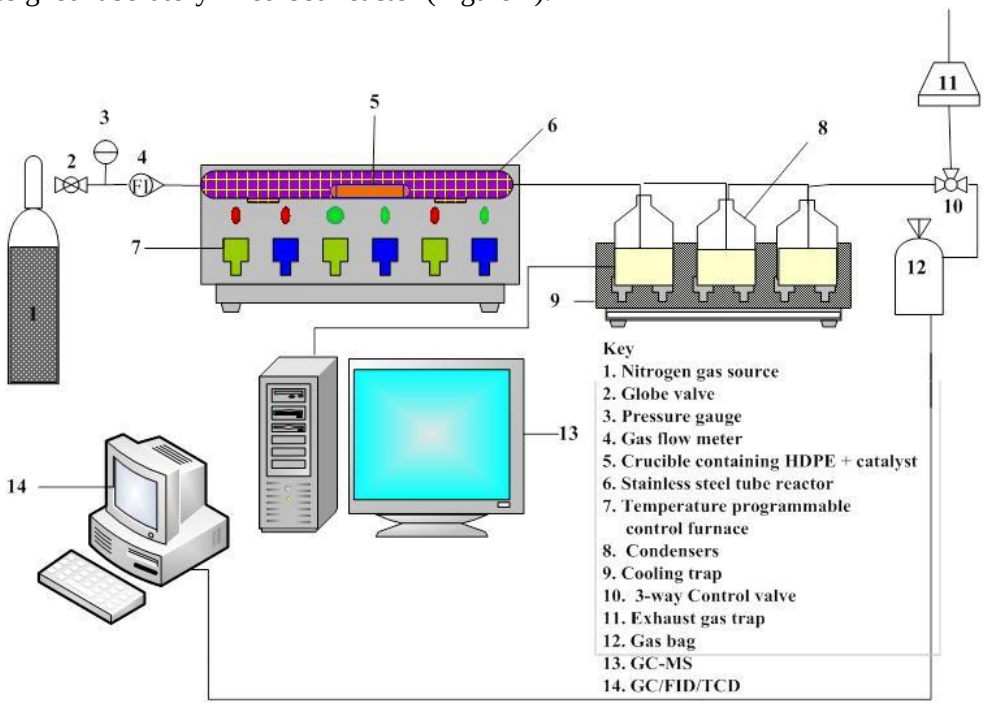

Figure 1. Schematic of the fixed bed reactor set-up the conversion

Results

Conversion of HDPE plastic over modified sulphated zirconia catalyst showed an excellent conversion of nearly 100wt% with liquid and gaseous hydrocarbon products at 66.0wt% and 34wt%, respectively. Repeated analysis at different temperatures, suggested temperature with optimal liquid yield at 410°C. This shows significant increase in liquids compared to many works reported in the literature. The liquid composition showed very low aromatic content. The results obtained suggest that chemical recycling in particular catalytic method could be a viable method for managing plastic waste.

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ENERGY SECTOR IN PAKISTAN - EXISTING SYSTEM AND OPPORTUNITIES FOR IMPROVEMENT

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ABSTRACT

The major source of energy in Pakistan was mainly based upon hydel system. This dependency however, remained intact for more than three decades but it did not last long and eventually the Country had to shift to other means particularly thermal source. This gradual transfer helped to curtail the gap between supply and demand of electricity but it became an expensive solution. Nuclear energy was explored as an alternate source for producing electricity which has however, had a minimal share in the energy mix for decades. Very lately, renewable energy was also made part of the energy mix. In recent years, coal is observed to have its share increasing mainly after the exploration of Thar coal.

Despite of having several alternate options availed along with the proportion of each component in the energy mix continuously varied, we are still unable to produce electricity up to the volume which may become sufficient for the need of the Country. Several energy policies introduced from time to time also failed to overcome this aggravated situation. The major reasons appear to be the lack of timely decision in opting the right energy mix, delay in utilizing the indigenous coal as well as renewable sources. Apart from that the indirect causes which include circular debts, poor management of DISCOs, deficient infrastructure, lack in opting energy conservation mechanisms and not using energy efficient equipment are also the major contributors towards reaching this situation.

The historical perspective, abrupt alteration in energy mix and other major causes of insufficient energy in the Country will be discussed in this paper. Finally, suggestions for improvement in the existing scenario will be highlighted.

OPTIMIZATION OF VENTILATION SYSTEM FOR ENVIRONMENTALLY CONTROLLED POULTRY SHEDS

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ABSTRACT

Poultry is the ever-growing food industry in Pakistan and to keep up with the demand of meat it is essential to increase its productivity. The most influencing factors in this regard are the design and orientation of sheds as they play vital role for energy conservation, heating and cooling distribution with controlled temperature and humidity inside the shed. In this paper, we present detailed preliminary computational fluid dynamics (CFD) analysis of optimized combinations of opening of ventilation systems for different seasons for environmentally controlled poultry shed (ECPS) already in use throughout Pakistan. For both dry and evaporative cooling conditions, all vents closed has been determined the optimized combination as air velocities across chickens are observed within acceptable limits of 0.5 m/s. Moreover, evaporative cooling effective temperature of almost 24˚C, with relative humidity of 60-70% is observed which is desired for the comfort of chickens in the shed.

Keywords: Cfd, Analysis, Ventilation System, Environmentally Controlled Poultry Shed

ROLE OF INTEGRATED WASTE BIOREFINERY IN CIRCULAR ECONOMY

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ABSTRACT

A waste-driven factory is intended to valorize waste sources as renewable feedstock to recover value-added chemicals, materials, alternative fuels, and energy. This concept aims to integrate waste treatment, resource recovery, alternative fuels, and energy generation to shift from fossil-based linear economies to circular economies. Although the traditional linear economies have resulted in rapid economic growth, but at the cost of increasing energy demands, environmental pollution, and climate change. Recently, the Paris COP21 summit has set out a roadmap to reduce greenhouse gases (GHGs) emissions to keep global warming to 'well below 2^{o}C'. Like global warming, the tremendous waste generation and its unsustainable disposal have emerged as a potential threat to our civilization. It is estimated that the current waste generation rate would escalate by three times by 2025. Traditional waste remediation methods are concerned with waste removal from collection points and their disposal in designated dumping sites where waste valorization to generate energy and other value-added products are rarely performed. These sites have become a major source of GHGs emissions contributing to climate change. As a result, nations are now focusing on treating or refining wastes instead of disposing, striving to recover energy and value-added products from waste to achieve a circular economy. In better words, using closed-loop waste bioprocessing units, the inherent net positive energy contained in solid, liquid, and gaseous wastes is harnessed and utilized as energy carriers. Despite their promising features, these individual processing technologies are incapable of handling the huge volume of waste at a single platform to achieve zero waste concept. They suffer from limited efficiencies and high capital and maintenance costs. Therefore, if these waste processing or waste-to-energy technologies could be integrated through the under-one-roof concept of a waste-driven factory, a significant part of wastes can be treated by various specialized techniques, while their outputs (heat, power, and fuel) could suffice the operating requirements of each other. An array of products including heat, power, fuel, and value-added chemicals, enzymes, and materials would be available, not only to run the waste-driven factory by itself but to support the national electric grids, vehicular gas stations, combined heat and power (CHP) units, and domestic heating and industrial furnaces. However, such waste-driven factories' overall sustainability should be assessed through various tools, including life cycle assessment (LCA), life cycle impact assessment (LCIA), and exergy.

Keywords: Waste-driven factories; Waste to energy; Alternative fuels; Sustainability

METAL NANOCLUSTERS AND THEIR NANOCOMPOSITES FOR RENEWABLE ENERGY TECHNOLOGIES

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ABSTRACT

Metal nanoclusters (<3 nm) with dimensions between molecules and nanoparticles are among the promising nanoscale materials for catalysis, renewable energy technologies, environment and biomedical applications. They behave like a "superatom" with exciting size-dependent physical and chemical properties and dynamic intrinsic characteristics. They are currently being envisioned to replace the natural photosystem II for the generation of green electrons in a viable way to facilitate the challenging catalytic processes in energy conversion schemes. We have developed a number of new protocols for the synthesis of metal nanoparticles and atomically monodisperse metal nanoclusters with decent control over their size and surface chemistry. These metal nanoclusters, nanoparticles and their composites with graphene oxide, carbon nanotubes and mesoporous carbon have been used as homogeneous and heterogeneous catalysts for a variety of reactions especially water splitting with interesting results. In this talk, I will discuss the synthesis and applications of metal nanoclusters, nanoparticles and their composites in renewable energy technologies i.e., water splitting, fuel cells, solar cells and CO_2 conversion and storage, with specific reference to our recent findings in this regard.

ALTERNATE ENERGY RESOURCES - AN OVERVIEW OF RECYCLING WASTE BIOMASS AND REUSE OF WASTE OILS (WLO) & LUBRICANTS FOR THE PRODUCTION OF BIOFUELS

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ABSTRACT

Human development has become synonymous with energy production and industrial growth. The connection between global warming, climate change and Greenhouse gas (GHGs) emissions due to excessive use of fossil-fuel represents a global environmental concern. Furthermore, land-use change for habitation of new settlements and industry has its own paradigm towards gradual degradation of environment. Conversion of forests into grassland or cropland for producing feedstock for an alternate biofuel production has continued in South Amrica, viz-a-viz Brazil etc., and could, in long run, jeopardize the balance between carbon sinks and GHGs, alongside feeding the population *"rhetoric"*. However, the greatest impediment in economic growth of any developing economy lies in its dependence on natural resources, i.e., gas and petroleum, for energy production. Besides, being a non-renewable and ever-depleting natural resource with continuous overuse and its geo-political supply chain has affected growth of developing worlds with price hike and tilt towards further poverty. Hence, agrarian developing economies globally, require rethinking on such supply-chain phenomena and must excavate and reset their priorities for sustainable supply of energy through indigenous resources, i.e., biomass, hydro, thermal, solar and wind.

Waste biomass and wild plant species with a high non-edible oil contents, i.e., wild almonds & cashew seeds, stone fruit family waste seeds, melon family seeds, rice-bran, neem, *Jatropha*, wild berries, jojoba varieties, etc., could become an alternate feedstock for biodiesel production through trans-esterification process. Moreover, with the reuse and recycling of waste edible oils (WLO) from restaurants and growing ever-growing fast-food industry could be another additional resource to overcome energy production and to arrest environmental degradation. In addition, further recovery or reuse of waste vehicular lubricants (WL) into a recyclable commodity can render a positive impact on environment, as well. In order to evaluate such potentials, a comprehensive study on the use of non-edible feedstock of *bitter almond oil* (BAO*), Jatropha,* and other wild seeds with high lipid contents for bio-diesel production was carried out with a minimal use of catalysts. Biodiesel quality was compared with Natural Diesel for its performance. Furthermore, the reuse of waste lubricating oil (WLO) into a useful by-product through trans-esterification followed by enzymatic reaction was compared with traditional acid-clay method for recovery and optimization.

To summarize results, waste biomass (Bitter Almond oil & assorted waste seeds) and WLO converted biodiesel was found within recommended International biodiesel standards (ASTM standards), i.e., acid value, flash point, kinematic viscosity, and copper corrosion etc. Based

on GC - FTIR analyses, the chemical and physical properties suits BAO to become a major feedstock for biodiesel production, followed by assorted stone-fruit waste seeds. Further, refinement and recovery of other products on glyceride-based products are being optimized and will augment natural product development for pharmaceuticals.

In case of Reclamation study by using Waste lubricating oils (WLO), the results exhibited the by-product as environment-friendly however, the processing method needed to be optimized to improve with a maximum reclamation or recovery of lubricating oil between 10-30%. In order to compare and evaluate transesterification process with other methods for reclaimed and waste oil, transesterification has shown promising results with 20-30% recovery with concurrent use of catalyst, however, to re-use the full potential of waste oil through by-product development, an additional step after chemical trans-esterification is being adapted in presence of fungal enzymes. For that purpose, algae & its enzymes are being tested for optimization of biofuel production. Coastline of Pakistan with rich algal population is also being explored to use this natural resource for biofuel production in our pilot projects at Bahria University, as well.

Keywords: Biofuel, Optimization, Waste Biomass & Cooking Oils, Waste Seed Oil (BAO), Waste lubricants (WLO), Transesterification, Catalysis, Acid-clay Methods, Algal Enzymatic Conversion, Reclamation.

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IMPACT OF CLEANING AGENTS ON EFFICIENCY OF ULTRAFILTRATION CERAMIC MEMBRANE FOR PRODUCTION OF CLEAN WATER

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ABSTRACT

A reliable application of cleaning protocols is imperative for optimal performance of water filtration through membrane. In this study, the application of strong chemical agents was examined for ceramic membranes. A series of experiments with artificial water solutions with foulants dextran and carboxymethyl cellulose were carried out. A conventional comparison of flux-TMP correlation to that of the clean water flux was used for analysing membrane performance. An additional increase in resistance of the membrane further to its natural resistance was taken as the major parameter for detecting the fouling on membrane. Conditions were effectively varied to observe their influence on water production as permeate. A comparative analysis for both foulants is reported. The relationship of fouling resistance vs. trans-membrane pressure for dextran was noted as linear whilst that for CMC there was a sharp change in gradient at 0.5 TMP. The existence of a flux on start-up below which a decline of flux with time does not occur was also noted for specified concentrations of the respective dilute solutions. Followed by an acid rinse, the application of combination of strong alkaline solutions with sodium hypochlorite as oxidizing agent was found to be appropriate for cleaning of the ceramic membrane. The outcome of increasing the temperature for cleaning agents along with a warm water rinse increased the cleaning capacity. These results which demonstrate the performance in membrane filtration are explained graphically.

Key words: *Crossflow; Flux; Membrane cleaning; Dextran; Carboxymethyl cellulose*

Introduction

Membrane fouling is the major factor responsible for the decrease in membrane efficiency by decreasing the water flux with time and increasing resistance. Being a notable problem in membrane filtration for clean water production, the membrane researchers of present times have been writing a lot on fouling. Fig. 1 shows an increasing trend in the number of publications published annually on membrane fouling since 2010 [1].

Fouling happens by submission of deposits to the membrane surface and/or inside the membrane pores and hence increases the resistance in addition to the membrane resistance (R_m). The performance of the membrane can be restored by efficient cleaning. This cleaning operation depends upon some factors mainly type of fouling and membrane material. This implies that membrane cleaning is an essential part of the

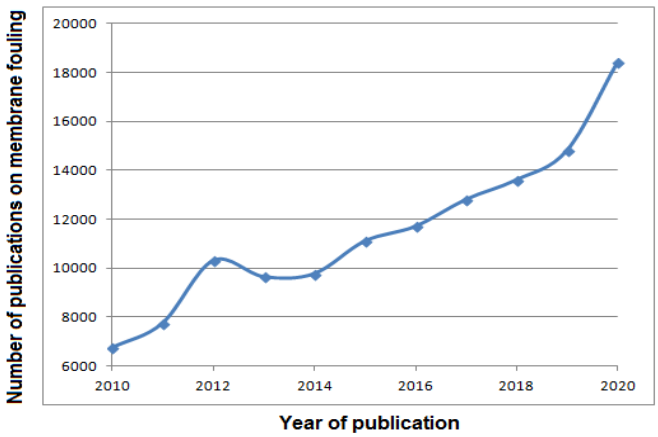

Fig. 1: Yearly number of publications on membrane fouling since the year 2010

membrane filtration operation. Normally, the cleaning procedure is advised by the manufacturer and hence the matter is not that well understood by most researchers. There are some factors which need prime importance like cleaning agent type, its concentration, cleaning time, its impact on membrane material etcetera. Inadequate handling of these cleaners and their procedure may affect the membrane operation for clean water production or in a severe case may damage the membrane.

Field et al. [2] categorized the cleaning agents used for cleaning microfiltration membranes into three broad categories: strong bases such as NaOH, strong oxidising agents i.e. NaOCl which is a source of free chlorine, and strong acids for which we used HCl here. They specifically described the mechanism of these agents as the strong bases brings change in pH and becomes responsible for increasing the electrostatic repulsion between membrane and the foulants. Hydrolysing the foulant is taken place is done by strong oxidising agents like NaOCl in our case. Since effectiveness of the cleaning agent is observed through the percentage recovery of the flux. It is widely accepted that cleaning is quite effective at zero trans-membrane temperature However; the crossflow velocity doesn't affect that much. The membrane cleaning chemicals have been widely divided into five categories namely caustic, oxidants/disinfectants, acids, chelating agents, and surfactants [3]. However, the hypochlorite normally remains a preferred choice because of multiple reasons including availability, price and efficient cleaning of bio-fouling. Previous researches reveal the successful cleaning operations for this fouling type. Maria and Lidia [4] working with the similar membrane type and fouling category found an effective cleaning action by using a combination of sodium hydroxide, phosphoric acid and sodium hypochlorite as a disinfectant to achieve an optimum recovery of the membrane properties. Ogunbiyi et al. [5] discovered an effective impact on microfiltration process in ceramic membranes through cleaning by using a combination of alkaline, hypochlorite and acid cleaning. They used solutions of caustic soda, sodium hypochlorite and nitric acid in different proportions and revealed a considerable increase in flux in the tubular membrane. Vanysacker et al. [6], through a comparative analysis with that of citric acid, realised that sodium hypochlorite has a significantly higher cleaning efficiency. Admitting the cleaning efficiency of hypochlorite solutions, controlled experimental conditions and precision in chlorine concentration is also very important as frequent use of these solutions weakens the membrane material and results in deterioration in the mechanical strength of membranes which may cause a much earlier loss in membrane integrity than that stated by the manufacturer [7].

This preliminary research focused on the cleaning of fouling from dextran and carboxymethyl cellulose for ultrafiltration ceramic membrane. An important part of the research was to look at how the cleaning agents work for such a fouled membrane when the foulants were firmly stuck to the membrane wall for clean water production which may be used widely for several purposes.

Conclusions

1. The application of a combination of strong alkaline solutions containing oxidizing agent (mainly sodium hypochlorite) followed by acid is found appropriate for cleaning of the ceramic membrane. The effect of increased temperature for cleaning agents followed by a warm water rinse contributes positively and increases the cleaning capability which ultimately increases the output i.e. clean water production.
2. The existence of a flux on start-up below which a decline of flux with time does not occur was found. It was of the weak form. The impact of concentration on fouling was greater for dextran than Carboxymethyl cellulose.
3. In comparison of solutions of carboxymethyl cellulose (CMC) and dextran, the former responded more abruptly for its flux for any TMP rise than the later and hence CMC has higher value of critical and limiting flux than dextran at same concentration and experimental conditions.
4. The resistance is widely accepted to be calculated through Darcy's law. The rate of change of foulant resistance with TMP is greater for dextran solution than CMC one. For dextran, a typical gradient does not change with TMP.
5. The applications of findings may be widely used as cleaning protocols for optimised water production through membrane technology.

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PHOTOPOLYMERIZATION OF ORGANIC-INORGAIC BASED SEPARATOR FOR ENERGY STORAGE DEVICES

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ABSTRACT

Photo polymerization allows to obtain of a highly cross-linked solid-state separator membrane that was designed for the use of energy storage devices. The electrolyte membrane was successfully fabricated by polymer and nanoparticles of ceramics the presence of UV photo-polymerization. The cross-linked solid-state membrane can accommodate a liquid electrolyte inside the membrane via strong interaction with lithium-ion and solvents. Solid-state Membrane shows much higher mechanical properties than pure PEO based separator. The fundamental function of ceramic nanoparticles is to support in building a stable separator interphase (SEI) and suppress the growth of dendrites. The prepared ceramic-based separator effectively renders to inhibit lithium dendrite growth in asymmetrical cell Li/SSE/Li test during charge/discharge at a current density of 2 $mAcm^{-2}$. In addition, the battery assembled of $LiFePO_4$/SSE/Li exhibits superior charge/discharge cycling. This provides a fundamental strategy that to improve the applications of energy storage devices performance.

Keywords: lithium dendrite, separator, photopolymerization

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SUSTAINABLE TEMPERATURE AND HUMIDITY CONTROL OPTIONS FOR AGRICULTURAL APPLICATIONS IN PAKISTAN

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ABSTRACT

For any nation, primary sources of energy consumption are involved in: heating, cooling, humidification, dehumidification, ventilation and/or air-conditioning (HVAC), which may be required for various applications. Currently, Pakistan is facing extreme energy shortage, therefore, low-cost and energy-efficient HVAC systems are principally required. As the Pakistan is an agriculture dependent country, therefore, low-cost HVAC systems are required not only for humans' thermal comfort but also for various agriculture based applications e.g. greenhouse air-conditioning, agricultural products' (fruits and vegetables) storage, and animals' (livestock) air-conditioning etc. In this regard, various innovative cooling and air-conditioning technologies have been introduced worldwide. Consequently, in this keynote speech, evaporative cooling and adsorption cooling based HVAC technologies are explored. These technologies are environmentally safe and can be simply operated by water or low-grade waste heat. The low-grade waste heat can be supplied economically by many ways e.g. solar thermal energy, natural coal, bio-gas and/or bio-mass etc. From the prospective of evaporative cooling, the speech focuses on Maisotsenko cycle (M-cycle) based evaporative cooling conception in comparison with conventional direct and indirect evaporative cooling. While adsorption cooling and desiccant air-conditioning systems are focused from the prospective of thermally driven systems. Importance of selection of refrigerant and adsorbent/desiccant is also highlighted. Based on geographic and climatic conditions of Pakistan, role of temporal and spatial variation for the development of sustainable HVAC system is addressed.

Keywords: Evaporative cooling; Adsorption cooling; Desiccant air-conditioning; M-cycle; Sustainability; Agriculture; Pakistan.

DESIGN ANALYSIS AND OPTIMIZATION OF STIRLING ENGINE BY ENHANCED METAHEURISTIC APPROCHES

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ABSTRACT

The importance of Stirling engine has proven the major contribution in thermal energy conversion technologies and waste heat recovery applications. In current study the design analysis and optimization of beta type Stirling engine was carried out with improved analytical model and enhanced optimization approaches. The enhanced optimization approach was developed by integrated strengths of Differential Evaluation (DE), Genetic Algorithm (GA), Simulated Annealing (SA) and reference point based Non-Dominated Sorting Genetic Algorithm (R-NSGA-II) with analytical Stirling design model. The model analysis results more than 3% and 20% increase in Stirling thermal efficiency and output power respectively.

Key words: Stirling engine, optimization, analytical modeling, metaheuristic approaches

Introduction

The energy scarcity, limitation in the use of fossil fuels and the impact of post pandemic (COVID-19) situation on the world embarked and shown new challenges also in energy conversion field. The ability to harvest energy from multi sources made Stirling engine technology more prominent in current era. The series of developments in design methodology of the Stirling engine has been reported but still the gap between theoretical and real thermal efficiency grabbed the intensions of the researchers [1].

The objective of the study is the development of designing approaches with the help of advanced computational and experimental methodologies. A prototype beta Stirling engine with rhombic drive mechanism was already developed and under experimental study by the authors [2]. In current work, the optimization model is strengthened by involvement another integrated optimization techniques wich combines the advantages of each metaheuristic approach and reduce the drawbacks to find the global and local minima for optimum system designing. The enhanced approaches are Differential Evaluation (DE), Genetic Algorithm (GA), Simulated Annealing (SA) and reference point based Non-Dominated Sorting Genetic Algorithm (R-NSGA-II) with analytical Stirling design model.

Methodology

A beta type prototype model is designed and manufactured as shown in figure 1. The solution methodology for the analysis and design optimization is presented in Figure 2. Thermal efficiency and output power were the objective functions and design parameters of heat exchangers were selected as decision variables during the engine analysis with enhanced optimization approach.

Figure 1 Rhombic drive mechanism of beta Stirling engine

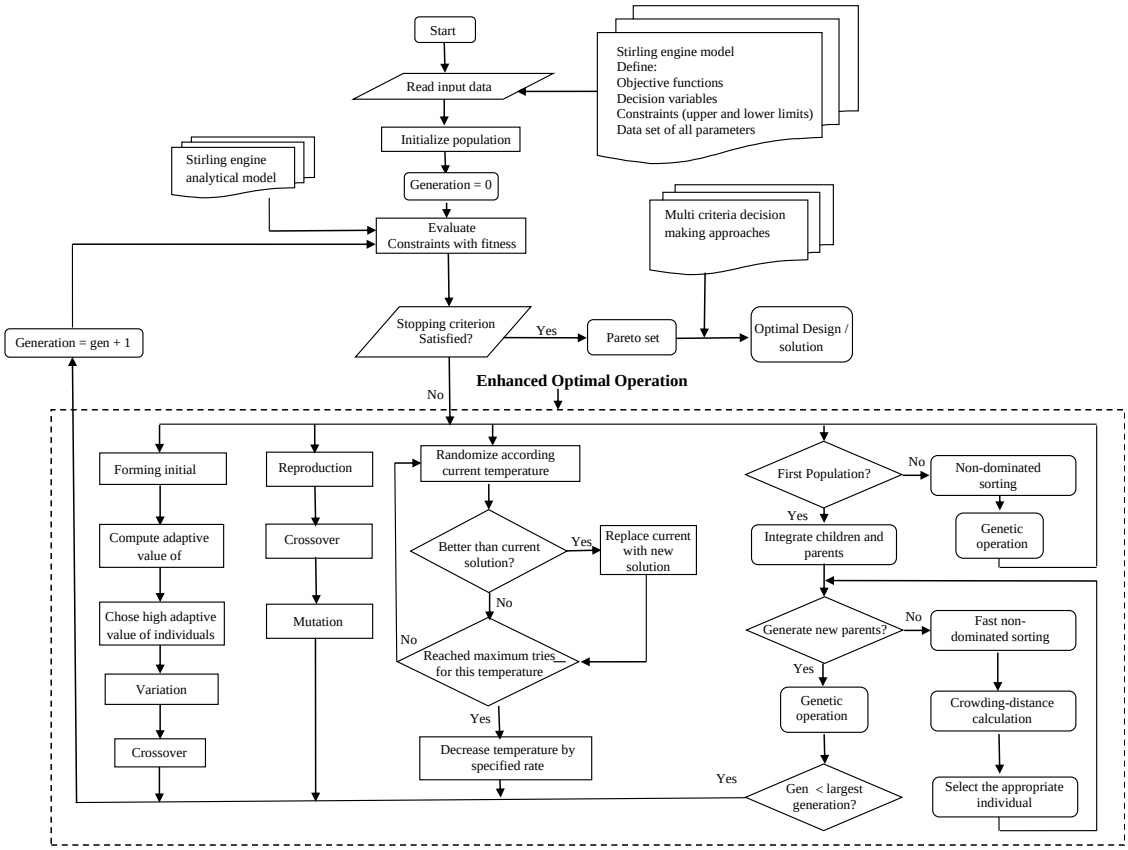

Figure 2 Logical diagram of enhanced optimization approach for beta Stirling engine

Results and Analysis

The engine analysis with enhanced approach of multi criteria optimization results good performance agreement at optimal parametric solution. The thermal efficiency and overall output power of the engine increased more than 3% and 20% respectively. The volume spaces (heater and cooler sections) are also reduced without affecting the performance curve of the engine.

Conclusions

This study revealed that the integrated version of enhanced metaheuristic approach has shown significant benefits for Stirling engine design analysis in terms of compact efficient engine design, optimization and performance evaluation. The development in analytical model of Stirling engine may also lead the real system design and exploration.

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STAINLESS STEEL AS SUSTAINABLE SOLUTION FOR GREEN ENERGY

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ABSTRACT

Stainless steel has proven indispensable to the renewable energy industry, and many of the advancements that have been achieved in the last several decades would not have been possible otherwise. For example, let's take a look at concentrating solar power plants. These are plants that rely on mirrors to focus sunlight onto a liquid in order to heat it. This process produces steam, which is then harnessed to turn turbines that produce electricity, in a similar way to how hydroelectric dams produce electricity. Stainless steel is crucial to such power plants. First of all, these plants tend to be in harsh environments with extreme heat and constant sunlight. Stainless steel's ability to withstand corrosion and high temperatures over many years is essential. The metal's natural hygienic properties are also important. Another important use of stainless steel is in wind turbines. Off-shore wind farms, which need to be able to endure highly corrosive marine environments, will often employ more than 10,000 tons of stainless steel. Even a regular turbine that could be found in any environment will often be made of stainless steel because of its lightweight, long life, and anti-corrosion properties. In the area of nuclear power, which is responsible for approximately 13% of the global energy supply, stainless steel is used for pressure tubes and in the containment unit that houses the nuclear reactor. The process of producing biofuels, such as ethanol, also relies on the corrosion resistance of stainless steel. Converting organic material into biofuels will involve a number of strong acids and other substances that are highly damaging to ordinary materials, but which will have little or no effect on stainless steel. Stainless steel has also been found to aid in sustainability when it is used in water pipes or pipelines. Compared with most other metals, stainless steel will maintain its integrity for much longer, reducing the amount of water or other liquid that is lost during the transfer and storage process.

Key words: *PIM, Stainless Steel, Corrosion resistance*

Introduction

Corrosion prevention of 316L stainless steel is significantly important for industrial applications. The parts produced from wrought alloys needs machining ,heat treatments and extra coating [1]. Therefore, residual stress appears during the machining process and carbide formations during the heat treatment process diminish the corrosion resistance of the parts. Currently, the parts produced through machining and casting need additional reinforcement of noble metals, carbides or coatings to protect them from corrosion [2, 3]. Based on the limitations of existing problems, an advanced fabrication technique is required to reduce the residual stresses and retain the maximum amount of chromium within the matrix and at the surface of the part. Presently, many industrial parts are produce from various metal alloys need reinforcement, heat treatment, machining and additional coating on the parts to enhance their mechanical properties and corrosion resistance [2, 4]. The advantage of the extant

research work is that it produces stainless steel material for various industrial applications without any additional heat treatment, machining and coatings by using the Powder Injection

Conclusions

The results showed that PIM is promising technique to fulfill the demand of various industries and the sintering parameters have significant effects on the mechanical, microstructure and corrosion resistance properties. The results also showed that the vacuum atmosphere along with higher post sintering cooling rate is responsible to achieve the optimum physical, mechanical enhanced corrosion resistive properties. Microstructural analysis of sintered test samples showed that porosity was decreased by increasing the post sintered cooling rate and by increasing the sintering temperature the pores become round, isolated and distributed within the matrix. Corrosion data measured by weight loss method showed that the minimum corrosion rate was 0.17 mpy with minimal leaching of metal ions.

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TAGUCHI OPTIMIZATION OF MACHINING PARAMETERS FOR AISI 304 STAINLESS STEEL USING A BIODEGRADABLE CUTTING FLUID

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ABSTRACT

Machining of hard materials produces a very high amount of heat due to friction between tool-work piece-chip interfaces. Therefore, the use of cutting fluids becomes significant for cooling and lubrication. Conventionally employed, mineral oil-based cutting fluids are required to be replaced by eco-friendly vegetable oil-based fluids due to the significant emphasis of current sustainability goals and make machining process environment friendly. Vegetable oils of the edible category have been mostly availed as cutting fluids to replace mineral oil-based cutting fluids. But using edible oils for machining can lead to disturbing the food supply chain. The aim of this research work is to utilize a non-edible vegetable oil-based cutting fluid and optimize cutting parameters including cutting speed, feed rate, and depth of cut. Castor oil will be used to formulate the new cutting fluid. Surface roughness will be considered as the performance evaluation criteria for the input parameters being cutting speed, feed rate, depth of cut, and type of cutting fluid.

Key words: Cutting fluids, Non-edible vegetable oil, Castor oil, Taguchi optimization, Surface roughness

Introduction

Stainless steel grade 304 has a wide range of applications. However, extremely large cutting forces are required to cut this material and surface roughness, built up edges, tool wear, and poor product quality is observed due to higher temperatures in the cutting zone [1].

Earlier in the 19th century, cold water was used as cutting fluid but due to poor lubricating capacity of water, mineral oils came into usage. These oils possess excellent lubricating as well as cooling properties resulting in excellent surface finish along with a remarkable decrease in friction. Throughout the world, engineering workshops are utilizing mineral oils for machining. These oils adversely affect the health of workers in machine shops by causing lung cancer, cough, asthma and other respiratory diseases and cause a huge contribution to environmental pollution when disposed of [2, 3]. Consequently manufacturing concerns must sink more money to dump them off effectively.

All the above concerns made researchers to hunt for some innovative ways of sustainable machining with more productivity [4]. So, the trend of utilizing vegetable oils as cutting fluids came into being. Many researchers used vegetable oils like coconut oil, palm oil, olive oil, canola oil, groundnut oil, walnut oil, and soybean oil etc. for turning, milling, and drilling [5].

The drawback of using edible vegetable oils is the harm to food chain. Hence this work consists of optimizing cutting parameters in combination with castor oil based cutting fluid for milling stainless steel grade 304 using the Taguchi method and analysis of variance to determine the most important parameters.

Methodology

Taguchi Method being the most robust design was utilized as the optimization method. Face milling operation utilizing coated carbide inserts and stainless steel 304 specimens was used for machining.

Machining was conducted using pure mineral oil and 5% and 10% blends of castor oil in mineral oil. The cutting speed was kept at 300, 350 and 450 m/minute. Feed rate was 0.05, 0.1, 0.15 mm/tooth and depth of cut was 0.5, 0.75 and1 mm respectively.
Taguchi L_9 (3^4) orthogonal array was utilized and face milling operation was conducted under mentioned cutting conditions. A portable MitutoyoSJ-210 surface roughness tester was utilized to measure the values of surface roughness. Minimum surface roughness was obtained using 5% blend of castor oil (as shown in Figure 1) at speed of 350 m/min, feed rate of 0.1 mm/tooth and 0.75 mm depth of cut.
ANOVA was conducted to find out the most significant cutting parameter. The type of cutting fluid proved to be the most significant factor for obtaining minimum surface roughness with 83.06% contribution. Cutting speed proved to be the second contributor with a contribution of 6.07% then came feed rate with a 5.59% contribution. The depth of cut had a minimum impact with a 5.28% contribution.

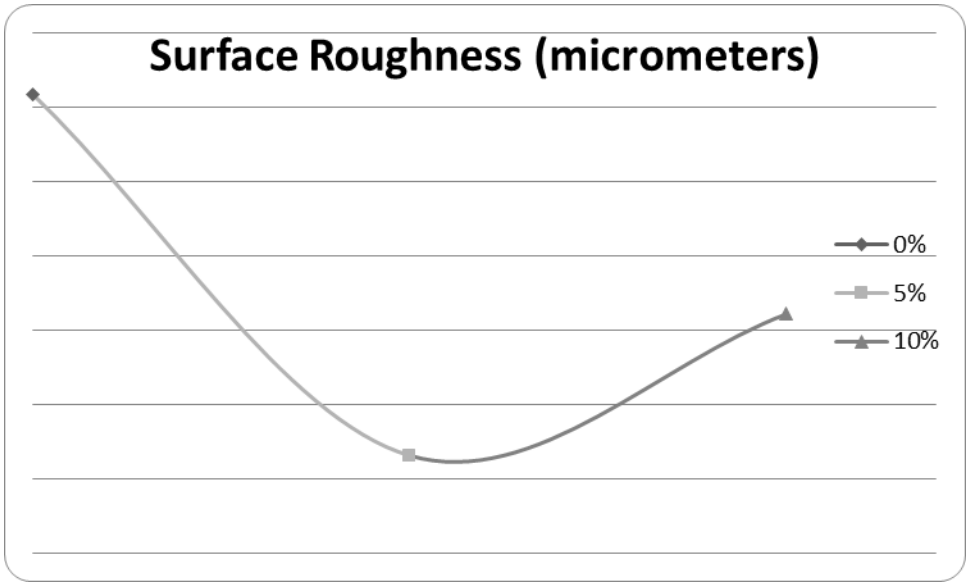

Figure 1: Variation in Surface Roughness at different Concentrations of Castor Oil in Mineral Oil

Conclusions

From the experiments conducted and results discussed, following conclusions have been made:

- Proper selection of cutting fluid along with adequate proportions of blends of vegetable oil is recommended.
- The mediocre values of cutting speed, feed rate and depth of cut produce best surface finish.
- ANOVA has shown type of cutting fluid to be the most significant factor.

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SURFACE-GROUNDWATER RECIPROCITY SCENARIOS FOR SUSTAINABLE IRRIGATED AGRICTURE IN RECHNA DOAB

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ABSTRACT

Pakistan is inherent by world largest continuous flow surface irrigation system. Unfortunately, it operates at very low efficiency, resultantly groundwater becomes parallel option for irrigated agriculture. In present study a groundwater model was developed for selected area of Rechna Doab using Arc-GIS and MODFLOW software. Three different pumping scenarios were simulated to predict the most viable option for sustainable irrigated agriculture. It was analyzed under scenario-D that abstraction from shallow groundwater areas may be promoted to create a balance between aquifer discharge and recharge. Present research work can facilitate the policy makers for identification of sustainable solutions related to groundwater depletion and waterlogging concerns. Future study may be extended to incorporate the vertical zoning of groundwater quality.

Key words: Groundwater, Surface water, Rechna Daob, Modflow

Introduction

World largest gravity driven irrigation system is situated in Indus Basin. Illegal use of canal water by head end farmers and substantial loss of water due to seepage create variation in surface water supply in Pakistan [1]. Presently, system operates at low efficiencies and high cropping intensities, and groundwater contribute as alternate source during critical stages of crops. Groundwater demand is increasing from head to tail whereas annual rainfall, groundwater recharge and canal water supplies are decreasing from head to tail due to climate variability [2]. Anomalies in groundwater recharge and discharge can cause serious threat to irrigated agriculture. If the groundwater abstraction exceeds the natural groundwater recharge for extensive areas and long times, over exploitation or persistent groundwater depletion occurs [3]. Therefore, present study was conducted to identify the most viable option for surface and groundwater management to attain sustainable irrigated agriculture in Rechna Doab area of Punjab, Pakistan.

Methodology

Hydrological geo-data base was developed using Arc-GIS for 0.515Mha and groundwater flow model with 1000m x 1000m resolution, 123 columns, 110 rows and four layers was developed in MODFLOW. The time variant data of evapotranspiration, river, recharge, and tubewell were incorporated for 16 stress periods. Three pumping scenarios were undertaken for 24 years (2013-2037) i.e., Scenario-P involved simulation of current groundwater abstraction, Scenario-Q, twenty percent more abstraction from fresh groundwater zone and twenty percent more supply to hazardous groundwater zone, Scenario-D, twenty percent more abstraction from shallow groundwater zone and twenty percent more supply to deep groundwater zone.

Results and Analysis

Groundwater depth varied from 1 m to 19.47 m toward tail end with an average slope of 0.14 m/km. Simulated model reveals improvement in groundwater depth at the rate of 4.3 x 10^4 m^3/d while total inflow and outflow into model domain is about 1.09 x 10^6 m^3/d and 1.047 m^3/d, respectively. The recharge rate into model domain was 6.3 x 10^6 m^3/d and discharge from aquifer was 5.75 x10^6 m^3/d. Current groundwater situation presents that there was no intimidation regarding aquifer mining or water logging under current normal climatic conditions. However, there is need to manage groundwater to maximize productivity and manage salinity for sustainable irrigated agriculture in variable climatic conditions. Scenario-Q revealed that groundwater would decline more rapidly in fresh groundwater zone in the range of 0.22 to 0.33 m/year and groundwater level would rise in range of 0.15 to 0.24 m/year in shallow groundwater areas at the head reach. According to Scenario-D, groundwater would rise in all irrigation administrative units in the range of 0.028 to 0.2 m/year. Under Scenario-D, groundwater level would rise from 2 to 4.6 m in different irrigation administrative units in 24 years (2013-2037).

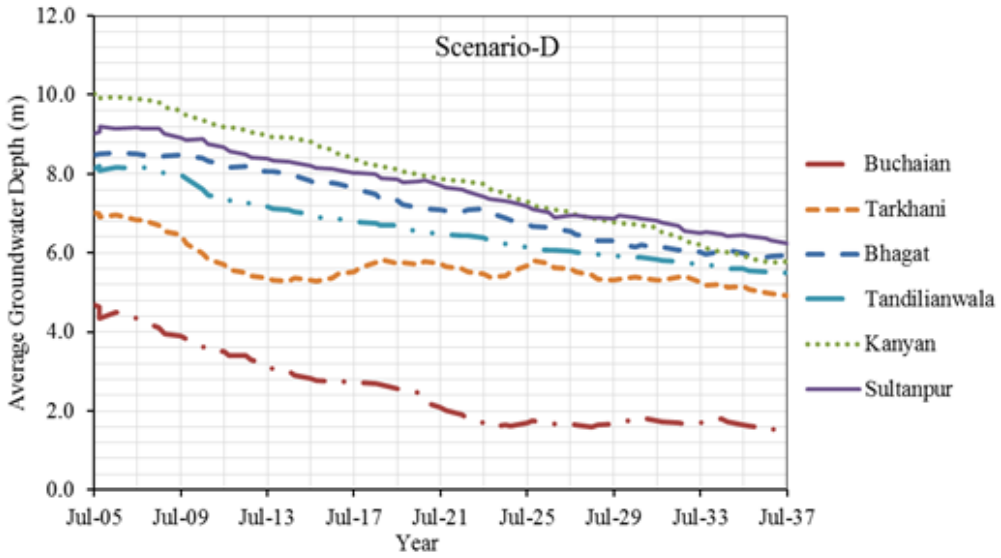

Figure 01: Groundwater depth zone (Scenario-D) future prediction

Conclusions

Study concluded the Scenario-D as most suitable strategy in curtailing the inequity of irrigation water in head-tail end perspective which otherwise stretched due to spatial climatic variability. Abstraction from shallow groundwater areas may be increased by 20 percent to manage water logging in head reach. It is suggested that extra pumped groundwater may be shifted to tail area by mixing with canal supplies or in any other economical way.

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ABSTRACTS

PRODUCTIN OF BIODIESEL WITH METHANOL USING KOH CATALYST BY TRANSESTERIFICATION TECHNIQUE

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ABSTRACT

Fossil fuels are used in abundance today to meet global energy demands. But since they are limited and depleting very fast mankind needs to find ways for finding and developing new sustainable and renewable energy resources like biofuels. These biofuels are based on carbon neutral cycle which will help in reducing Green House Gases (GHGs). This study is put forth to develop biodiesel by making Alkyl Ester through transesterification process and blending it with ordinary diesel. The blends are produced in such a way that they exhibit physio-chemical properties same as diesel and can run common diesel engine without any modification. Canola seed and methanol is used for the preparation of Alkyl Ester in the presence of Potassium Hydroxide (KOH) as a catalyst. Temperature of the reaction is maintained at 65 °C, the molar ratio of Methanol/oil is 6:1 and concentration of the catalyst is 1.1 wt. %. Blends of biodiesel and conventional diesel with various percentages, i.e., 5 %, 15 %, 25 %, 35 % and 45 % by volume are prepared. Nissan RD28 diesel engine is used for testing of the blends under speed ranging from 1000 RPM to 3500 RPM under an incremental increase of load. It is noticed that the brake fuel conversion efficiency of B35 is nearly same as that of the conventional diesel at all engine speeds. At 3000 RPM, B15 has 7.6 % more brake torque and 7 % more brake power than that of conventional diesel. When the speed was raised to 2500 RPM, 50 % lower brake specific fuel consumption was observed for B25 blend.

Key words: Biodiesel, Renewable Energy, Transesterification, Carbon footprint reduction

DESIGN OF OPTIMUM CUTTING CONDITIONS THROUGH ARTIFICIAL INTELLIGENCE TO REDUCE ENERGY CONSUMPTION IN ABRASIVE CUT OFF OPERATION.

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ABSTRACT

An intelligent grinding machine has been designed which operate on optimum feed rates to reduce specific energy consumption. Using the experimental data, feed rates have been optimized using artificial neural network and integrated with machine controller. Operating at optimum feed rates, enabled to reduce energy use and associated carbon emissions.

Key words: *Specific energy consumption, optimization through neural network, intelligent cut off grinding machine*

Introduction

Significant portion of carbon emissions in manufacturing is attributed to the energy consumed in metal cutting[1].To reduce energy use in machining, optimization of cutting conditions through artificial neural network is considered as most efficient way[2]. Grinding is one of the most energy intensive process, and numerous efforts have been conducted to reduce the energy use through neural networks[3].However, the integration of neural network with controllers to operate machines on optimal cutting conditions is very limited for grinding. In a few studies, significant effort has been made to design the artificial neural network based grinding machine controller to achieve the good surface finish[4], but reducing the energy use through optimizing the input parameters has not been attempted for stock removal grinding process. The present research brings forth a novel idea to reduce the energy consumption in grinding through artificial intelligence. An intelligent grinding machine based on neural network controller has been designed and manufactured to cut the materials based on their optimum feed rate, hence reducing the associated energy use and emissions.

Methodology

A combination of experimental data of different materials and artificial neural network technique has been employed to design the experimental set up that has capability to remove material from work piece at optimum feed rate. Using the experimental data of specific energy consumption at various feed rates for abrasive cut off operation, an artificial neural network has been created, tested and validated in Matlab. The optimum values of feed rates obtained through ANN, have then been integrated with controller which will operate machine on optimum feed rate based on the energy consumption through power analyzer.

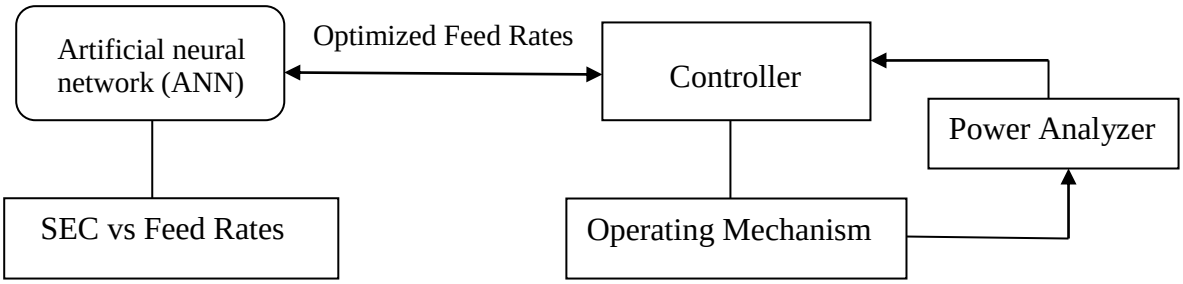

Fig 1. Frame work of neural network integration with machine controller

Results and Analysis

Sample data of specific energy consumption has been used to find out the optimum feed rate which resulted in minimum energy use without compromising tool life. The materials tested for optimum cutting conditions are Copper, S235JR, Al 1100 and Inconel 718. The optimum feed rate for copper and Al 1100 was 1.488 mm/s. For comparatively hard materials, like S235JR and Inconel 718, the optimum feed rate reduced to 0.899mm/s. The correlation coefficient between the experimental and predicted results was found to 0.90, which indicated the good accuracy of neural network models .The accuracy of solution increased as data set point became large.

Conclusions

Designing the abrasive cut off machine based on artificial neural network integration with controller, is a useful technique to reduce energy consumption by cutting materials on optimum feed rate. The optimum values of feed rate for minimum energy consumption indicate that this experimental set up is suitable for brittle materials at comparatively medium feed rates.

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DESIGN AND MODELLING OF A DOMESTIC SOLAR GEYSER INTEGRATED WITH PARAFFIN-WAX PHASE CHANGE MATERIAL

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ABSTRACT

Due to this natural gas shortage in the country, solar geysers have become viable options for domestic use. However, a solar geyser can only provide hot water during the day and is temperature dependent. A phase change material integrated solar geyser is a good solution that stores the thermal energy for later use and can provide hot water even at night. Phase change material integrated solar geyser is still a very new concept in Pakistan and no commercial model is available in the common market for people to buy for domestic use. This paper aims at designing an efficient model of a phase change material integrated solar geyser for a small to average family in Pakistan that uses 100 litres/day for washing and bathing purposes. This study emphasizes on what should be the criteria for choosing the most feasible phase change material and can be useful in helping fabricate a commercial model of solar geyser with phase change material that can provide hot water round the clock.

Key words: solar geyser, phase change material, paraffin wax

Introduction

With stagnant natural gas production of 4000 mmcfd since 2011 in the country, the gas shortfall is expected to increase further [1]. The supply demand gap is expected to escalate to over 5.6 bcfd in 2025 [2]. Hence developing an alternative system for heating and hot water supply that does not consume natural gas can be of great benefit. Although producing solar thermal energy is done for solar heating in various parts of the country, effective storing of this thermal energy is a challenge. A major drawback of solar geyser is that it cannot store the solar energy and is only effective during the day. Solar heating is weather dependent; hence, an efficient thermal storing system is needed to make heating available during variable temperature conditions especially at night. One solution to this problem is the use of an integrated phase change material (pcm) for storing thermal energy. Few studies have attempted the use of pcm in Pakistan for energy storage. In Pakistan, Waqas et al attempted to use salt hydrates as pcm based solar space heating for residential use [3]. Furthermore, Malik et al used Potash Alam as the pcm for solar thermal energy storage system [4]. Also, Hasan et al compared the use of pcm integrated solar system at various locations to find that pcm based solar system are more feasible in hotter climates like Pakistan [5].

This study aims at designing a feasible cost effective model for domestic purposes that can serve as an alternative for gas geysers using paraffin-wax as pcm. The various parameters are determined for the pcm integrated solar geyser for a small to average family consuming 100 Litres/day for washing and bathing purposes only. Currently, no commercial model of pcm integrated solar geyser exists in the market in Pakistan. This design shall prove beneficial for commercialization of the model for availability for the people of Pakistan in winters.

Methodology

The main components of a pcm integrated solar geyser are a solar collector, a pcm chamber, a water tank and a temperature regulator shown in schematic diagram below. In pcm integrated solar geyser, during daytime, the solar radiation falls on the solar collector. The incident radiation is received and collected through solar collector array to heat water. At the same time, this solar energy is absorbed by the pcm storage unit and raises the temperature of heat transfer fluid. The hot temperature of the heat transfer fluid causes a change of state of the pcm. A huge amount of energy (latent heat) is stored

during the change of phase. At nighttime, when solar energy is no longer available, pcm releases its stored energy to heat the water whose temperature is maintained by temperature regulator.

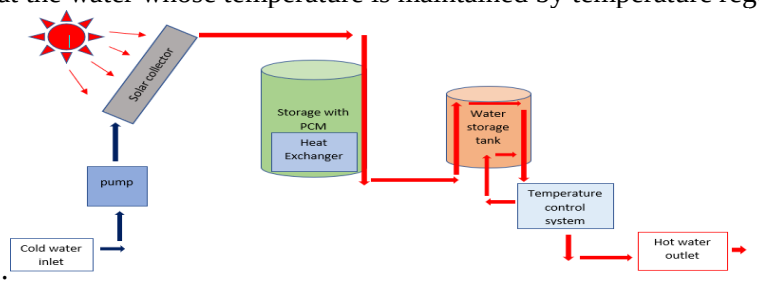

Figure 1: Schematic diagram of the processs

Results and Analysis

Paraffin wax is used with latent heat of 190 KJ/kg. Assuming 100litres is required to be heated for nighttime, amount of heat generated is 10467.5KJ/kg and mass of pcm needed to generate this heat is calculated to be 55.1 kg. With water flowrate of 1.2 m^3/sec, pump power of 30W is needed to pull water at height of 30 feet. Total thermal storage capacity of pcm at constant pressure is 11020 KJ. This yields that collector yield/day is 2.55KWh/ m^2 with collector area of 12.23 m^2.A design model of a pcm integrated solar geyser is prepared with phase change material as paraffin wax. Properties of paraffin wax like high latent heat, specific heat and storage capacity make it suitable as pcm. From the mathematical model calculations, it is expected that a total of 55kg of paraffin wax in 25 tubes can be used in pcm storage chamber to generate heat of 10467 KJ/kg. This can help provide 100 litres of water for the night at a temperature of 45˚C. The paraffin wax can be melted in 150-180 minutes as shown in figure below and can store sufficient heat to make this model a feasible model.

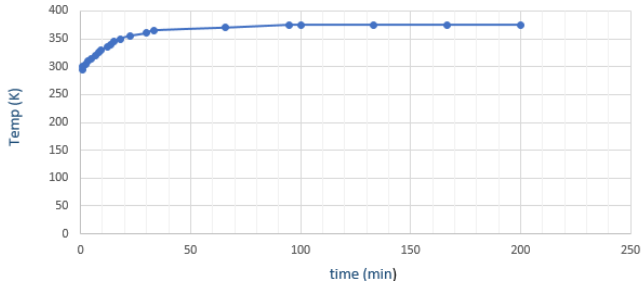

Figure 2: Melting behavior of Paraffin-wax

Conclusions

The pcm integrated solar geyser has the capacity to be used as an alternative to natural gas geyser. Pakistan faces natural gas shortage which leads to gas shortage in many cities. A pcm integrated solar geyser is a viable solution which can store the solar energy in the form of thermal energy with the help of pcm. This can make hot water avaible throughout the day irrespective of the time or weather. Pakistan is still new to this technology and commercial models are still not as popular. According to this study, for an average family that uses 100liters/day, a pcm chamber with 25 tubes containing 55 kg of paraffin can be utilized to store enough energy to provide hot water at 45˚C at night time. Parffin wax is used as a pcm due to its high latent heat and melting point close to desired temperature. The pcm melting time is approximately 150 minutes. The design proves to be a good alternative for domestic heating application for an average family in Pakistan. The next step should be to fabricate the model to test the design and assess the true feasibility of the model.

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BIOGAS PRODUCTION AND ENHANCEMENT FROM COW DUNG THROUGH BIOLOGICAL MEANS

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ABSTRACT

Pakistan is among the countries which are facing serious challenge of energy crises. Use of alternate energy sources is need of the day. Biogas energy is cheaper and environment friendly alternate source. Farm wastes are abundantly available in 65% rural settings of Pakistan and can be used to generate biogas. However improvement of quality and quantity of biogas around the year is a big barrier for successful adoption of technology. In present study NARC-inoculum (consortium of already isolated and tested bacterial strains: *B. dimunuta, P. bauzanesis* and *B. paramycoids*), Chinese inoculum and Digestate inoculum were tested for biogas production along with un-inoculated control. Cow dung with pH 7.2 and C: N ratio 22 was used as substrate in 20 L batch reactor. Results revealed that inoculated treatments produced 8 times more volume (25-35 L) of biogas than control (2.7 L). Methane content in control treatment ranged from 15-45% and in inoculated ones from 30-60% during study period. Maximum cumulative biogas was produced by NARC-inoculum (35.3 L) followed by Ch-inoculum (32.5 L) and D-inoculum (24.8 L). Without inoculation only 2.7 L biogas was produced. Results showed that bacterial inoculation enhanced biogas production.

Key words: *biogas, Methane, cow dung, bacterial inoculant, bio-slurry*

Introduction

Pakistan is facing energy crises since last couple of decades and its demand is increasing at tremendous pace. Energy is life line of the economy of a country. The conventional energy reserves of Pakistan are diminishing constantly and oil import bill is increasing year by year. Pakistan fulfils 99% of its energy needs from conventional energy sources, while renewable energy contributes merely up to 1% [1]. Renewable energy is a form of energy occurring naturally and can be replaced with time scale. Renewable energy include; wind, biogas, tides, rain, geothermal heat and sunlight etc.

Biogas energy obtained from bio-based technologies can play a vital role in mitigating energy crisis. Huge amount of agricultural waste including animal waste and crop residue is being generated in the rural areas of Pakistan. Similarly, urban landfills also receive million tons municipal waste annually. Irrational dumping and un-controlled decomposition of these organic wastes is causing environmental pollution. Biogas/bio-methane produced by anaerobic digestion of agricultural and farm wastes, is a cheaper and environment friendly alternate energy source which can play key role in supplementing the energy supply particularly in rural areas. The present study focused on enhancement of quantity and quality of biogas production from cow dung through the introduction of efficient biodegrading bacterial strains as bio-inoculant in bioreactors.

Methodology

A lab scale study was designed to examine the consortium of already isolated and tested bacterial strains: *B. dimunuta, P. bauzanesis* and *B. paramycoids* labeled as NARC-inoculum with comparison to Chinese inoculum (Ch-inoculum) donated by Lanzhou University, China and digestate inoculum (D-inoculum) consisting of bioslurry from biogas plant of NARC. The experiment was conducted in the batch reactors of 20 L capacity fitted with valve and storage assembly. Fresh cow dung slurry (C: N ratio 22 and pH 7.2) + water (1:1 ratio) was used as substrate and all reactors were filled up to 14 L while rest space was kept unfilled for gas collection. Inocula were added @ 7.5% in respective treatments at start of experiment except control. Bioreactors were kept at 37±2 °C in the incubator for 40 days. Biogas was collected in storage bags and measured in special stopper bags of known capacity

in term of volume with 10 days intervals. The methane contents were analyzed on gas analyzer (Geotech-5000).

Results and Analysis

Biogas production started during first week of incubation and periodically recoded with an interval of 10 days for 40 days (Fig. 1). Results showed that at day-10, all inocula treatments produced significantly higher biogas quantity (6.5 L by NARC-inoculum, 6.4 L by Ch-inoculum and 5 L by D-inoculum) compared to control (0.5 L). Similar trend of biogas production was recorded in second interval of 10 days (10 L by NARC- inoculum, 9.05 L by Ch- inoculum and 7.65 L by D-inoculum compared to 0.6 L by control). Statistically similar results were observed during third interval of 10 days. However, in fourth interval of 10 days, a decline in biogas was recorded in all inocula treatments. Minimum decline was observed in NARC-inoculum (8.95 L) followed by Ch- inoculum (8 L) and 4.85 L by D-inoculum (Fig. 1).

The results of cumulative biogas production for 40 days are illustrated in Fig. 2. Results revealed that NARC-inoculum treatment produced maximum biogas (35.35 L), followed by Ch-inoculum (32.55) and D-inoculum (24.85 L). Biogas production by control was only 2.7 L in 40 days. Hence NARC-inoculum performed best among all. Rabia et al. also observed as increase in biogas production by adding digestate inoculum in bioreactor [2].

Results regarding methane percentage in biogas revealed maximum rise in methane percentage (50%) by D-inoculum and Ch-inoculum on day-10. It was followed by NARC-inoculum (30%) and minimum methane percentage (15%) was by control .i.e. slurry without any inoculum. At day-20 methane percentage of all treatments were increased; maximum (60%) by D-inoculum and Ch-inoculum, followed by N-inoculum (45%) and 30% by control. At day-40 the methane percentage of biogas produced by Ch-inoculum and N-inoculum was similar (60%). However, there was a decline in methane percentage of D-inoculum biogas from 60 to 45%. This showed that Ch-inoculum and NARC-inoculum sustained compared to D-inoculum. The reason is that Ch– and N-inoculum have isolated and tested biodegrading bacteria as compared to D-inoculum which contained diversified microbial community. Minimum rise in methane percentage (15 to 45%) was observed in control.

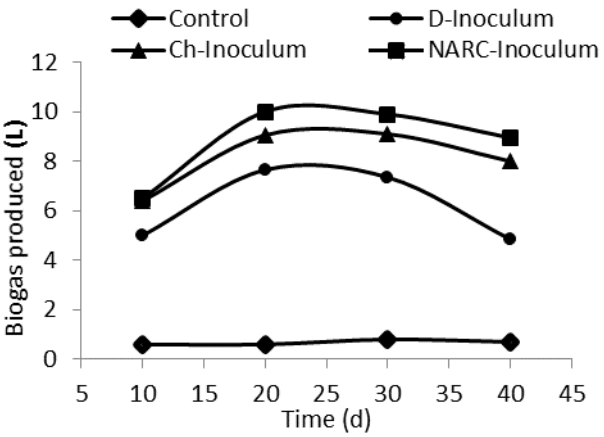

Fig.1. Biogas produced at different time intervals by various inocula with different additives

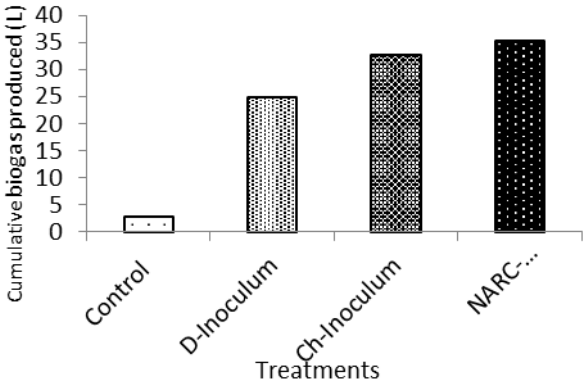

Fig. 2. Cumulative biogas production

Conclusions

It was concluded from the results of the study that inoculated treatments performed better than un-inoculated control. Hence quantity and quality of the biogas produced can be enhanced by using microbial inoculum.

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ENHANCEMENT OF THERMAL ENERGY STORAGE USING COPPER MESH IN PARAFFIN BASED PACKED BED

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ABSTRACT

Due to intermittent nature of the solar energy, a continuous supply of the thermal energy can be provided by storing the extra available energy. In this study charging time of Thermal Energy Storage based on Latent Heat storage is studied numerically. The objective of this study is to decrease the charging time of a packed bed latent heat thermal energy storage which was integrated with the solar water heating system. Thermal energy storage unit contained paraffin as Phase Change Material (PCM) which was filled in spherical capsules. Initially Water was used as heat transfer fluid, then refrigerant R-134 and R-22 were also used as Heat Transfer Fluid (HTF). The comparison is in terms of their thermo-physical properties was also performed. Results showed that using Refrigerants as HTF decreased charging time. It was also observed that edges of packed bed were melting much slower than remaining bed. Therefore, in order to increase heat transfer in the edges, some geometric modifications are also discussed in which the addition of copper mesh is investigated.
Key words: *Thermal Energy Storage, Latent Heat Storage, Phase Change Material, Packed Bed*

Introduction

Renewable energy is under focus nowadays after the rapid increase in the emissions of the greenhouse gases. Solar Power is considered one of the most important types of renewable energy [1]. Solar Energy is captured by the solar collectors and Photovoltaic Cells. Photovoltaic Cells captures solar energy [2] and then converts into electricity that can be used or stored in batteries. Solar energy is not only used for generating electricity, but it can also be used for other purposes including domestic and commercial water heating and heating spaces in winters [3]. For that purpose, energy is captured using solar collectors. But this energy is intermittent in nature. Also, there is mismatch between the available solar energy and required load. This mismatch can be overcome by storing solar energy [4]. This solar energy can be stored using thermal energy storage. To use Thermal Energy Storage, there are two basic methods, Latent Heat storage (LHS) and Sensible Heat Storage (SHS). SHS is the most commonly used method, in this type of heat storage method, water may be used as heat storage systems. These types of units provide space heating. SHS has low heat storage capacity per unit volume or energy density and its non-Isothermal behavior during charging and discharging makes it less effective as compared to LHS [5]. LHS have high energy density and it can store the heat at same temperature. LHS materials are known as Phase Change Material or PCMs [5]. The objective of this work is to study the effects of HTF and copper mesh on the charging time of Packed Bed of Encapsulated PCM.

Methodology

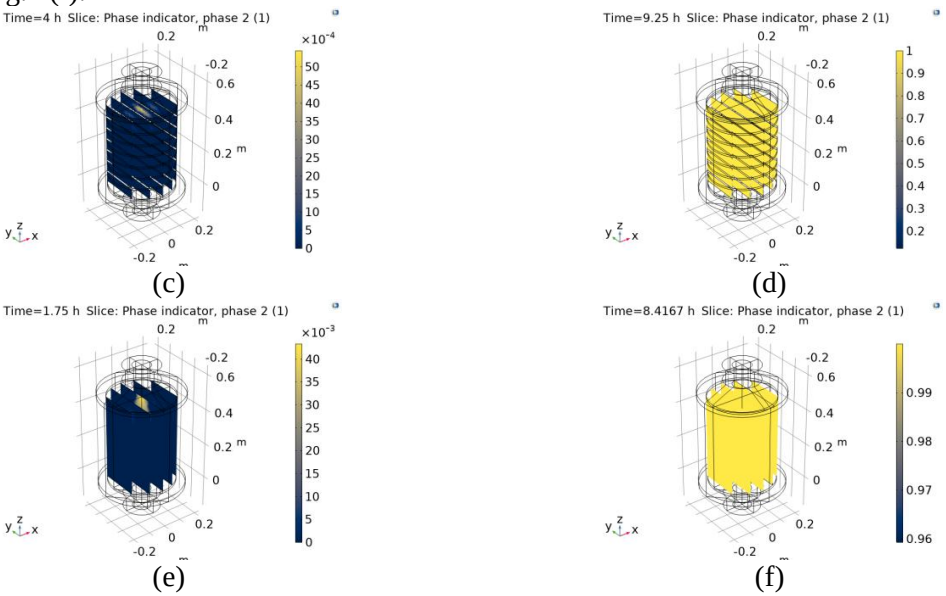
COMSOL Multiphysics was used to numerically solve this model. Experimental results of [5] were used to validate the present mathematical model. This thermal energy storage (TES) configuration consists of cylindrical packed bed of paraffin encapsulated in spherical HPDE capsules. Paraffin packed bed is insulated with glass wool as shown in fig. 1(a). Packed bed cylinder has height of 470 mm and radius of 180mm. whereas encapsulation has diameter of 55mm. Thickness of insulation is 50 mm. This TES is charged with heated HTF from solar collector. Which is continuously, giving 375W to HTF for heating. Three different types of HTFs were used to study the charging time of the TES. The edges of packed bed took much longer time than the rest of the bed to melt. In order to decrease the charging time, heat transfer near the edges must be increased, which was done by adding copper mesh in the z-direction at every 55mm. Thickness of mesh was 10mm, mesh size was 10x10mm as shown in fig 1.(b).

(a) (b)

Fig. 1 (a) Model of packed bed PCM module. (b) Copper mesh added in packed bed.

Results and Discussion:

Fig. 2(c) and fig. 2(d) below shows that melting began at 4 hours and was completed at 9.25 hours when copper mesh was used. There was 15.9% reduction in charging time when copper meshes were used. The Phase state of PCM at Starting time and ending time melting for R-22 is presented in fig. 2(e) and fig. 2(f).



(c) (d)

(e) (f)

Fig 2. (c) Melting started at 4 hr. with copper mesh (d) Melting finished at 9.25 hr.
(e) Melting started at 1.75 hr. with R-22 as HTF (f) melting finished at 8.4167 hr.

Conclusions

The obtained results showed that, charging time of PCM can be reduced by selecting HTF with high thermal diffusivity. When R-134A was used as HTF charging time was reduced by 20.45% and by 23.63% when R-22 was used as HTF. Charging time can be also be reduced significantly by increasing heat transfer near the boundaries. Which was done by adding layers of copper mesh at every 55mm along the z-direction. This copper mesh helped to melt the PCM near the boundaries in the much less time. Charging time was reduced by 15.9% when copper mesh was incorporated.

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THE EVALUATION OF FIXED AND AUTOMATED SHADING DEVICES ON ENERGY PERFORMANCE OF COMMERCIAL BUILDINGS: A STUDY CONDUCTED IN THE CLIMATIC CONDITIONS OF LAHORE

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ABSTRACT

The commercial buildings are using huge amount of energy to heat, cool and light the space and to maintain thermal comfort. One of the reason for this high energy consumption is the façade design of these buildings. Window is one of the significant component of building façade as it provide high air leakage and least insulation point in the façade. In order to solve this problem, world needs buildings which require lesser energy to maintain the ideal conditions and are energy efficient. In hot climate like that of Lahore, excessive amount of heat gain occurs due to increased WWR and glazed facades. Energy efficient / high performance facades, therefore, do not have entire glazing. Rather, windows of such facades must be designed carefully to increase the insulating capacity and decrease air leakage simultaneously. Shading is a passive strategy which increase the resistivity of window and can make it energy efficient. And shading control patterns increase the efficiency of such windows and facades. This research is carried out to understand the efficiency of moveable /automated shading device over conventional fixed shading device on energy performance of a window opening. The simulation is conducted for the climate conditions and geographical values of Lahore with a semi-arid climate. The results of the simulation showed that the installation of moveable shading devices always reduce the energy consumption in the buildings more as compared to the conventional fixed shading and is always advantageous. The benefits of the moveable / automated shade is evident on all orientations.

Key words*:* Energy Consumption, Automated Shading Devices, Energy Performance, Semi-Arid climate

Introduction

The world is changing very fast. There is a change in lifestyle of people all over the world. This change in lifestyle along with the increasing population is causing an increase in energy consumption in various sectors of life. [1] Building sector is note able in this respect as it is responsible for 40% of energy consumption and 19% of GHG gas emissions.[2] A considerable contribution in this excessive energy consumption has been made by commercial buildings due to entire glazed facades which have become a trend all over the world. The building envelope is a barrier and must acts a modifier between outdoor and indoor climate. [3] There is a need to design façade which must respond to outdoor climatic conditions. Window is an important element of façade design as it is a weak thermal link in the façade. Window needs to be carefully designed as it is responsible for the heat gain as well as heat loss.[4] Solar control can provide an optimal solution to counter excessive heat gain and heat loss through windows. Shading is a way to add solar control value and to increase the resistivity of windows. All kinds of shading devices can help but automated shading has some extra benefits over the conventional fixed shading. This research is conducted in the semi arid climate of Lahore in order to investigate the role and benefits of shading systems in commercial facades specifically focusing on automated shading sytems.

Methodology
The study is conducted through computer simulation and façade is modelled in a software named as comfen. The name "Comfen" is derived from commercial fenestration and is well suited for the research. As the target is the commercial building and the issues related to the energy consumption through glazed surfaces. The scenarios are created with managing different parameters of window design. Some of the parameters like WWR and glazing material have remained constant and the type of shading systems vary in each scenario.
Results and Analysis
The designed scenarios are simulated on cardinal orientations and results are discussed in terms of energy use breakdown, annual energy consumption and glare control. The results show that the automated exterior shading performed better as compared to conventional fixed shading systems. The efficacy of automated shading observed to be highest on east and west orientations where sun angle is low. The installation of external automated shading reduced the temperature of the room by 5^{o}C on west orientation. The solar gain through window can be reduced to 10% of incident radiation on façade by installation of automated shading device. Results show that the amount of daylight entering the room is not reduced due to automated shade as compared to fixed shading and glare is also reduced.

Conclusions

The energy efficient or low energy buildings have become a topic of concern and research these days. Reason is that natural resources are depleting day by day and we need buildings which require less energy to operate and maintain comfort level. In this context, dynamic facades are being discussed as they respond to the changing external conditions well. Automated shading device, therefore, is taking lead over fixed shading devices. The automated shading device is highly efficient to control glare and enhance daylight level, resisting excessive heat gain simultaneously. Its efficacy is best on east and west orientations with low solar angles. These benefits are a step forward from the benefits of fixed external shading. However, the performance of automated depends upon robust construction and requires high maintenance.

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AUTOMATION OF A BIOGAS PLANT FOR EFFICIENCY AND SAFETY IMPROVEMENTS

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ABSTRACT

The objective of this study is to limit human monitoring, increase efficiency, develop, and analyze real-time data collection system. For this purpose, Arduino, and an automation system based on Wi-Fi was installed at the biogas plant site where this study was conducted. Temperature and pressure sensors were installed on the digester whereas, the humidity sensor was attached with the biogas filter. The maximum temperature of the digester was recorded to be 44^0C while the minimum was 31^0C. The pressure was recorded at 880 psi at the digester. The highest composition of methane (i.e., 55%) was recorded at 3 PM with a digester temperature of 44^0C having moisture contents of 93% and after passing through the humidity filter moisture contents were reduced to 35%. The lowest composition of methane (i.e.,48.1%) was recorded at 7 am with a digester temperature of 31^0C and consisting of 95% moisture contents which was reduced to 37% after the humidity filter.

Keywords: biogas, automation, temperature, pressure, humidity

Introduction

Due to the energy crises, the economy of Pakistan is very much disturbed [1]. This shortage of electric power affects the backbones of the economy such as agriculture, trading, import, export and businesses also the domestic spheres [2]. Pakistan has 0.159 billion animals' producing nearly to 0.652 billion kilograms of dung every day which can produce 0.0163 billion m^3 bio methane daily and 0.021 billion tons of fertilizer every year. Pakistan has installed many biogas plants, where the security, safety and technical measurements have not been the point of attention. Here we present a solution to enhance the efficiency and safety of the installed biogas plants.

Materials and Methods

Automation of the biogas plant was achieved by installing aforementioned sensors at the specified points as depicted in Figure 1.

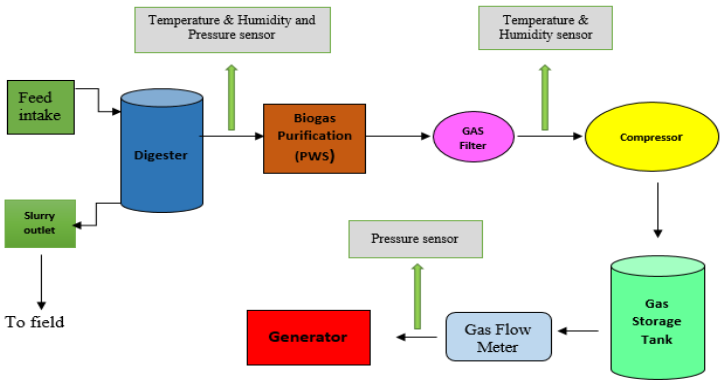

Figure 2: Block diagram of the biogas plant and installed sensors

Results and Discussion

Temperature effect on biogas generated Anaerobic organisms are highly affected by temperature. As the temperature is increases the performance of microorganisms enhances. During the day when temperature increased to 44 ^{o}C a 55% of CH_4 recorded. The lowest percentage of CH_4 was noted with a digester temperature of 31 ^{o}C. A similar trend was observed for the case of CO_2.

The humidity sensor served as an indicator for the quality of biogas being generated. The moisture content of the biogas from the digester was reduced by passing the gas through the gas purifier when silica gel was utilized to absorb moisture. The humidity sensor also indicates when the silica gel is to be replaced to further reduce the moisture level.

The installed sensors not only provide real-time data for the biogas being produced but also serve as indicators in case of failure of an equipment in the system. Automation of such plants may also provide new avenues for efficient biogas production and safety.

Conclusions

As a result of automating the intalled biogas plant at UAF main capmus, it was observed that as temperature of the digester increases the production of gas also increases. The maximum production of gas at a temperature of 38 ^{o}C to 45 ^{o}C. It was also obtaserved minimum amount of biomethane produced resulted when the temperature of the digester was the lowest i.e., 31 ^{o}C. The humidity sensors were applied to observe the percentage of produced biogas and also to check if the humidity chamber was operating properly. If the the moisture content of the biogas coming out of the humidity chamber was not significantly reduced, this would indicate that the chamber requires maintainance and that the silicon present within the chamber has to be dried prior to further treatment of biogas.

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TECHNO-ECONOMIC CHALLENGES OF INTEGRATING RENEWABLE ENERGY PROJECTS IN NATIONAL GRID OF PAKISTAN: A CASE STUDY OF 500 MW SOLAR PLANT

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ABSTRACT

Due to the constant increase in urbanization, population, and industrialization in Pakistan, the national energy demand is constantly increasing. This has resulted in a tremendously increasing load on the national grid. Due to outdated infrastructure, the current grid of Pakistan cannot bear that load. Further, the integration of intermittent renewable energy sources such as solar and wind will also cause serious issues. Merely building new infrastructure and supply lines will most probably not solve the current crisis, and hence a smart automated system is needed to meet this ever-increasing demand. This study describes the major technical and economic challenges faced while integrating a large scale 500 MW solar plant with the national grid of Pakistan. The plant will be simulated using the solar radiation figures for the City of Multan. Modeling was done using current and planned transmission which was not previously designed for handling intermittent renewable generation. The results from the study indicate that the power generated by up to 500 MW systems can be evacuated to 220 KV systems of the National Transmission Distribution Center (NTDC) without any transmission limitation. Further, the study also proposes how to overcome the major challenges and barriers faced in this integration. They are mainly divided into both technical and economic barriers which will occur to replace the outdated current grid infrastructure with a completely new one.

Key words: Smart Grids, Renewable energy integration, Pakistan energy sector, Energy Modeling

Introduction

Current energy sector of Pakistan is completely centralized with big thermal based power plants that controls up to 65% of total electricity generation [1]. Because of their large size, the power plants are placed at some specific locations from where the electricity is transmitted through big transmission and distribution lines. Now because of the recent shift observed in power sector, decentralized systems are getting more and more importance. The biggest advantage being that they can be of any renewable energy source such as wind, solar, biomass, or etc [2].

The conventional energy system is highly reliant on fossil fuels. Not only Pakistan is deficient in natural reserves of these fuels, they also pose serious environmental and economic constraints. This has further accelerated the growth of renewables across the globe. Initially, renewable energy plants were directly connected since they were small and could be controlled by use of induction control systems such as squirrel cage in case of wind turbines. But with an increase in plant size and capacity, control parameters have become more complex and it is now a dire need to intelligently control these parameters. The main advantages of using renewables is the dependency on indigenous resources and reduction of environmental loading [3].

However, the shift in renewables is linked with many technological and economic challenges. There is a very high infrastructure cost and more importantly renewable energy sources are intermittent in nature which means that a complete energy sector cannot solely rely on them. Further, the renewables have a larger dispatch time which has made the whole system more heterogenous and difficult to control [4]. Especially for a country like Pakistan, where energy crisis is already a burden on economy, the challenges are far greater.

Hence, based on the literature, a comprehensive approach is needed to answer the above-mentioned challenges and elaborate the linking facts. This study presents the technical and economic challenges in integrating a 500 MW renewable system with voltage and frequency harmonics as main parameters. This study can then be used as a pathway for designing policies that can integrate

Methodology

This section covers the methodology adopted to perform the assessment and various sources through which the data was collected. As already mentioned, the electricity demand of Pakistan is constantly increasing due to demand driver. IRENA solar flux was used to integrate into a hypothetical national grid through which the system was analyzed. Then mathematical modeling approach was used to perform energy assessment.

Results and Analysis

This study performs techno-economic assessment of integration of a 500 MW solar powered plant for city of Multan. Further, the study also checks the major limitations the system would suffer for integration with smart grids. Modeling was done using current and planned transmission which was not previously designed for handling intermittent renewable generation. The results from the study indicates that the power generated by up to 500 MW systems can be evacuated to 220 KV systems of NTDC without any transmission limitation. Reactive power of the system was maintained at 132 kV by through maintaining power factor in NTDC within range of 95%. During loading of the components, transformers and lines were loaded below the maximum ratings. For power evacuation of this voltage, National Transmission Distribution Center and MEPCO Pakistan will be responsible. NTDC will evacuate using 220 kV transmission line and MEPCO would evacuate with 132 kV network.

Conclusions

This system integration will pose both financial and technical challenges since the development of smart grids in Pakistan is not even in the initial stages. The biggest challenge will be the investments required to bring such a large change i.e., the transition from a conventional outdated grid structure to a completely new system. Further, a significant number of technical challenges will be there including training personnel and integration of renewables due to their intermittency.

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OPTIMIZATION OF THERMAL PARAMETERS OF A MOLD FILLING PROCESS IN AN INJECTION MOLDING OPERATION

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ABSTRACT

This research study is focused on optimization of thermal working parameters in injection molding operation to improve the quality of plastic products. Thermal parameters play a key role in plastics product in injection molding process. The values of thermal working parameters depend upon the type of plastics, the dimensions of product and dimensional tolerance etc. Confronted with world-wide competition in injection molding industry, determining the process parameters in injection molding operation is no longer good enough by using trial-and-error approach. Quality features may vary due to shifting of process conditions or drifting during production caused by machine wear, operator fatigue or environmental change. Determining optimal process thermal working parameters settings critically effects quality, production's cost and productivity in manufacturing. This work aims at to optimize the quality of a car side mirror plastic cover by balancing the diverse thermal working parameters. The quality of car side mirror plastic cover is improved by using response surface methodology (RSM) with design of experiment (DOE). Optimum parameters are associated with quality to produce product without hard fitting, air bubbles, flow marks and black dots. Plastic product of Acrylonitrile butadiene styrene (ABS) material is produced with 450 tons injection molding machines with different injection pressure, melt temperature, flow rate and viscosity. This research work is applied on injection machine inj02 450 tone which has major defects rate that was counted as 35% of total rejection before optimization. After optimizing the thermal working parameters, more than 50% process has improved and this rejection reduced to 16% of total rejection.

Key words: *Thermal parameters, RSM, DOE, Injection molding, injection pressure.*

Introduction

In plastics injection molding, plastic material is used in the shape of granules or pellets while manufacturing. This raw material is heated at certain temperature to be melted. This molten material is then inserted in mold cavity where it is solidified to get the chosen shape of molded part. At that moment, the molded part is cast out by mound opening[1]. The thermal working parameters such as injection pressure, melt temperature, viscosity of molten material and material flow rate are need to be optimize to produce a good quality plastic part. Response surface methodology (RSM) with design of experiment (DOE) is eminent method which delivers a well-organized procedure for optimization. This method is generally used for optimization of design of products and process all over the world[2]. Due to this advantage of (RSM) with (DOE), that contain possibility of study of interface and simplification of experimental plan among various thermal parameters. Cause and effect matrix as well as analysis of variance (ANOVA) are constructed to determine which thermal working parameters are most critical and substantial [2]. Through the cause and effect with ANOVA analysis, optimum working parameters could be prophesied[3]. The process development in molding process, design of experiment (DOE) is used to find the working parameter of machine which has substantial influence on output of injection molding operations. The convenient way in injection molding machine set-up depends upon trial-and-error method or technician or operator's experience[4]. This molded part has many complaints and poor feedback from customer that disturb the customer's relation with company. So, we focused on quality of this part and searched a way to improve the

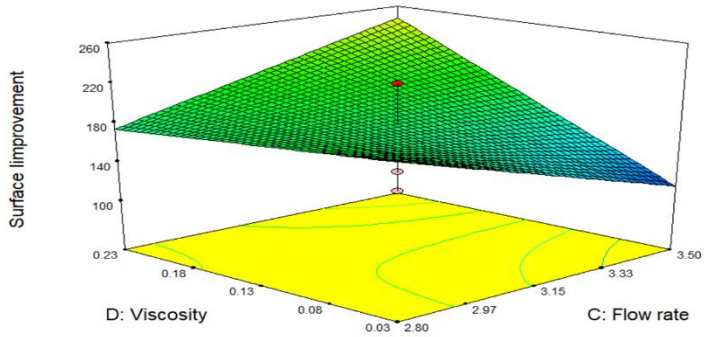
quality of such molded part for future[5]. The quality of this product is improved by adjusting responsible working parameters that are melt temperature, injection pressure, viscosity and flow rate.

Methodology

Response surface methodology (RSM) is well-known method optimization and model prediction [38]. Through this method, relationship between various process parameters and the response would be determined according to desired criteria and the value of parameters would be studied in the relevant response. In design of experiments (DOE), full factorial is used with two levels and four factors. Four independent thermal working parameters are studied in this research include melt temperature, injection pressure, flow rate and viscosity of molten material. These thermal working parameters are optimized through Design Expert software (version 7.0.0) and ANOVA test as well as RSM plots are constructed.

Results and Analysis

We have identified root cause of hard fitting, black dots, air bubbles and flow marks in analyses phase. In analyses phase, the root cause of these defects was identified to be the working parameters. Design of experiment (DOE) can be used to adjust these working parameters. To identify key input variables, cause and effect matrix was used to improve output variables in process. It was found from cause-and-effect matrix that nine input variables were included and only four out of nine as well as one output variable will be tested through DOE.



Problem	After	Before
Hard Fitting	52	270
Flow marks	55	120
Black dots	48	122
Air bubbles	40	85
Flashes	13	85
Colour line	6	73

Conclusions

In this research study, thermal working parameters are optimized to improve the quality of injection process. Response surface methodology (RSM) with design of experiment (DOE) was successfully applied to optimize the thermal working parameters. We concluded that these poor-quality products affected the company reputation time, money and efforts are lost when poor quality product is wasted, recycled and reworked. Design of experiment (DOE) was used to find out working parameters which would produce number of defects that were injection speed, melting temperature and injection pressure. This improvement is achieved by more than 50%.

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PERFORMANCE EVALUATION OF PHASE CHANGE MATERIAL (PCM) BASED FREE COOLING SYSTEM

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ABSTRACT

Greenhouse emissions around the world are increasing day by day due to increase in demand of global energy utilization in buildings for different purposes. Large portion of energy is used for heating, cooling, and air conditioning purposes in buildings. Phase change material (PCM) can be used to store cold during night time which can be used during day time for lowering the temperature of buildings also known as free cooling. This paper presents the mathematical modelling and experimentation under real time weather conditions of PCM based free cooling system using Lauryl Alcohol. Results of mathematical model and experimental results were compared and percentage error was 4 to 4.5%. Moreover, to analyze the performance of PCM based free cooling system three other PCMs were selected under suitable melting point range i.e, RT22HC, RT25HC & RT27 at three different air inlet velocity i.e, 1, 2 & 3 m/s. Charging time of all PCMs can be reduced 50 to 55% at higher air inlet velocity (3 m/s) and discharging time of all PCMs can be increased 55 to 60 % at lower air inlet velocity (1 m/s). On the basis of above results optimum air inlet velocity was selected for charging and discharging process to evaluate best suitable PCM for free cooling.

Key words: *Phase Change Material, Free Cooling, MATLAB*

Introduction

Buildings utilize 40% of the total global primary energy out of which 20 % is consumed by HVAC system [1], [2] contributing in the degradation of the environment. Researchers are working to minimize the energy demand for buildings which is consuming most of it on cooling and heating operations. A lot of work is being done on free cooling as many phase change materials (PCM) can be used to store cold of night as latent heat of fusion and during day time this can be used to reduce the temperature of building, this energy storage is called as latent thermal energy Storage [3].

This paper presents modelling & experimentation of a PCM based free cooling system. Mathematical model was developed on MATLAB and validated by experimental results and performance evaluation of three selected PCMs was done on same mathematical model to analyze the results and to choose the best suitable PCM for free cooling applications.

Methodology

1-D steady state mathematical model of heat exchanger was developed using MATLAB to study the performance of different PCMs i.e, Lauryl Alcohol, RT22HC, RT25HC & RT27 under different conditions. In mathematical model enthalpy method was used to solve the heat transfer between heat transfer fluid (HTF) and different phase change materials (PCM). For analyzing and evaluation length of PCM was divided into three parts, conduction & convection was studied in the first part while in second and third part conduction process was studied.

Experimental setup for PCM based free cooling was established using Lauryl Alcohol as PCM. Main parts of the experimental setup include data logger, air blowers, K type thermocouples and heat exchanger which contains aluminum tubes in which PCM was encapsulated. Figure 1 demonstrates the location of main parts and photograph of setup during experimentation.

Results and Analysis

Validation of Results:

Figure 2a shows that Lauryl Alcohol phase transition from sensible to latent heat in experimental and MATLAB results is around at 22.5 ˚C and 23.5 ˚C respectively at 150 to 160 min during charging process. Figure 2b shows that during discharging process phase transition of PCM from latent to

sensible heat for experimental results and MATLAB Results can be observed at 65 and 67 min respectively. Error between experimental and MATLAB Results shown in Figure 2a and Figure 2b was calculated and it was 4 to 4.5 % by using percentage error calculation formula.

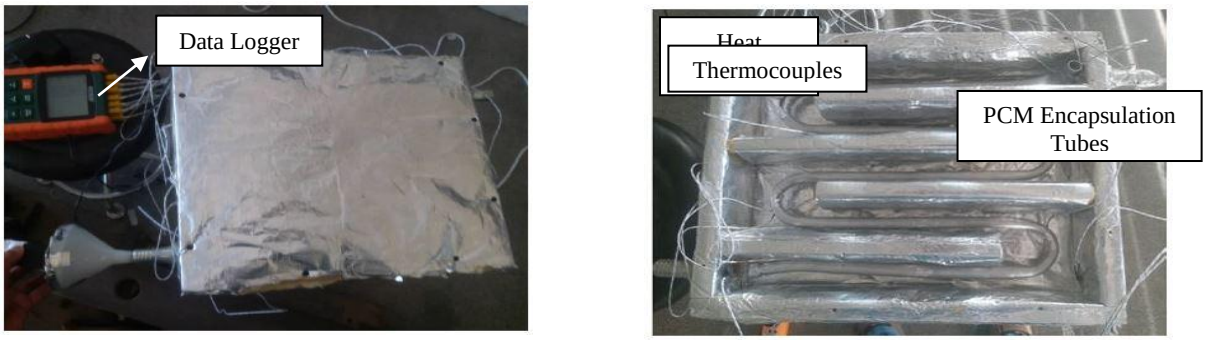


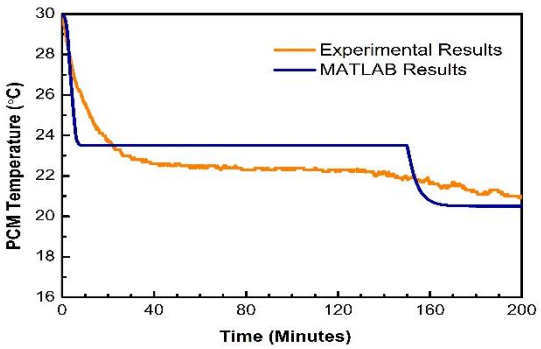
Figure 1: Main Components and Real Time Photograph of Setup

Air Inlet Velocity Selection:
Optimum velocity was selected among inlet velocity 1, 2 & 3 m/s for selected PCMs i.e, RT22HC, RT25HC & RT27 so that charging time during night time can be decreased and discharging time during day time can be increased. Charging time of PCM can be decreased at higher air inlet velocity while discharging time of PCM can be decreased at lower air inlet velocity.
Therefore, for charging process air inlet velocity of 3 m/s whereas for discharging process 1 m/s was selected as optimum velocity of air to analyze performance of all selected PCMs.

Conclusions

Comprehensive study and experimentation on performance of PCM based free cooling indicate the impact of inlet air velocity on overall performance and to choose the best suitable PCM for free cooling applications

a) Mathematical model was validated by performing the real time experiment using the same properties of PCM and heat exchanger. Percentage error was calculated for mathematical model and experimental results which was 4 to 4.5%.
b) Performance of three other PCMs were evaluated using the same numerical model & at three different velocities i.e, 1, 2 & 3 m/s.
c) On the basis of above results optimum air inlet velocity was chosen to analyze the performance of PCMs so that suitable PCM can be selected for free cooling that PCM RT27 takes shortest time to charge and longest time to discharge i.e, 50 and 250 minutes respectively as compared to other PCMs.



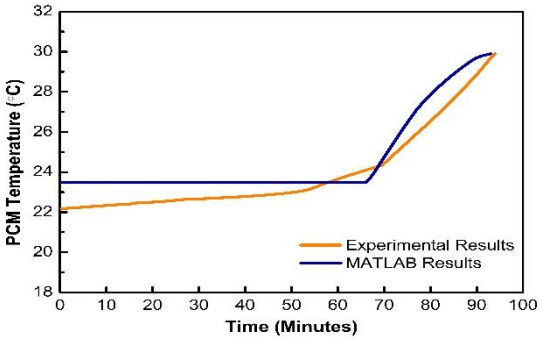


Figure 2a: Charging Process Comparison **Figure 2b: Discharging Process Comparison**

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GLOW IN DARK CONCRETE: A STEP TOWARDS CONSERVATION OF ENERGY

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ABSTRACT

This research aims to develop a glow in the dark concrete by producing glowing aggregates, to use on floorings, stairs, and ceilings. The concrete appears very dark at night, and a pedestal cannot detect the way, slopes, and steps; thus, accidents may happen at night. Glowing aggregate concrete helps to detect the paths at night and reduces lighting costs and accidents. So, to achieve sustainability and economy, we need to use glow in dark aggregates in concrete. For this purpose, the exposure of phosphorescent pigment applied to coarse aggregates and its afterglow has been studied. The compressive strength was conducted. The aggregates were coated with different percentages of glow in the dark powder to find the best glow. Different ratios of concrete were considered to check the economics of specimens. Glowing aggregates give lower values of compressive strength as compared to control samples. The durability of the glow can be achieved by using a sealant. The higher cement content can be used to avoid the reduction in compressive strength. The utilization of glow in dark concrete can help in the conservation of energy by keeping bulbs off at night and providing safety against falls and accidents.

Keywords: *Glow-in-dark aggregate 1, Phosphorescent powder 2, Strontium aluminate 3*

Introduction

Though concrete is largely used material, plain concrete is not aesthetically very appealing. At night, concrete appears very dark, and pedestrians cannot detect the way, slopes, stairs etc., without street lights. Many accidents happen at night due to dark streets. Typical unshielded streetlights are also thought to be energy-inefficient. If we introduce such aggregates that glow in the dark, it creates visible ways, stairs, and slopes. The same can be done for ground and rooftops to comply with the paths. The energy consumption due to street lights and bulbs can be reduced by utilizing glow in dark concrete.

Bruijn (2010) introduced a method for making concrete, which contains small light giving a piece of glass consisting of light-giving pigments [1]. According to Zhao *et al.* (2013), Luminescent concrete absorbs sunlight during the day, and stores light energy; in the dark, it emits the stored light energy in the form of light. [2]. Giuliani and Autelitano **(**2014**)** conducted the research. Among 2 pigments, i.e., strontium aluminate and zinc sulfide, Strontium aluminate exhibited a longer glow and better properties [3].Gavgani (2017) produced concrete with titanium and sulfide powder, along with zinc sulfide [4].

This study's main objectives are to produce indoor and outdoor lucent aggregates of concrete that glow in the dark and make concrete aesthetically pleasing

Experimental Methodology

The samples were prepared using OPC, fine aggregates, coarse aggregates, white/ transparent paint, and phosphorescent powder (strontium aluminate). The paint was mixed with Phosphorescent powder, 20%, 30%, and 50% by weight of paint. The first coat of plain enamel paint and the second coat of prepared paint was applied on aggregates containing phosphorescent powder. Three mixes were prepared for each composition i.e. (1:2:4 and 1:1.5:3).

Results and Analysis

Paint with 20% phosphorescent powder on aggregates glowed visibly only for 1 hour 30 minutes. For 30% of phosphorescent powder, the glow was for 2 hours, and for 50% powder, the glow was for 3 hours (Figure 1). A faint glow was noticeable for the whole night. Figure. 2 presents the compressive

strength of the samples. For samples of concrete (1:2:4), the compressive strength was reduced by 18%. Similarly, for samples of concrete (1:1.5 :3), compressive strength was reduced by 15%.

Figure. 1 Glow in Dark Samples (up: night, down: day)

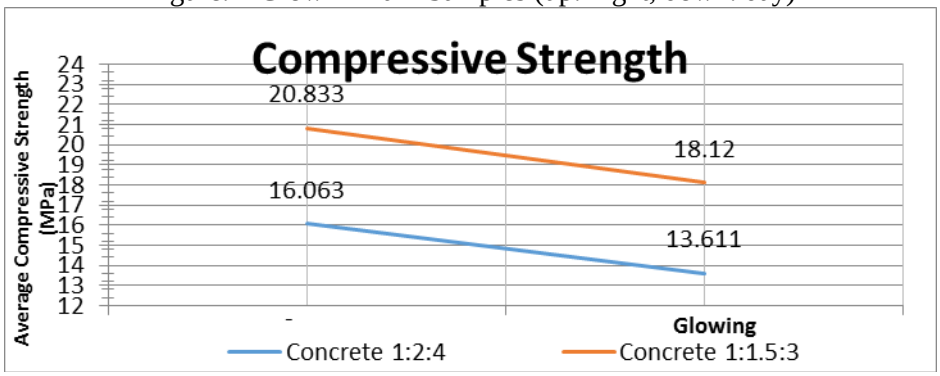

Figure 2 Compressive Strenght of Glow in Dark Samples

The compressive strength was decreased due to paint on the coarse aggregate, making the aggregate surface polished and smooth. The decrease in compressive strength can be compensated by using higher cement content.

Conclusions

Based on this research, the following conclusions can be drawn:

- The compressive strength of the control sample (1:2:4) was decreased by 18%, and for the control sample (1:1.5:3) was decreased by 15% in the case of the glowing sample.
- By increasing the duration of exposure, the duration of glow was increased.
- Such glow in dark concrete is acceptable and feasible to be used. It can imply toward slopes and steps without switching on light bulbs, leading to energy conservation.

Acknowledgment

The research work was financed under grant No 21-1673/SRGP/R&D/HEC/2017 awarded to Dr. Maria Idrees. Special Thanks to Anika Tauqeer for helping in experimentation.

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MULTI-OBJECTIVE OPTIMAL REACTIVE POWER DISPATCH CONSIDERING THE INTEGRATION OF PROBABILISTIC WIND AND SOLAR POWER

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ABSTRACT

The exponential growth of unreliable renewable power production sources in the power grid results in hard to regulate reactive power. The optimal reactive power dispatch (ORPD) problem is formulated to compute voltage level, transformer tap ratio, and MVAR injection of shunt var compensators (SVC) values in the power system. The ORPD problem is a multi-objective problem, therefore, in this paper, simultaneous minimization of active power loss, voltage deviation, and operating cost of renewable and thermal generators are considered the objective functions. Usually, renewable power generators such as wind and solar are uncertain. Hence, probabilistic mathematical modelling such as normal, Weibull, and lognormal probability distribution functions (PDFs) are implemented to model the generation and demand to generate 1000 scenarios with the Monte-Carlo simulation (MCS) techniques. Afterwards, to reduce the computational burden, a scenario reduction technique is applied to pick 24 representative scenarios. These 24 scenarios are solved by using an efficient constrained coevolutionary multi-objective optimization (CCMO) algorithm. IEEE 30 bus test system is considered to achieve effectiveness and superiority of CCMO. Three stochastic study cases have been analyzed in the simulation results. Simulation results indicate that the proposed algorithm is used to detect the optimal global solution of the ORPD problem.

Keywords: *Optimal reactive power dispatch, Operating cost of power, Multi-objective optimization, Renewable energy resources*

Introduction

World global environment regulations have constituted more significant contests to the thermal power generation industry because they emit hazardous gases into the atmosphere. On the other hand, renewable energy sources (RES), especially wind and solar, have taken substantial attention from both industry and academic circles in recent years. They didn't create greenhouse gases such as NO_x and SO_x [1] in the atmosphere. Integration of uncertain RES into the power system causes difficult to control reactive power. Massive power system components such as transformers and transmission lines largely depend on reactive power consumption and generation. Therefore, optimal reactive power dispatch (ORPD) has a more significant impact on the power system's planning and operation. In the literature, various Multi-objective evolutionary algorithms have been implemented to solve ORPD problem and the summary of the surveyed literature is given in Table I.

Table I. Summary of Literature review of MOORPD

Algorithm	Test system	Nature of Problem	Constraint Technique	Objective Function
MEAASS [2]	30	Deterministic	Penalty function	P_{LOSS} & VD
TPEM [3]	14 & 30 Bus	Stochastic/Deterministic	WSA	P_{Loss} & VD
ICA & PSO [4]	57 & 118-bus	Deterministic	Penalty function	P_{Loss} & VD
MODEA [5]	33 RDS-	Deterministic	Penalty	P_{LOSS} & VD

	Bus		function	
2ArchMGWO [6]	30, 57 & 118-bus	Deterministic	Penalty function	P_{LOSS} & *VD*
MCGT [7]	39-bus	Deterministic	ECM, WS & GP	P_{Loss} & *VD*
ABC-FF [8]	14 & 39-Bus	Deterministic	Penalty function	P_{Loss} & *VD*
NSGA-III [9]	57-bus	Deterministic	Penalty function	P_{LOSS} & *VD*
SHADE-EC [10]	*30 & 57-bus.*	Probabilistic	ECM	P_{Loss} & *VD*
MOEP [11]	30 bus	Deterministic	Penalty function	P_{LOSS}, *and VSI*
GAMS [12]	57 bus	Probabilistic	ECM & FSA	P_{LOSS}, *and VSI*
QODEA [13]	30, 57 & 118-bus	Deterministic	Penalty function	P_{LOSS}, *VD and VSI*
MOALO [14]	30, 57 & 300-bus	Deterministic	FR	P_{LOSS}, *VD and VSI*
MOICA [15]	30, 57 & 118 bus	Deterministic	CDP	P_{LOSS}, *VD and VSI*
APO-PSO [16]	30, 57 & 118 bus	Probabilistic	Penalty function	P_{LOSS}, *VD and VSI*
GAMS [17]	30 & 118	Probabilistic	Epsilon Constrained	P_{loss}, *O&M of WT, VSI*
TLBO [18]	30 &118-bus	Probabilistic	Linearization	P_{LOSS}, *VD*
SMO-OD-CRPR [19]	30-bus	Probabilistic	ECM	*LM* & reserve power
ECM [20]	30-bus	Probabilistic	ECM	Cost, P_{LOSS}, *VSI*

ECM=epsilon constraint method, CDM=constraint domination principle, FR=Feasibility rule, FSA=Fuzzy selection approach,

P_{Loss}=Active power loss, VD=Voltage deviation, VSI=voltage stability index (L_{index}), WSA=weighted sum approach, LM=loading margin,

IC=Cost of SVC, OAPD=Optimal active power dispatch, O&M=Operation and maintenance cost,

Table I shows that the limited number of papers were reported to solve probabilistic multi-objective ORPD (MOORPD) problems considering active and reactive power generation costs. It has been studied that the solution of the MOORPD problem and the injection of probabilistic wind & solar energy has not been taken into account. In this work, first, the 1000 scenarios with the help of MCS are generated. After that, a scenario reduction procedure is employed to select the representative 24 scenarios to limit its complexity. IEEE.30-bus standard test system is chosen to investigate the simulation results of CCMO.

Methodology

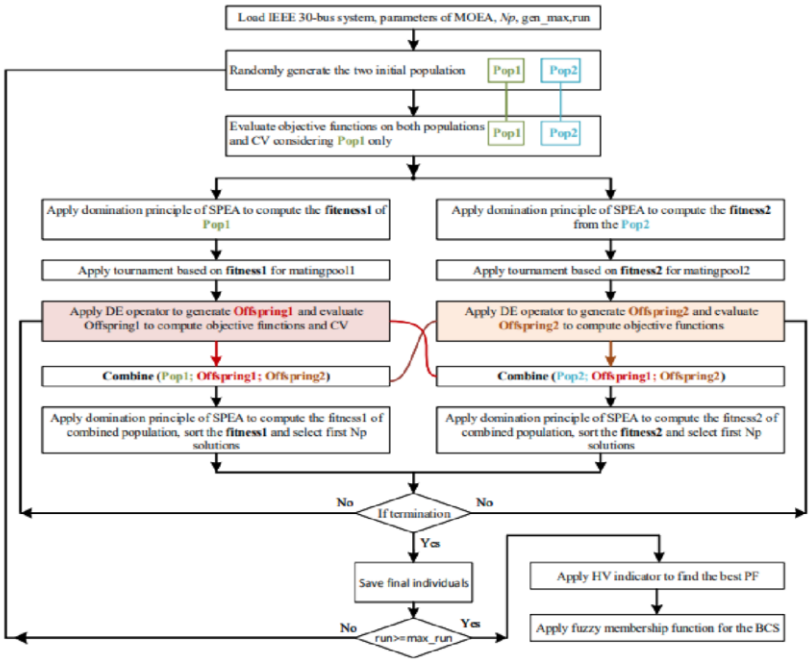

Fig. 2. Flow diagram of the proposed method

Conclusions

In this paper, the new constrained coevolutionary Multi-objective optimization (CCMO) algorithm is considered to solve probabilistic optimal reactive power dispatch (ORPD) problem. Integration of uncertain renewable energy sources (RES) such as wind and solar-type generators are considered to modify the standard IEEE 30 bus test system. Appropriate PDF such as Weibull, lognormal and normal PDFs are supposed to model the uncertain generation of RES and load demand. Various conflicting objective functions i.e., operational cost of RES and thermal generators, active power loss P_{loss} & voltage deviation *VD are* well-thought-out to find the optimal set of transformers tap ratio, generator voltage, and line charging capacitors. For the probabilistic ORPD, proposed PDFs are modelled to generate 1000 scenarios of wind velocity, solar irradiance, and load demand. After that, these scenarios are reduced to 24 representative scenarios with the help of the scenario reduction technique to decrease computational complexity. Three study cases are analyzed and compared based on the combination of considering various conflicting two and three objective functions. Simulation results show that the CCMO can find widely distributed Pareto Front and globally optimal solutions. Furthermore, the fuzzy decision-making technique is successfully applied to find the best compromise solution for the system operator. Moreover, all the decision variables and constraints are within limits.

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COMPARISON OF THERMOPHYSICAL PROPERTIES OF FATTY ACIDS USING TEMPERATURE HISTORY METHOD AND DIFFERENTIAL SCANNING CALORIMETRY FOR THERMAL ENERGY STORAGE APPLICATIONS

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ABSTRACT

The paradigm shifts of energy markets from conventional to renewable sources for energy production has created an opportunity for research in the area of thermal energy storage. Phase Change Materials (PCMs) are becoming an area of interest in thermal energy storage due to their high thermal energy storage capabilities. Considering their capacity to store latent heat at low temperatures and desirable thermodynamic properties, fatty acids as PCMs are becoming increasingly popular. The aim of this study is to focus on the significance of the Temperature History Method (THM) to determine the thermophysical properties of fatty acids and establish a contrast between the THM of thermal characterization and the DSC analysis. In this study, the thermophysical properties of two fatty acids, (stearic and palmitic acid) utilizing two separate experimental methods are analyzed and address the benefits and shortcomings of these techniques. Differential Scanning Calorimetry (DSC) can analyze the thermophysical properties of various PCMs, but this technique offers some limitations. The THM for determining the thermophysical properties of PCM is one of the convenient and reliable ways and used to characterize the multiple samples simultaneously. The comparison shows a 4.86% deviation with the available thermophysical properties in the literature and 2.96% deviation with the DSC results. The maximum relative differences of melting point, latent enthalpy, and specific heat capacity obtained from the THM are found within 1.52%, 2.96%, and 1.71% with DSC, and 0.67%, 4.86%, and 2.57% with literature, respectively.

Key words: *Thermophysical properties, Temperature History Method, Phase change materials*

Introduction

Fossil fuels are the world's primary energy source and 80% of the world's energy consumption is fulfilled by this source [1]. The shift of the energy market from conventional to renewable energy sources is the most effective way of energy production to minimize dependence on fossil fuels and to cut carbon emissions. The integration of the Thermal Energy Storage (TES) system with the energy production system is an efficient way to fulfill demand and supply chain.

Fatty acids as organic PCMs are gaining popularity due to their capabilities to store latent heat at low temperatures in large amounts. They offer few excellent features over other types of PCMs such as low cost, high stability, high density, low super-cooling temperature, non-toxicity, no flammability, and non-corrosively attracts the user for thermal storage purpose [2,3]. In such a way, fatty acids are appropriate PCMs for thermal energy storage.

The thermophysical properties determination of PCMs is a very significant factor while constructing new energy storage systems. Yinping et al. [4] introduced Temperature History Method (THM) as an alternative method to determine various characteristics of PCM for thermal energy storage corresponding to time and temperature. Li et al. [5] carried out the comparison between the DSC and THM and measured the deviation (less than 8%).

The primary purpose of this study is to focus on the significance of the THM to determine the thermophysical properties of fatty acids (stearic acid and palmitic acid) and compare them with DSC measurements and literature data to estimate the deviation of THM's results.

Methodology

Two methods: Differential Scanning Calorimetry (DSC) analysis and Temperature History Method (THM) were used to characterize and compare their thermophysical properties of the stearic acid and palmitic acid.

DSC is a thermal analysis technique that tests the endothermic or exothermic heat flow in the pan containing sample and reference pan. It provides the heat flow curves corresponding to temperature

[6]. In this study thermophysical properties of samples were determined at a heating rate of 5°C min-1 from 10°C to 80°C then cooled down to 10°C.

The original experimental setup of THM was proposed by Yinping et al. [4]. The main principle of this method is to recognize and plot the temperature of analyzing and reference material (distilled water) concerning time. Usually, the thermophysical properties of the samples using the THM are calculated with the assistance of discharging curves. The charging (25-85°C) and discharging curves (range 80-20°C) plotted from the THM's results of both samples of fatty acid.

Results and Analysis

The comparison of the thermophysical properties of both stearic and palmitic acids PCMs obtained from THM with DSC results and literature values to evaluate the deviation of THM's results. The relative differences in the THM's results with DSC results are 1.52% and 0.70% in melting points and 0.69% and 2.96% in latent enthalpies of stearic acid and palmitic acid respectively. Similarly, the relative differences in the THM's results with Zhang et al. [7] are 0.28% and 0.67% in melting points, 0.21% and 4.86% in latent enthalpies of stearic acid, and palmitic acid respectively. In the case of specific heat capacities of stearic and palmitic acids, relative differences with Karaipekli et al. [8] and Rozanna at al. [9] are 0.40%, 2.57% in the liquid phase and 0.45%, 1.43% in solid-phase respectively and with DSC are 0.40%, 1.71% in the liquid phase and 0.89%, 0.47% in solid-phase respectively.

Conclusions

The current study focuses on the thermophysical properties of two fatty acids. It addresses the benefits and shortcomings of the THM of thermal characterization and the DSC analysis. The THM can characterize the numerous samples in large volumes simultaneously. This study mainly focuses on the thermal characterization of fatty acids (stearic and palmitic acid) using the THM. The THM is one of the convenient and reliable methods for calculating peak melting and freezing temperatures, latent enthalpy, and specific heat capacity. The results show consistency with the thermophysical properties available in the literature and the DSC results. The maximum relative differences of melting point, latent enthalpy, and specific heat capacity obtained from the THM are found within 1.52%, 2.96%, and 1.71% with DSC, and 0.67%, 4.86%, and 2.57% with literature, respectively.

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PERFORMANCE ANALYSIS OF COMBINED HUMIDIFICATION DEHUMIDIFICATION (HDH) SYSTEM COUPLED WITH AIR CONDITIONING SYSTEM

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ABSTRACT

Performance analysis of Humidification Dehumidification (HDH) system coupled with vapor compression system through an enthalpy exchanger has been performed to provide conditioned space and fresh water as a product. Results shows up to 20% reduction in input power for hot regions and 30% increased fresh water productivity at an average production rate of$10 l/h$.

Key words: Humidification-Dehumidification, Enthalpy Exchanger, Air Conditioning

Introduction

HDH system is being used for fresh water production using low grade heat source and vapor compression system is widely used for air conditioning which consumes most of the electricity produced. Air at the exit of HDH system is at lower temperature and higher humidity when this air is used in vapor compression system instead of ambient air it results in significant power savings in hot and humid regions where decrease in sensible load dominates the increase in latent load. Along with power savings fresh water is also collected through HDH system and in evaporator coil as well thus productivity of HDH system also enhanced. A combined system schematic diagram is shown in Figure 3. Ambient air enters into humidifier gets hot and humid by incoming hot water then enters

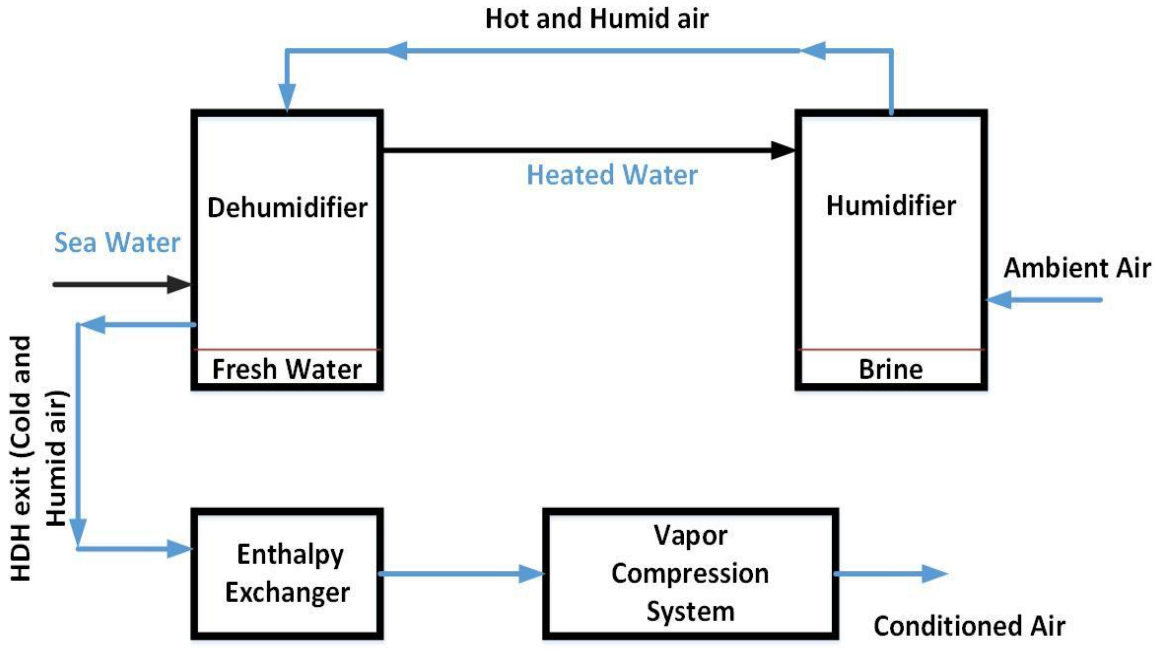

Figure 3: HDH System combined with Vapor Compression System through an Enthalpy Exchanger

into dehumidifier where it interacts with cold sea water, condensate or fresh water is collected in dehumidifier and then air enters into enthalpy exchanger where it temperature and humidity decreases by its interaction with return air from the room. Then air enters into evaporator for further cooling to a lower temperature of comfort zone.

Methodology

Key modeling equations are based upon energy and mass balance analysis of components. Model used for vapor compression system is based upon the modeling equations of vapor compression system [1]. While modeling equations for enthalpy exchanger are used which gave best results in agreement with experimental data [2]. These equations have been solved iteratively using F-Chart Software. Different performance parameters of HDH system has been studied to optimize the performance and effect of different climate conditions has also been studied.

Results and Analysis:

Results shows that there exist optimum mass flow rates for both air and water which depends upon the ambient conditions i.e. temperature and humidity of air and maximum and minimum temperature of water. HDH system shows better performance in dry regions. Dry regions show high Gain Output Ratio(GOR) while increasing ambient air temperature decreases GOR. Optimum Mass Flow Rate Ratio of water to air is always greater than 1 in case of water heated HDH system. HDH closed air open water cycle results are in exact agreement with the results present in literature [3].

Combined system shows significant power savings in hot and humid regions where average temperature is greater than 35 degrees Celsius, and average humidity is greater than 50%. With a constant maximum water temperature average fresh water productivity is about $10 l/h$. Exergy Destruction and Irreversibility Ratio of components also improves when a combined system is used.

Conclusions

Performance analysis of Humidification Dehumidification(HDH) system combined with air conditioning system has been performed to assess its performance for different climate conditions it terms of thermal optimization of HDH system, water productivity and power savings for air conditioning. Following conclusions have been drawn from the study

- Open air Open water HDH cycle has high GOR as compared to closed air open water cycle
- Combined system shows a reduction in compressor input power for hotter regions up to 20%, with a water production of 10 liters per hour
- Combines system shows average less exergy destruction for hotter region

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NUMERICAL INVESTIGATION ON TRANSITION FROM STRATIFIED TO SLUG FLOW DURING STEAM-WATER INTERACTION IN A HORIZONTAL PIPE

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ABSTRACT

The direct heating of water with steam is an energy efficient process in which steam is directly utilized to heat the subcooled water. Being an efficient way of transferring mass and heat energy, it is widely used in many industrial applications like mixing heat exchanger and district heating systems. The heat transfer coefficient during steam direct heating has been reported as high as $4MW/m^2K$. In the meantime, during the heating of water, the steam is directly condensed with subcooled water. This steam-water direct mixing phenomenon under certain conditions can originate rapid condensation of steam leading to the production of fast and violent pressure oscillations known as condensation induced water hammer (CIWH). The transition from stratified to slug flow provides the basis for the onset of condensation induced water hammer. In this paper, computational study on transition of stratified to slug flow was investigated by using ANSYS Fluent software. Subcooled water was injected at different injecting velocities into steam filled horizontal pipe section. It has been observed that the flow regime shifts from stratified to slug flow with the rise in water velocity with the advent of bridging conditions. The transition from stratified to slug is moved upstream with the rise in water injecting velocity, causing early flooding. The result of this study may be useful in the safe design and economic operation of industries where steam and water are simultaneously used as working fluids, especially in nuclear industry where a single accident related to CIWH may lead to accidental release of radioactivity, which is harmful for human beings and environment as well.

Key words: steam-water direct heating, direct contact condensation, flow transition

Introduction

The Steam-water direct contact heating is a process in which the subcooled water is directly heated with steam. Among the scholars, this process has attained enormous consideration as it has been regarded as an effective way of transmitting mass and heat energy. Furthermore, this process requires little driving potential and space. The contact area at the phase interface in this heating process is large which accelerates transportation of heat and mass [1-3].

The phenomenon of the steam-water direct mixing depends upon several thermal, mechanical and physical factors. The dynamic interaction between these variables finally drives the steam-water direct mixing [1,3,4]. During this mixing process, subcooled water causes the rapid condensation of the steam. This condensation of steam with subcooled water is also called direct contact condensation (DCC). Under certain conditions, the DCC phenomenon can trigger a bubble burst that leads to the generation of fast and violent pressure oscillations. This pressure rise under the influence of steam condensation is often termed as condensation induced water hammering (CIWH). The rapid pressure surges created by CIWH are of great importance, especially when the frequency of the pressure oscillation becomes close to the natural frequency of the equipment concerned. As a consequence, the resonance phenomenon takes place which imparts extra load to the systems. It can cause damage to the integrity of structures leading to the possible failure of pipes, equipment and system in relevant industries which can even result in personal injury and deaths.

Literature survey shows that many scholars have researched the phenomena of DCC steam-water primarily including the shapes of steam plume, flow regimes, coefficient of heat transfer, pressure oscillations, etc [1-3]. In the past, several attempts have been made to prevent and minimize the CIWH phenomenon. But because of the complexity of the phenomenon, the fundamental physics of CIWH is not fully understood. Therefore, a reliable CIWH prediction is important and an analysis of the flow transition from stratified to slug flow is crucial in this regard.

Therefore, the purpose of this study is to investigate the transition from stratified to slug flow through computational fluid dynamics (CFD) analysis. This transition provides the basis for the initiation of CIWH. The CIWH research, as described earlier, is very relevant in many industrial applications for the safe design of piping systems, equipment and other systems. Therefore, in relation to the safe operation of various industrial processes involving DCC, the present study is of vital importance.

Methodology

In this study, sub cooled water was injected into a horizontal pipe section filled with saturated steam. ANSYS Fluent was used to perform the CFD computations, in two-dimensional domain. The geometry of the test section consists of horizontal pipe with internal diameter as 66 mm and length of 2500 mm. The water was injected by varying velocities at fixed temperature of 313 K (40ºC) into a dry saturated steam at pressure of 600KPa (6 bar) & temperature of 432 K (158.8°C). The subcooled water injecting velocity was varied as 1, 3, 5, 7 and 9 m/sec. The CFD methodology was validated by comparing the present results with the published findings of Datta et al. [4]. After validation, the effects of water inlet velocity on flow transition were discussed in detail.

Results and Analysis

In this work, CFD study on transition from stratified to slug flow has been carried out by injecting subcooled water into steam filled test section. This flow transition provides basis of onset of condensation induced water hammers (CIWH). The parametric effects of water inlet velocity on flow transition from stratified to slug have been studied and discussed in details. It is found that both the phase coexisted and the flow regime remains stratified at lower water injecting velocity of 1-3 m/s. The volume fraction distribution has shown almost similar trends at different axial locations within the test section except with a time shift. However at higher injecting velocities, the water wave front moved quickly and reached the pipe top wall, causing the bridging phenomenon to start. The development of bridging triggered the transition from stratified to slug flow with the formation of steam pockets. With the increase in water injecting velocity, the transition from stratified to slug flow has been shifted upstream causing early flooding. The study may be helpful for providing guideline for understanding of condensation induced water hammer transient during water heating process which primarily depends upon transition from stratified to slug flow.

Conclusions

The transition from stratified to slug flow has been investigated in a steam filled horizontal pipe from injection of subcooled water. It has been found that with the increase in velocity of water, the flow regime changes from stratified to slug flow with the onset of bridging conditions. Furthermore, with the increase in water injecting velocity, the transition from stratified to slug is shifted upstream causing early flooding.

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MODELLING AND SIMULATION OF ECO-FRIENDLY SOLAR CELLS SENSITIZED BY NATURAL DYES

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ABSTRACT

One of the biggest environmental challenge for scientists, researchers and policymakers is the development of renewable energy sources for minimizing energy crises without impacting the climate. Natural dyes based organic solar cells are third generation dye sensitized solar cells(DSSC) which are cost effective and bio safe. Their fabrication is relatively easy with flexibility than Silicon based solar cells. In this study modelling and simulations of DSSCs are done to identify the key parameters addressing the improvements in the efficiency of these solar cells. The electrical circuit parameters used in simulations are extracted from the current density-voltage (J-V) characteristics of natural dyes based DSSCs measured under 1 sun condition. The simulations are carried out in MATLAB software to validated the model parameters for three different DSSCs made of pomegranate, beetroot and N-719 dyes. Data is calibrated by taking into account the effect of series resistance, shunt resistance and other parameters. The detailed set of parameters based on electrical considerations is delivered which will not only help to study the impact of physical parameter of DSSC but will also help in controlling and improving the performance and efficiency of Dye sensitized solar cells.

Key words: *natural dyes, dye sensitized solar cells, simulation of DSSC*

Introduction

The energy crisis is a socio-economic issue triggered by a limited supply of energy. Nowadays the focus of research is on creating carbon-free energy sources to minimize energy crises without impacting the climate. In comparison to conventional silicon-based solar cells the key features of dye sensitized solar cells(DSSC) are low cost, environment friendly processing, efficient performance under diffused light and versatility in terms of colors and structures [1]. Due to low cost, easy availability and eco-friendly properties, natural dyes have received great consideration from scientists over past several years [2]. However, the physical and chemical phenomena that take place inside DSSCs are complex and modeling and simulations of DSSC is a challenging task. Several researchers have attempted to extract the effective parameters to establish robust models for interpreting their internal properties. Supriyanto at el [3] simulated plant extract natural dyes based DSSCs by modifying the internal parameters. The simulation results indicated that the output current and voltage of DSSC is affected by the absorbance of dyes, working temperature and irradiation intensity. Several electrical models are also proposed to predict the electron transport maximum power point, fill factor, fractal geometry of oxide semiconductor on the short-circuit current density, open-circuit voltage and efficiency [4]. Kumar et al [5] extracted calibrated model parameters for predicting the maximum efficiency and the effect of working electrode thickness on the performance of DSSC.

In this research, natural dyes based DSSC are modeled and simulated. Simulation are performed for two natural dyes (pomegranate and beetroot) and one metallic dye (N719). The physical parameters

are extracted and their impact on the performance of these cells is studied. The simulated results are compared with the experimental results.

Methodology and Results

The structure of the DSSC has been modeled as shown in figure(inset). Detailed set of physical parameters based on electrical considerations has been extracted. Electron diffusion equations were used to obtain short circuit current density (J_{SC}) and open circuit voltage (VOC) as given below;

$$J_{SC} = \frac{q\phi L\alpha - \left(L\alpha\cosh\left(\frac{d}{L}\right) + \alpha L e^{-\alpha d} + \sinh\left(\frac{d}{L}\right)\right)}{\left(1-\alpha^2 L^2\right)\cosh\left(\frac{d}{L}\right)} \quad \ldots\ldots (1)$$

$$V_{OC} = \frac{mkT}{q}\ln\left(1 + \frac{\phi\alpha\tau\left(L\alpha\cosh\left(\frac{d}{L}\right) - \alpha L e^{-\alpha d} - \sinh\left(\frac{d}{L}\right)\right)}{n_0\left(\alpha^2 L^2 - 1\right)\sinh\left(\frac{d}{L}\right)}\right) \quad \ldots (2)$$

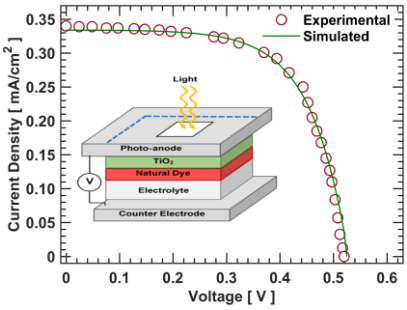

Fig. Experimental and simulated current-voltage Characteristics of Pomegranate dye DSSC, inset is the schematic of the solar cell.

These parameters have been extracted taking into account the thickness of the conducting oxide semiconductor, ideality factor and electron diffusion length. Absorption co-efficient has been calculated by using optical path length and absorbance obtained from measured absorption spectra. All values are obtained under steady state illumination conditions. The simulations were carried out in MATLAB software to validated the model parameters for three different DSSCs made of pomegranate, beetroot and N-719 dyes. Data was calibrated by taking into account the effect of series resistance, shunt resistance and other parameters. The simulated results were compared and were found to be in close agreement with experimental results. The experimental and simulated results for pomegranate dye DSSC are shown in figure.

Conclusion

Modelling and simulations of natural dyes based DSSCs are carried out in MATLAB software to extract model parameters. Data was validated by taking into account the effect of series resistance, shunt resistance and other parameters. The simulated results are well in agreement with the experimental results. The detailed set of parameters based on electrical considerations is delivered which will help in understanding the behavior of DSSCs and controlling and improving their performance and efficiency.

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A PRELIMINARY REVIEW OF INNOVATIVE APPROACHES FOR PERFORMANCE OPTIMIZATION OF VERTICAL AXIS WIND TURBINE

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ABSTRACT

Urban wind energy generation is currently receiving increasing attention. Among various types of wind turbine, vertical axis wind turbines (VAWTs) are the most suitable for urban wind condition. This paper presents a preliminary review of current innovative ideas and approaches to improve performance VAWT. From the literature, numerous interesting research on innovation of VAWT design have been conducted including modification of blade design, application of active and passive flow controls on the blade and pitch angle control systems as well as innovation of conventional turbine design. With these effective approaches, the self-starting ability as well as the aerodynamic and power performance of VAWTs could be improved significantly.

Keywords: Innovative, optimization, vertical axis wind turbine, wind energy

Introduction

Modern wind turbines have two main types: horizontal axis wind turbines (HAWTs) and vertical axis wind turbines (VAWTs). HAWT focuses on large-scale wind energy generation while VAWT is more suitable for small-scale urban applications. Generally, the main research interest in optimization of VAWT is currently focusing on mitigating the effect of dynamic stall that associated with the complex aerodynamic characteristics of VAWT as well as improving turbine power performance and ability to self-start. In this paper, current innovative approaches for VAWT performance enhancement are reported and described to help designers in designing an optimum VAWT.

Innovative Blade Designs

Blade is a vital component in wind turbines especially for the lift-type wind turbine. Therefore, to allow the harness of wind energy efficiently requires the optimal turbine blades, preferably to mitigate the effect of dynamic stall. Several practical approaches, utilizing either active or passive flow controls, have been recorded in the literature. For instance, Zhu et al. [1] conducted an extensive review of research on jet actuators including continuous jet actuators, synthetic jet actuators, pulsed jet actuators and plasma jet actuators.

Blade morphing is one of the passive flow control methods and is currently gaining much attention. The main objective of blade morphing is to maximize the lift generation by dynamically altering the blade shape correspond to the azimuthal position during turbine revolution. A study by Hefeng et al. [2] concluded that blade with deformation ability could delay the flow detachment on the blade, hence preventing the early drop of lift force generation.

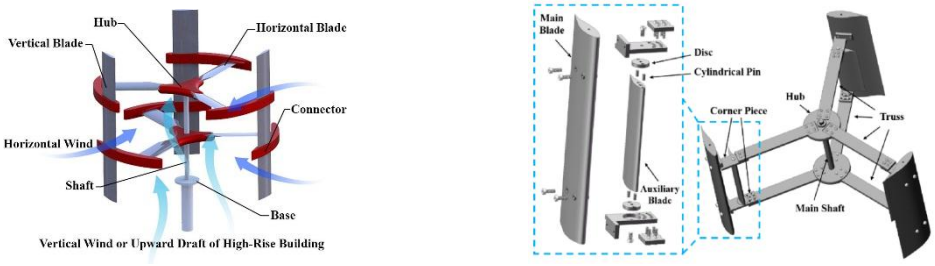
Innovative Pitch Angle Control Method

Due to the constant change of angle of attack during rotation, the aerodynamic performance of VAWTs is highly influenced by flow separation experienced by the blade. Apart from determining the optimum blade design, the use of blade pitch angle control system to adjust blade pitch angle with respect to different zones during operation has been proved to improved turbine performance. A study conducted by Manfrida and Talluri [3] exhibited that the adoption of dynamic pitch adjustment technique on the turbine allows a great improvement of the tangential force on the downstream, where the drag force is dominant.

Innovative Turbine Designs

In addition, various new and innovative designs of wind turbine have been introduced in previous studies to improve the efficacy of VAWT in several aspects such as the turbine's ability to self-start, turbine power and aerodynamic performance as well as reducing noise generation. For instance, Chong et al. [4] proposed a novel cross-axis wind turbine (CAWT) that combines the advantages of HAWT and VAWT. The novel turbine showed an increase in rotor rotational speed by 70% and power coefficient 2.8 times higher than traditional Darrieus VAWT.

A novel straight-bladed VAWT was also introduced by Su et al. [5], where the proposed model showed a better self-starting performance and could achieve higher power coefficient than conventional H-type VAWT. This better performance was contributed by the ability of the turbine to generate constant positive static torque coefficient at all azimuthal position and constant power output in varying wind speeds.



(a) (b)

Figure 1 Schematic of (a) CAWT [4] and (b) a novel VAWT by [5]

Conclusion

VAWTs offer a cost-effective energy solution for urban energy generation. With their various advantages and suitability in urban areas, VAWTs could be the best alternative energy harvesting method in built environments that are known to have complex, unsteady and highly turbulence wind conditions. Tremendous amount of efforts have been devoted on optimizing VAWT performance with the aim of increasing the use of VAWT to a commercial scale. With the aforementioned innovative approaches, the performance of VAWT has seen a remarkable increase in the last decade on continue to do so in the future.

Acknowledgement

The authors would like to acknowledge the Ministry of Higher Education of Malaysia for the financial support under the Fundamental Research Grant Scheme (FRGS/1/2019/TK03/UKM/02/6) and Universiti Kebangsaan Malaysia for the Research University Fund (GUP-2018-131).

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DESIGN AND ENERGY ANALYSIS OF A SOLAR DESICCANT EVAPORATIVE COOLING SYSTEM WITH BUILT-IN DAILY ENERGY STORAGE

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ABSTRACT

Heat storage with thermochemical (TC) materials is a promising technology for solar energy storage. In this paper, a solar driven desiccant evaporative cooling (DEC) system for air-conditioning is proposed which converts solar heat energy into cooling with built-in daily storage. The system utilizes thermochemical heat storage along with the DEC technology in a unique way. Magnesium Chloride ($MgCl_2.6H_2O$) has been used which serves as both; a desiccant and a thermochemical heat storage medium. The system has been designed for subtropical climate of Lahore, Pakistan, for a bedroom with 8 hours of cooling requirements during the night. MATLAB has been employed for modelling the system. The simulation results show that 57 kg of Magnesium Chloride is sufficient to meet 98.8 % of cooling demand for the entire month of July when cooling demand is highest. The cooled air supplied to the building also meets the fresh air requirements for proper ventilation.

Keywords: desiccant; evaporative; cooling; air conditioning; solar; energy storage; refrigeration

Introduction

Buildings consume 40% of the world's primary energy and are responsible for about one-third of global CO_2 emissions [1]. The cost efficiency of energy saving in buildings is high. Cooling and refrigeration is responsible for about 15% of electricity consumption worldwide. In countries with a warm climate such as Hong Kong, this can be as much as 30% [1]. Desiccant evaporative cooling (DEC) is an interesting and promising technology which can utilize low-grade heat to produce cooling. In DEC, heat is used to dry desiccant (hygroscopic) material and this dry material is used to produce dry air by absorbing water vapor from it. Then, in the next stage, water is evaporated in this dry air to produce cooling due to evaporation. DEC is a promising low-energy cooling technology as the moisture (latent cooling load) from humid air is removed by utilizing the chemical affinity between desiccant material and water and not by reducing the temperature below dew point. A DEC system can also utilize waste heat, solar heat, geothermal heat or heat from natural gas, hence reducing the peak electricity demand. DEC systems are naturally suitable for applications where ventilation requirements are high. A DEC system can use both solid sorption materials or liquid sorption materials. Commercially available desiccants are silica gel, natural and synthetic zeolites, activated alumina, lithium chloride, and synthetic polymers [2]. DEC technology decouples the latent and sensible cooling loads making it possible to condition spaces with a wide range of design conditions [3].The open DEC cycles produce conditioned air directly whereas closed cycles are mostly used to produce chilled water. Most of the standard open cycles use a rotating desiccant wheel in combination with a silica gel or lithium-chloride solution as sorption material [4]. Desiccant dehumidifiers are used along with air conditioning systems to remove the latent load (water vapour)

from air before it enters the air conditioning system. These are used in commercial buildings where integrated heating, ventilation and air conditioning (HVAC) systems are installed [5].

Methodology

MATLAB has been used for simulations. The desiccant holding reactor has been transiently modeled numerically in such a way that its total length is divided into 20 segments and a suitable time step of 30 seconds has been selected. The initial design and simulation of reactor gave total hydration time of 29 hours for mass of desiccant of 201 kg. For meeting the cooling demand of selected building (system integration), this time is reduced to 11 hours for 57 kg of desiccant material. The solar collector is modeled numerically and is integrated with dehydration model of the reactor. It is found that $7m^2$ collector dehydrated the desiccant material in approximately 5 hours.

Results

The integration of hydration model of reactor with models of heat exchangers and evaporators showed that the designed solar DEC system can meet 98.8% (solar fraction) of the cooling demand of the building for the whole month of July by providing 122.86 kWh of cooling. The system provided the solar fraction of 70.4%, when the number of people in the building and heat addition by electrical appliances is doubled. However, the cooling provided by the system in the second case increased to 156.17 kWh because less cooling is wasted. Cooling output of the system increased with increasing heat exchanger effectiveness, when the heat exchangers' effectiveness increased from 0.7 to 0.8, solar fraction increased from 70.4 % to 82.44 % which shows that investing in better heat exchangers is desirable for such a system. Decreasing the U value of the room from 0.35 to 0.25 W/m^2K, the solar fraction increased from 82.44 % to 84.2 %.

Conclusions

A solar DEC system has been designed and analyzed using numerical simulations. The system has been uniquely designed in such a way that the desiccant material ($MgCl_2.6H_2O$) serves two purposes simultaneously; it works as a desiccant and as a daily solar heat storage medium. The system has been designed to produce solar cooling for a small building situated in subtropical climate of city of Lahore, Pakistan. The results obtained by using the weather data of city of Lahore show a strong feasibility of using solar driven DEC in subtropical climate (higher latent cooling loads) where enough solar energy is available during the day which can stored and used during the night for air conditioning.

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MODEL PREDICTIVE CONTROL (MPC) BASED MPPT TECHNIQUE FOR SOLAR PHOTOVOLTAIC SYSTEM UNDER WINTER WEATHER CONDITION OF SWAT, PAKISTAN

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ABSTRACT

Maximum power point tracking algorithm (MPPT) performs an important function in photovoltaic (PV) power collection generators as they draw maximum output power in case of variable temperature and irradiation conditions. The output power of solar panel in snowy season is lower than the summer season because the snow prevents the solar irradiance from reaching the photovoltaic cells and keep the temperature below -10°C. The Power-voltage graph of PV module is almost flat horizontally in the snowy season and it is very difficult for the MPPT algorithm to achieve maximum power point condition. The proposed paper solves the mentioned problem by introducing the model predictive control (MPC) based MPPT algorithm that predict the output power for the future sampling instant in 10 micro-seconds. The simulated results proves that the proposed technique operates the system at exact MPP in snowy season with respect to the conventional MPPT technique. Moreover, the computational burden of the proposed technique is also lower than the conventional technique. The results from the proposed and conventional techniques are verified on MATLAB/Simulink.

Key words: Model predictive control (MPC), Maximum power point (MPPT)

Introduction

Availability of abundant energy with low carbon footprint is the most important aspect of sustainable future. Solar energy is one of the most promising source of clean energy. This is why it is one the fastest growing source of energy with more than 40% growth annually [1]. However, higher penetration of grid connected PV systems pose significant challenges [2, 3]. Although PV systems are very environmental friendly but the efficiency of PV system is very low, it is around 13-17 % [4]

Efficiency of PV systems varies with environmental parameters such as ambient temperature, irradiation, and humidity [4]. The MPPT measures the output current and voltage from the PV system and determines the operating point that operates the system at MPP. There are multiple ways to implement MPPT algorithm e.g. perturb and observe (P&O), incremental conductance (InC), fuzzy logic based tracking and model predictive control (MPC) [5]. P&O is the two most commonly used technique in MPPT implementation [6]. In comparison to P&O technique, MPC offers faster response and lower power ripples under rapidly changing irradiation and temperature. MPC can be implemented without requiring costly sensing and communication equipment for direct measurement of solar irradiation variations [7, 8].

Methodology:

In the proposed technique, the PV system is connected to load through boost converter that insures the operation of the PV system at MPP. The MPC based P&O algorithm is used as a MPPT technique that insures the operation exact MPP point in snowy weather conditions. The MPC algorithm predicts the output power for the future sampling instant within 10 micro second. The proposed technique insures the operation of exact MPP in snowy weather condition.

Proposed System:

The control block in the proposed system include MPC based model that regulates the inductor current given by the MPPT algorithm. The MPPT algorithm in the proposed system include P&O

based algorithm that insure the selection of correct MPP point. The correct MPP point is then regulated by the MPC control block.
Result and Analysis:
The proposed system is analysed in MATLAB/Simulink. The irradiation is kept low because of low temperature and snowy conditions in swat, Pakistan. The irradiation pattern is selected in such a way that all the worst conditions of swat, Pakistan are incorporated in it. PV power. The results from the benchmarked technique depicted that it fails to operate the system at MPP for the irradiation conditions from 1.5 to 3 seconds.

Conclusions

In this paper, method for operating the PV system at MPP is suggested in snowy weather conditions of swat, Pakistan. The proposed method not only ensures the exact MPP point but also cater the variation of irradiation conditions in snowy weather condition. The computational cost of the proposed and conventional techniques are evaluated and concludes that the computational burden of the proposed technique is lower than the conventional technique.

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COMPARATIVE ASSESSMENT OF ENERGY GENERATION POTENTIAL THROUGH SUGAR WASTE IN PAKISTAN

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ABSTRACT

A global trend towards sustainable development has stimulated a need to transition from conventional carbon intensive fossil fuels towards low carbon pool sources such as bioenergy. Among different bioenergy resources, use of sugarcane and consequently bagasse has been most widely accepted, especially its use in cogeneration plants. This study identifies the energy generation potential of bagasse through cogeneration in Pakistan. Bio-IRENA simulator for theoretical, and JDW sugar mill is used for analyzing the technical potential. With aid of energy modeling and experimental investigation, it has been identified that each ton of bagasse can produce around 0.8 to 5 TWh of electricity (depending on technology) through simple, 11 TWh of heat in heat production process and 7.3 TWh in combined heat and power (CHP) plants. Considering the total annual production of sugar in Pakistan to be around 5.2 million tons, the country can generate approximately 1600-2890 GWh energy each year (technical potential). Along with economic benefits, it will also result in lower environmental emissions and social benefits. Hence, to ensure a sustainable development of bioenergy industry in Pakistan, there is a need to develop a proper supply chain that can aid the transfer of sugarcane and bagasse from the production unit to supply units.

Key words: Biomass, Bioenergy, CHP Plants, Waste to Energy, Bioenergy Supply chains

Introduction

Reliance of Pakistan on coal as the future energy alternative might result in power locking due to overcapacity burden. Conventional energy sources also threaten to result in financial traps that eventually increases the circular debt on the economy. Furthermore, Pakistan is going for an energy transition and it should be realized that for a sustainable development, communities that do not have access to clean energy should be able to make it when Pakistan make that transition. However, despite the above-mentioned factors some rural communities in Pakistan are still lacking access to clean energy. This requires us to transit from conventional to renewable sources, and considering an agriculture based economy, there is a large potential in Pakistan to commercially use its bioenergy resources in its energy sector [1]. However, the use of crops for energy purpose might pose a competition with the food sector of country and hence utilizing of agricultural residues as compared to the original crop is a more sustainable approach. Sugarcane is among the major crops of Pakistan and bagasse pose a significant potential to be used as an energy source. However its utilization on a commercial scale is very limited thus requiring a need for assessing its technical and theoretical potential. This study hence performs a comparative assessment of bioenergy production through use of bagasse in CHP plants.

Methodology

Methodological overview of the study is provided in the figure. Bio-IRENA simulator is used to find the technical potential of bagasse in Pakistan. The input parameters include its crop plantation area of sugarcane, annual yield, crop to residue ration, rainfall conditions, and moisture content. The simulator in return provides output of energy generation potential based on different technologies and

end-use sectors. Since bagasse is used in other sectors, the output value is then multiplied by availability factor which identifies the potential that can be directed towards the energy generation. This theoretical value is then compared with an actual bagasse based sugar plant of JDW sugar mill for analyzing the technical potential. Based on these values, a technical potential has been analyzed for Punjab (which has been chosen as the case study area) [3]. For analyzing the do-able financial strategies, an LCOE based model has been used to calculating the cost of electricity generation under varying cost of technologies and processes.

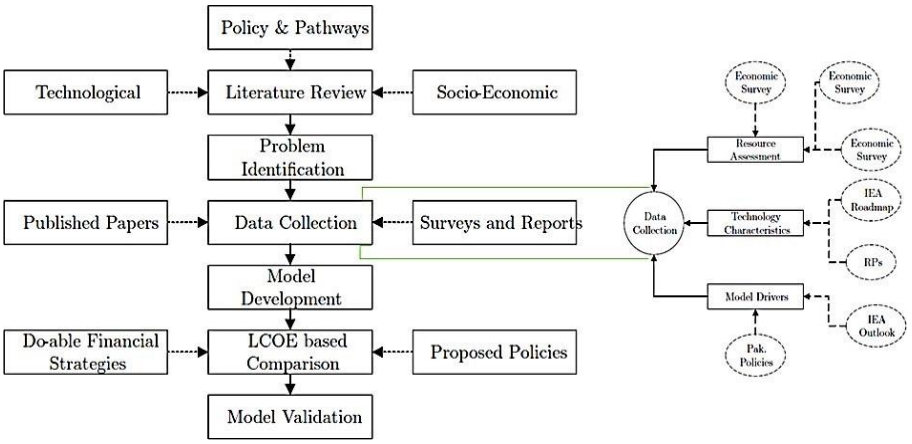

Figure 1: Data collection process and methodological framework

Results and Analysis

The results obtained from the model depicts that energy potential of bagasse can be used on both transport and power sector. For ethanol production, bagasse in Pakistan has a potential to produce 4455 L ha^{-1} of ethanol through use of 1st generation ethanol engine. Based on total crop availability, theoretically bagasse can produce around 3372 million Liters of ethanol annually. This equals a total of 71.7 PJ of energy annually. The energy produced from bagasse can range from commercial production of heat to electricity in single and CHP plants. Now for power sector, annual technical potential of bagasse ranges from 0.8 TWh to 5.81 TWh depending on the technology (biomethane engine with least and gasification steam turbines with the largest potential). For simple heat production, same quantity of bagasse has a theoretical potential of around 11 TWh, while in CHPs, the heat production drops down to a value of 7.38 TWh.

On the other hand, the experimental data obtained from JDW sugar mills depicts a total generation potential 2653 MWh by using 4227 metric tons of bagasse per hour, out of which 891.2 MWh can be supplied to the national grid, while the remaining is self-consumed. Now comparing the per ton values of both technical and theoretical potential, a percentage error of only 10% is present which depicts that entering the same technological details and near accurate values for crop statistics, technical potential can be correctly calculated using the provided model.

Conclusions

Commercial utilization of bagasse based bioenergy can provide multiple benefits by assisting Pakistan to achieve its sustainable development goals via a clean energy transition. Due to an agriculture based economy, bioenergy has a large potential in Pakistan and hence a sustainable supply chain should be established to ensure its optimal utilization in energy sector.

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A BRIEF REVIEW ON EXPERIMENTAL AND SIMULATION-BASED ANALYSIS OF PARABOLIC TROUGH SOLAR COLLECTORS USING NANOFLUIDS

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ABSTRACT

Among several replenish able energy resources such as geothermal, tidal, wind, biomass etc., solar energy utilization has become prominent in developing and developed countries. Several collectors have been employed to operate in diverse temperature ranges such as low temperature collectors (30–80 °C flat plate), intermediate temperature (linear Fresnel reflector 60–250 °C and parabolic trough solar collector (PTSC) 60–400 °C) and high temperature collectors (100–1500 °C parabolic dish reflector). PTSC is widely used in various countries for the purpose of steam generation. Various research studies both experimental and theoretical have been carried out for heat transfer and thermal efficiency enhancement in PTC systems. Several methods are used to enhance PTCs heat transfer by rearranging various design parameters and employing various working fluids. In this study a detailed analysis of use of nanofluids both in experimental and simulation setups will be reviewed. PTSC review employing aforementioned conditions will be quite helpful for new researchers.

Key words: Parabolic Trough Solar Collector; Nanofluids

Introduction

Non-renewable energy resources are depleting day by day on one end and on the other end they are causing environmental problems like acid rain, pollution and climate change. To overwhelm these problems researchers are striving for eco-friendly and everlasting resources of energies. Solar energy is pivotal source of energy in this regard [1]. In alternative resources of energies; solar energy potential is up to the mark. Solar system has potential to turn solar energy into other beneficial sources of energy [2]. Among various solar collectors' PTCs are most viable for medium temperature ranges. As PTCs absorbs solar radiations and concentrate them on collector axis. Collectors consist of receiver having working fluid in tube (Fig.1). They are used in industries and power plants for medium temperature ranges to provide source of heating or generation of steam [3].There are several parameters on which performance of PTC depends but thermal performance of PTCs chiefly depends on working fluids [4].Nano sized particles are dispersed in base fluids to optimize the thermo physical properties of the base fluid. Nano Particles dispersion in base fluids improves the thermal conductivity and heat transfer capabilities of the nanofluids. A comprehensive research using nano fluids such as Fe_3O_4/H_2O, TiO_2/H_2O, CuO/H_2O, SiO_2/Therminol VP-1, Al_2O_3/Synthetic oil and (CuO+Ni)/N2 have been carried out [5]. Many authors carried experimental and simulation-based researches in heat transfer enhancement domain in heat exchangers and parabolic trough solar collectors.

Methodology

Various experimental and simulation based investigations using PTC and including nanofluids as working fluids studied in detail as given below.

Experimental Studies

Experimental investigations using parabolic trough solar collector and nanofluids by different researchers are given below.

Multi walled carbon nanotubes (MWCNT) investigated in PTC in two concentrations (0.2% and 0.3%) using oil as base fluids. Efficiency enhancement was observed 4-5% and 5-7% for lower to

higher concentrations of nanofluids respectively. Black Chrome coating on copper absorber and clearing gap between GC and receiver also applied and observed significant heat transfer and efficiency enhancement [6].

Numerical Studies

There are several numerical based studies using PTC and nanofluids are given below.

Numerical based studies performed using Syltherm 800-Al2O3 by solving Reynolds Navier-Stokes equations applying practicable k-ε models and by varying volumetric concentrations from 0-8%. Optimum increase in thermal efficiency attained 8% at lowest Reynolds number and highest employed concentrations of nanofluids. Furthermore, it is analysed by increasing volumetric concentrations and Reynolds number; thermal efficiency of PTC decreases significantly owing to drop in pressure [7].

Conclusions

Experimental and numerical based studies having PTSCs and nanofluids have been reviewed in this paper. Maximum heat transfer enhancement and thermal efficiency improvements gained by using metallic nanofluids such as CuO. Experimental and numerical studies using nanofluids have better thermal performance results for PTSCs than using any simple base fluids. Nanofluids depicts better results than simple base fluids due to thermal conductivity enhancements and higher particle density. For further research work on PTSCs thermal improvements using nanofluids, following suggestions must be considered. Combination of metallic and non-metallic Hybrid nanoparticles in single and hybrid base fluids with variable concentrations is recommended

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COMPARISON OF SPRAY CHARACTERISTICS FOR BIO DIESEL AND DIESEL FUELS USING EULERIAN–LAGRANGIAN MULTIPHASE FORMULATION

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ABSTRACT

Biofuels and their blends with the diesel fuel are good alternatives to be used in diesel engine because of the reduced exhaust emissions and reduced dependency on fossil fuels. Quality of biofuels depends upon their spray characteristics and heating value. Biofuel obtained from waste cooking oil (WCO) is of great interest from past few years because of its reduced production cost and less residual waste. Spray properties for WCO has been studied by few authors in the past however, its numerical analysis has not been investigated in detail yet. In this paper, spray behavior is studied for biodiesel derived from waste cooking oil (BDFc), palm oil (BDFp), and diesel fuel under various injection and ambient conditions. This paper is focused on modelling fuel atomization in ANSYS FLUENT using Eulerian–Lagrangian multiphase formulation. Drops are injected as particles using Lagrangian scheme into the cylinder of continuous gas phase. This gas phase is modelled using Eulerian scheme**,** and several sub models are coupled with our simulation like drop breakup, drop collision, dynamic drag, and turbulence model. Spray characteristics include penetration length (PL), Sauter mean diameter (SMD), and spray cone angle investigated under various injection conditions. Results revealed that greater penetration length, larger drop size and cone angles are observed for the fuels with greater viscosity. Higher injection pressure increases PL, cone angle but reduces drop diameter. Increasing ambient densities decreases SMD and PL while the cone angle is increased. The results are useful for understanding the behavior of biofuels in an engine environment and also the changes needed in an injection system for optimum spray characteristics that will eventually improve combustion efficiency and lead to reduced exhaust emissions.

Key words: *Cavitation, Coalescence, Penetration Length, Sauter mean diameter*

Introduction

Nowadays, biofuels have attracted engine manufacturers as an alternative fuel in place of diesel because of their renewable nature and better exhaust quality. Biodiesels have excess of oxygen that enhances combustion and reduces the particulate matter and soot emissions [1]. They usually have higher fuel viscosity and surface tension that affects fuel injection process and spray characteristics which have a major impact on combustion process and eventually the thermal efficiency of an engine. To use biofuels in diesel engine it is necessary to study the fuel spray and mixture formation characteristics which provides better insight to the performance and emission properties. Previous research carried out experimentally studied the spray behavior of Palm oil and cooked oil and it was found that biodiesels had greater cone angle and larger drop size compared to diesel fuel [2]. Agarwal et al. [3] studied spray behavior of Karanja biodiesel at various injection pressures and injection timings for a multihole injection nozzle. Lee et al [4] investigated the macroscopic spray properties of biodiesel and its blends obtained from soybean and canola oil. Mohan et al. [5] revealed the spray characteristics of waste cooking oil biodiesel and its blends with diesel fuel at high injection and ambient pressures. Biofuel produced from a waste cooking oil (WCO) is cheaper in terms of feedstock. Hence, in this study, spray PL, SMD, cone angle are investigated for biodiesels

extracted from waste cooking oil (BDFc) and palm oil (BDFp) and the results are compared with diesel fuel by numerical analysis.

Methodology

Eulerian–Lagrangian multiphase formulation is used in ANSYS FLUENT in which fuel is injected in the form of particles into a gas phase (air) inside the injection chamber. Particles are tracked using Lagrangian methodology while air inside the chamber is modelled using Eulerian approach. Transport equations of Mass, momentum and energy are solved for gas phase. Particles are tracked by their trajectory calculations and its properties are updated as it passes through the gas phase.

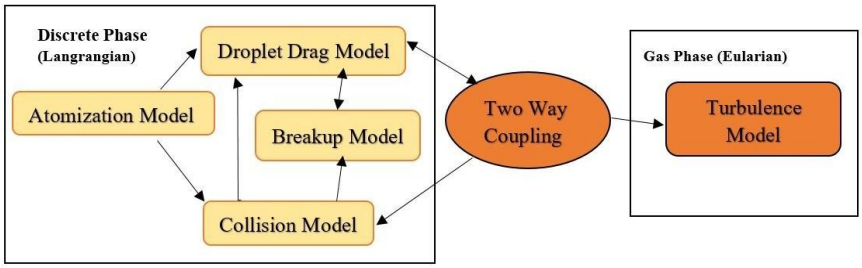

Fig 1. Diesel spray numerical model interaction diagram

Results and Analysis

Fig 2. (a1 & a2) shows that maximum PL is found for BDFp at 2000 bar injection pressure and 15 kg/m^3 ambient density and minimum PL is observed for diesel fuel at 1000 bar injection pressure at an ambient density of 30 kg/m^3. Greatest cone angle is for diesel fuel at Pinj =2000 bar and ambient density of 30 kg/m^3 as it is the least viscous while the least cone angle is at Pinj = 1000 bar for BDFp (**Fig 2.** (b1 & b2)). SMD is maximum at Pinj = 1000 bar for an ambient density of 15 kg/m^3 as shown in **Fig 2.** (c2).

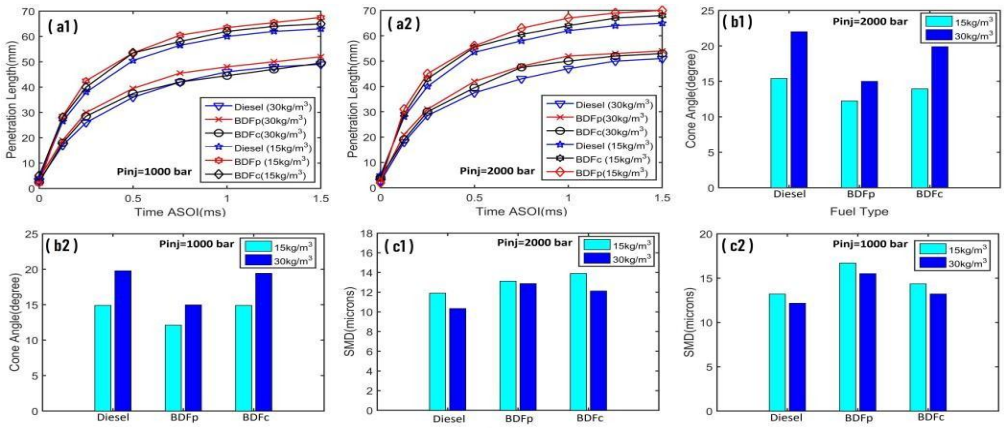

Fig 2. Penetration Length (a1 & a2), Cone angle (b1 & b2), and SMD (c1 & c2) for Diesel and Palm oil (BDFp) and Waste Cooking oil (BDFc)

Conclusions

In summary, biodiesels (BDFp and BDFc) show similar results as compared to diesel fuel, slight difference is due to high viscosity and density of biofuels due to which longer PL, greater drop diameters and cone angles are observed. Increasing injection pressure decreases cone angle, SMD but increases PL. Higher ambient density decreases PL and SMD while the cone angle is increased.

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HYDEL DAM VS SOLAR PARK: A SUSTAINABLE FUTURE CONCERN CASE STUDY FOR PAKISTAN BASED ON TECHNO-ECONOMIC ANALYSIS

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ABSTRACT

With the rapid increase in power demand and scarcity of natural resources, harnessing renewable energy sources has become a necessity. The Pakistan government has planned to enhance the renewables' share in energy mix to 30% by 2030. To cope up with the increasing power demand, the government has planned a mega hydel project entitled Diamer-Bhasha hydropower station. And it is a proven fact that the climatic conditions of Pakistan are excellent to integrate the solar power generation. This paper is focused on comparative analysis of techno-economic-environmental perspectives of photovoltaic grid connected systems vs proposed hydro-power systems. RETScreen software tool is used for modelling and analysis purposes. Outcomes conclude that both power generation options are competitively suitable to pursue but the main factor is of time to get completed the project that favours the PV more than hydel project.

Key words: Solar PV, Hydel, Economic, RETScreen

Introduction

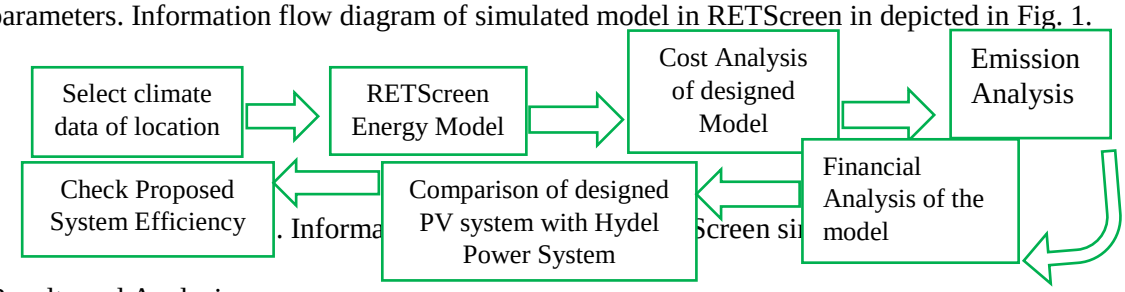
Pakistan is one of the nature gifted lands on the earth planet with immense renewable potential whose energy demand is increasing at 3% per annum rate [1]. Government is making multiple plans to address this increase, but the pre-requisites are not in support with that could highlight the bright sustainable future. The main pre-requisites include effective planning and economy. Economy is following the declined curve since years that has reached in negative value now [2]. In planning perspective, government plans and actions itself are in opposite directions like alternate and renewable energy policy 2019 and cola projects of China-Pakistan Economic Corridor (CPEC) [3]. Above all is the priorities of decision makers that do not favor the country as proven from the history of Diamer Bhasha Dam. Government is trying to build this dam for years. This was first suggested in 1980, and after that its feasibility report was prepared and revised in three different years, then finally contract was issued in 2020 [4]. Then another hurdle came across in form of COVID'19 that proved as add-on towards previous post-event strategic planning and project has become controversial. This project is planned to get completed in nine years after the start of installation. It is uncertain that is project will be completed in time happened in case if Neelum-Jhelum [5] project that was more than four times smaller in capacity. Thus, to address the emerging issues, fulfill the planned energy strategies and to move on with the pace of the world's revolution, renewable energy sources including solar, wind based projects are need. Solar and wind both are location specific, but wind is more than solar.

In this work, a grid connected type solar PV system is modelled having same installed capacity as that planned Diamer-Bhasha Dam equivalent to 4500 MW. Its technical and economic comparative analysis is carried out using RETScreen user interface. Technical analysis is carried out in terms of generated electric power, capacity factor and for economic analysis NPV and IRR are compared.

Methodology

A 4500 MW grid connected PV system and Hydel project are modelled in RETScreen software using the embedded weather data of selected locations for the project reported by National Aeronautics and

Space Administration. Technical and economic feasibility is carried out considering multiple parameters. Information flow diagram of simulated model in RETScreen in depicted in Fig. 1.



Results and Analysis

Performance of both energy system's is evaluated in the terms of techno-economic-environmental parameters. The key differences in both systems are comparatively presented in Table 1.

Table 1. Comparative analysis of solar PV and hydel projects

	Initial Cost	Annual Cost (O&M)	Annual Generation	Net Annual Revenue	NPV	Payback	Gross GHG Reduction	Benefit-Cost Ratio
	USD	USD	GWh	USD	USD	Years	tCO_2	No. units
PV	6.27 B	30 M	9,074.463	395.33 M	1.96 B	7.2	3,712,532	2.00
Hydel	14 B	140 M	18,098	594 M	80.24 M	8.4	7,403,970	1.00

Conclusions

In this paper solar park and hydel power plant of the same capacity (4500 MW) were investigated in terms of techno-economic-environmental parameters. Excessive set of simulations show that hydel dam generates almost twice as much in electricity as of its solar counterpart, however, it requires 9 years for completion against 1 year for solar park. And within that 8 years gap, the installed solar PV system would have contributed 72595.704 GWh to the national grid, generating over $3.16 billion in revenues. Low initial investment, easy to maintain and close revenue figures put the PV system at lower risk consequently making it stand at $1.96 billion in NPV against $80.24 million of hydel-power power plant. The PV system also indicates faster cash in-flows, recovering the investments earlier and thus produces economic and green electricity.

The purpose of this proposed PV project is not to neglect the importance of hydel dams that are and will definitely be remained the need of the country. But in current scenario, when hydel projects will take more than nine years to get commissioned, the wait of its completion could lead to dark nights in the country. So, the proposed project will take much less time and would be an add-on towards power sector while the construction of hydel project should remain continued along aside.

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ENERGY OPTIMIZATION OF A NANOFLUID BASED HYBRID PHOTOVOLTAIC THERMAL SYSTEM USING DUAL BUCK-BOOST CONVERTER

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ABSTRACT

The depletion of fossil fuels and environmental concerns are the main reason to focus more on renewable energy resources. In the past few decades, photovoltaics (PV) focused on the cheapest electricity production worldwide. Increase in solar modules size; new issues come in fronts such as more voltage drop and thermal mismatch due to temperature, tolerance mismatch and higher current and voltage rating of solar panel which affects the system designing. Combining the Nano-Fluid based thermal system and intelligent Buck Boost converters with photovoltaic can overcome these issues. The paper discusses about the designing of dual outputs of a single PV Panel, dropped voltage and current issues due temperature and other effect on a high power/size solar panels in the market. The design is based on the Simulink based simulations of Intelligent Buck-Boost converter and practical work of Nano fluid with an overall electrical and thermal efficiency of 31% was found with PV/T and Buck-Boost converters and dual outputs of a panel.

Keywords: Buck-Boost Converter, Photovoltaics, Hybrid PVT system, Nanofluids, Energy optimization.

Introduction

As the world is growing, renewable energy is one of the cleanest ways to generate electricity. As per the world health organization, approximately 4.2 Million people die every year due to pollution. The burning of fossil fuels, transportation, and industries are the main reason for it and due to that, renewable energy is on focus. Reduction of 90% of traffic from half of the world; approximately 30% of the pollution reduced in Covid-19 attracted people towards renewable energy [1] Every renewable energy has its pros and cons, but currently, the generation of electricity from photovoltaic is one of the cheapest ways worldwide. Different governments are trying to encourage their people by giving them various subsidies. The photovoltaic power plant's one-time cost provides a minimum of 25 years of electricity whose payback period is less than three years. Photovoltaic has a bright future, and researchers have taken its problems seriously.

In 1954, Bell laboratory produced the first crystal silicon cell, which converted 4% of the sun's energy into electricity. In 2021, a manufacturer, 'Sun Power,' launched the X series, 22.8% efficient. A lot of variations and improvements are made and are still in progress in PV technology. But several factors need advancement in PV technology like the different Shadow effect, thermal mismatch, tolerance mismatch, the voltage drop due to temperature, etc. For improvements, the said issues should be resolved to attain better performance. Shadow effects such as soiling, leaf and bird dropping decay the current, which affects the output power of a panel. Fluctuations in current and voltages due to the conditions mentioned earlier make the output unstable and deny the desirable power. Similarly, thermal issues to which solar cells are susceptible, increase in temperature reduce the semiconductor bandgap, and affect all the parameters [2]

In the new coming technologies, the manufacturer introduced the high voltage and high current solar panels in the market, such as Trina Vertex series, which have high current, Longi LR4-72HPH series and Sun Power X-series with high voltages. The high current module can't connect with any PWM based inverter as it has a 50A range, and a single module is giving near 20A. The installation company is unable to attach even three solar modules. In parallel, the MPPT range for small inverters is near 18-20A, so the second string of inverters can't install. As a result, the full PV range can't connect with the inverter. For commercial and industrial projects, high voltage is not suitable as every big inverter can connect an excess amount of PV, which reduced the overall project cost. By installing

the Longi LR4-72HPH series, an excess amount of PV can't be installed, and the project cost will increase with

the addition of another inverter. The companies tried to introduce new technology, but the specific inverters are currently not in the market. Different converter circuits can resolve each problem separately, and various researchers proposed other techniques to overcome such issues. In the past, the cells of solar panels were connected in series. Nowadays, solar cells are connected in parallel and series combination, so installing the Buck-Boost converter for each section separately can recover more power compared to a single Buck-Boost converter on both sections. An intelligent Buck-Boost converter can handle all the mismatching, voltage and current drop with a single circuit's help on a single section. The circuits will judge the output voltage and current of each section separately and make decisions as per requirement on the base of algorithms, which stables the overall string for smooth operation.

In the summer, the solar cell's temperature reaches near 65OC, and approximately 0.5% efficiency decreases on a 1oC increase in temperature, which is a significant loss for small and big PV power projects. Keeping the temperature in its nominal range can increase its efficiency. Several ways to cool the solar panel were proposed, such as bypassing the air or water from the solar panel's back to capture the PV heat. Capturing all the solar panel heat is not easy from the air or water as the specific heat Cp is not so high, using the Nano-fluids of Al2O3 have high specific heat comparatively water and air [3] Using Nano Fluid, the PV module will reduce its temperature and the voltage will start increasing, which drops due to temperature [4] The Buck-Boost converter's installation and passing Nanofluids from the back of the module can increase the overall efficiency by approximately 30%.

Methodology and Results

The main work was to optimize the PV energy which dropped due to temperature. For that purpose, two intelligent Buck Boost converters were used on a single solar panel to work on each part separately for better performance. Two buck Boost converters attached with a single solar panel and then water and nano Fluid passed through the back side to cool down the PV to keep the voltages on its nominal conditions to get the maximum power. Simulink based Buck Boost converters were designed and the results and the Simulink model is given below.

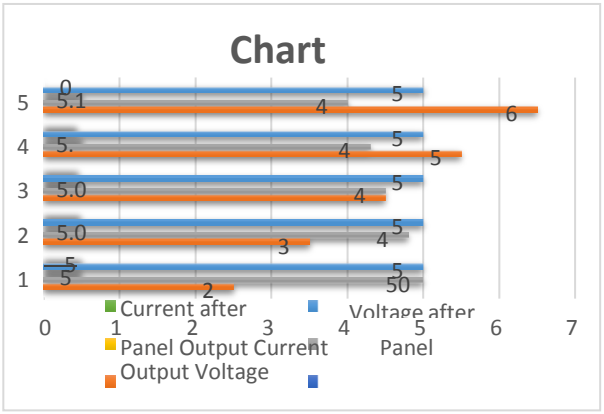

Figure 1 Output voltage and power under Different cell Temperature

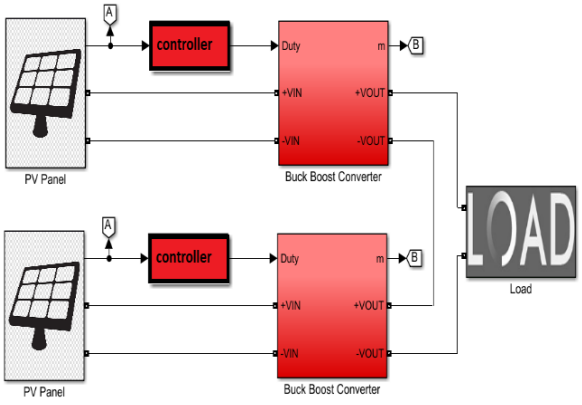

Figure 2 MATLAB Simulation for dual output of PV with dual Buck-Boost Converter

Conclusion

The high temperature of PV shows different voltage drop, thermal mismatch, tolerance mismatch etc., which deteriorates its performance. Temperature reduces output power which affects PV efficiency. The optimization of efficiency done by installing Dual Buck-Boost Converters with two outputs of PV separately and Al2O3 based Nanofluid. In last, results were analyzed; the Buck-Boost converter and Nanofluids increase the system's overall approximately 31% efficiency.

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UPGRADATION OF ALGAN-BASED DEEP ULT RAVIOLET LIGHT-EMITTING DIODES INTERNAL QUANTUM EFFICIENCY WITH ALINGAN-BASED ELECTRON BLOCKING LAYER

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ABSTRACT

The optoelectronic characteristics of AlGaN-based deep ultraviolet light-emitting diodes (DUV LEDs) with step-graded electron blocking layer (EBL) are numerically analyzed. The results show that the internal quantum efficiency (IQE) and radiative recombination rate are excellently improved by incorporation of AlInGaN Step-graded EBL. This significant enhancement is due to the optimal recombination of electron-hole pairs in the active region. This is attributed to the increase of the barrier height due to the decrease of lattice mismatch between the last quantum barrier (LQB) and EBL.

Key words: Efficiency, AlInGaN, UV LEDs

Introduction

For solving the real-world problems, such as water and air purification, decontamination of medical equipment's, photolithography techniques, are require a unique UV band spectrum which must be economical good, efficient, and environmental friendly [1, 2]. Thanks, to AlGaN-based semiconductor alloys, which having these special characteristics such as, mechanically strong, long-life, free-toxic elements such as mercury and lead, etc. Therefore, it is a promising candidate for the above practical applications [3]. But small IQE and efficiency droop specially at high current is still a main challenge in the development of efficient UV LEDs [1, 2]. To tackle this issue, we proposed step-graded AlInGaN-based EBL in UV LEDs. The simulations results show that the optical performance of DUV LEDs dramatically improved.

Methodology

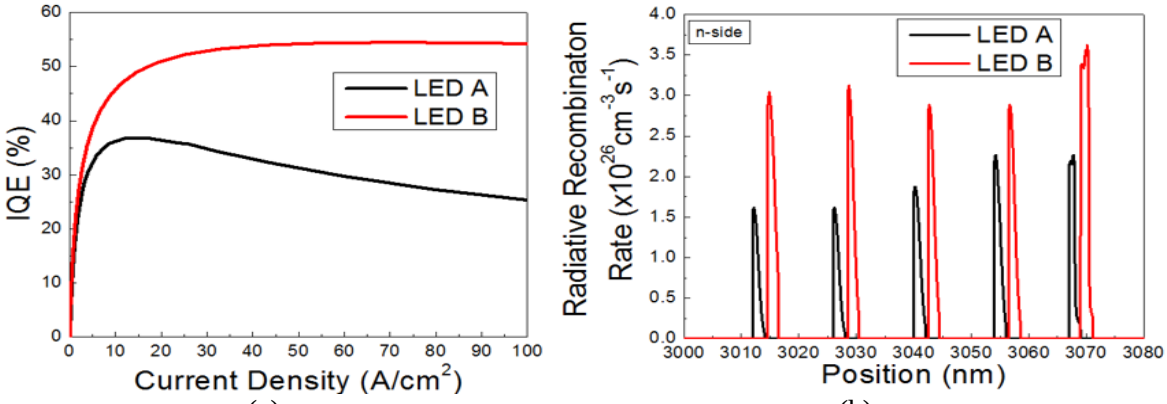
The AlGaN-based DUV LED represented by (LED A) is used as a reference LED in this study, which **numerically simulated using the SiLENSe 5.14**. The reference LED (LED A) comprises of a 3 µm wide electron injector n-$Al_{0.6}Ga_{0.4}N$ layer with doping concentration (1 x 10^{18} cm^{-3}) , the active region consists five pairs of undoped quantum well (QWs) and barrier ($Al_{0.45}Ga_{0.55}N$/ $Al_{0.56}Ga_{0.44}N$), followed by a 10 nm thick $Al_{0.6}Ga_{0.4}N$ EBL layer with doping concentration (5 x 10^{19} cm^{-3}). Two p-type layers i.e., $Al_{0.4}Ga_{0.6}N$ and GaN each having thickness of 50 nm and doping concentration (5 x 10^{19} cm^{-3}). The proposed LED represented by (LED B) is identical to LED A except that the conventional EBL is divided into five layers of $Al_xIn_yGa_zN$, each has a thickness of 2 nm. Further, the EBL is step-graded such that the composition value x, y, z for the first EBL is (0.5, 0.02, 0.28), followed by a 5% decrease of aluminum composition in the next layer (0.45, 0.02, 0.38) and so on up to five consecutive EBLs.

Results and Analysis

Fig. 1 (a) illustrates the IQE profile for both LEDs. The peak IQE of LED A and LED B is ~36% and ~56%, respectively. The IQE of LED B is increased by 54% as compared to LED A. Interestingly, the efficiency droop is severely decreased in LED B as compared to LED. Fig. 1 (b) shows the radiative recombination rate at 70 A/cm^2. The electron-hole pairs radiative recombination for LED B is impressively increased almost by 60% when compared with LED A. It is because of the optimal recombination of electron-hole in the active region of LED. The enhancement in IQE and radiative recombination are very clear. So, it is evidence that the optical performance of LED B (proposed structure) is improved because of the step-graded AlInGaN-based EBL.

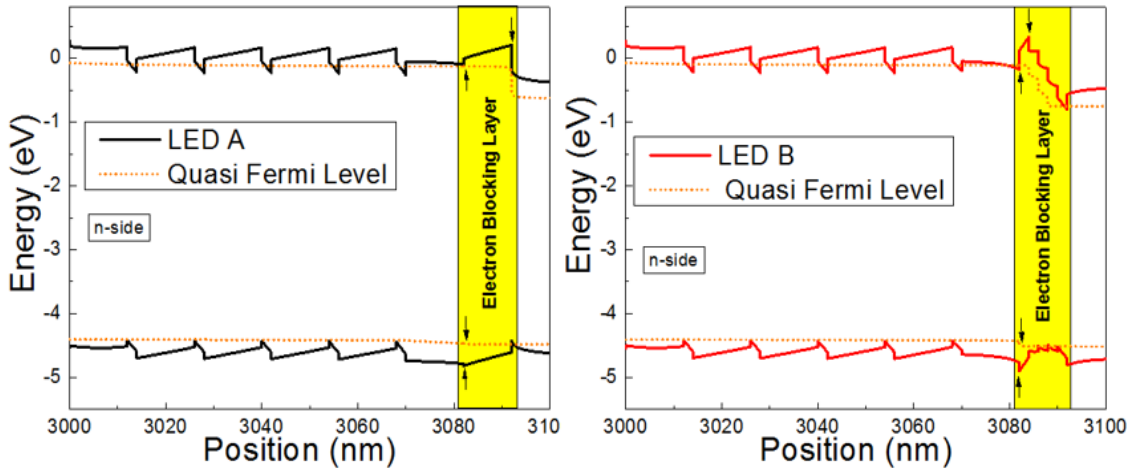
Fig. 2 (a) shows the band profile of both LEDs at 70 A/cm^2. Band analysis is the best approach to observe the electron and hole transport. We can also find the potential barrier height of EBL via band

profile. In Fig. 2 (a) the downward band bending is more visible between LQB and EBL and it is mainly due to the high polarization and lattice mismatch that leads to decrease the potential barrier height of EBL and electrons can overcome it easily [4]. The potential barrier height for electron and hole in LED A is ~328.4 meV and ~340.3 meV, respectively. Inversely, in LED B the potential barrier height for the conduction and valence band is ~436.8 meV and ~328 meV respectively, resulting the better ability of electron confinement as well as hole transport into the active zone as shown in Fig. 2 (b). It is due to decrease of lattice mismatching, which leading lowering the polarization effect [4]. It is highly believed that this band-gap engineering is only possible due to our proposed LED structure.



(a) (b)

(a) IQE as a function of current density, (b) Radiative recombination rates across the active region of both LEDs.



(a) (b)

Fig. 2. Energy band profile (a) Conventional EBL structure (LED A), (b) step-graded EBL structure (LED B) at 70 A/cm^2.

Conclusions

we have investigated the effect of AlInGaN-based step-graded EBL on the optoelectronics behavior of AlGaN-based DUV LEDs. The results show that our proposed structure improved the recombination of electron-hole pairs in the MQWs, because of reduced polarization which attributed to lattice

matching. This not only ameliorated the IQE but also severely reduced the efficiency droop as compared to LED A. So, we highly believe that this approach provides a guideline to the researchers for achieving high IQE as well as near-droop-free efficiency DUV LEDs.

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COMPARATIVE ANALYSIS OF DIFFERENT CONFIGURATIONS OF THERMOPHOTOVOLTAIC OPTICAL CAVITIES FOR IMPROVED IRRADIANCE USING MONTE CARLO RAY TRACE METHOD

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ABSTRACT

Thermophotovoltaic optical cavity is the portion of thermophotovoltaic system where heat transfer and conversion of heat into electricity takes place. Radiation heat transfer being dependent on view factors is not able to transfer heat uniformly which results in nonuniform irradiance on TPV cells and thus loss of opportunity to produce power. This work aims at investigating dependence of heat transfer and thus photocurrent production on view factors by comparing different configurations of optical cavity. Monte Carlo simulation has been used for tracing rays to quantify heat transfer which has also been proved to be very efficient statistical method for evaluating heat transfer problems.

Key words: Thermophotovoltaic Optical Cavity, Irradiance nonuniformity, Monte Carlo Ray Trace

Introduction

Irradiance on photovoltaic cells governs the production of photocurrent and has direct linear relation to it [1]. But dependence of radiation on view factor [2] does not allow the entire cell array to receive same irradiation resulting in irradiation nonuniformity with more irradiation at the mid than at edges. This is commonly known as edge effect and it decreases the total power output of cell array as cells at edges are producing less power than at mid for the same source. These effects have been quantified in this study by increasing view factor of the arrangement and calculating increase in irradiance uniformity. Instead of conventional method of double integration for calculating view factors, a statistical method known as Monte Carlo simulation has been used for this study programmed in MATLAB.

Methodology

Firstly, Monte Carlo ray tracing method has been verified to be used for evaluating view factors by forming Monte Carlo code for finding view factor of simple perpendicular planes configuration. Then, Monte Carlo code has been developed for finding radiation heat transfer in an optical cavity having cylindrical emitter and flat plate cell arrays surrounding it in hexagon, for each cell of the array, and its results are compared against the ones available in literature. Finally, irradiance on each cell of cell arrays arranged in square, pentagon, hexagon, heptagon and octagonal arrangement has been evaluated and are compared on the basis of irradiance uniformity by keeping the distance between emitter and receiver same.

Results and Analysis

View factors obtained from Monte Carlo simulation for 108 geometrical configurations of perpendicular rectangular plates with common edge have an average percentage error of only 1.631% which proves it to be an efficient method for evaluating view factors. Monte Carlo simulation for finding irradiance on cells of cylindrical emitter and hexagonal arrangement of flat plate receivers configuration resulted in an average percentage error of 3.3624% depicting efficacy of Monte Carlo simulation for evaluating heat transfer problems. Therefore, using Monte Carlo ray tracing method, irradiance on square, pentagon, hexagon, heptagon and octagon arrangements have been evaluated and irradiance uniformity for these arrangements has been found to be 47.9491%, 59.5747%, 63.5656%, 67.2483% and 69.0242% respectively. Average irradiances for these arrangements have been evaluated as 1.1205, 1.2649, 1.3327, 1.3688, 1.3881 W/cm^2 respectively.

Conclusions

Monte Carlo ray tracing method is an efficient radiation modeling tool with wide range of applications. This method has been used for comparing different optical cavities on the basis of irradiance they receive and irradiance uniformity. Increasing number of receivers around emitter from four to eight has resulted in increase in irradiance uniformity by 21% and average irradiance and thus photocurrent by 23.88%.

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OPTIMIZING DESIGN AND PROCESS PARAMETERS TO IMPROVE THERMAL EFFICIENCY OF DOMESTIC GAS STOVE BURNERS

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ABSTRACT

In this study, thermal efficiency of a domestic gas stove was improved by optimizing design parameters such as burner design, loading height, primary aeration, and semi-confinement of flame. Experimental results showed that swirl burner design of the flame increased the residence time of the combustion products and hence increased the thermal efficiency by 1.6% at the optimum loading height of 2.5 inches. Primary aeration improved the efficiency by increasing flame temperature and promoting the completion of combustion reaction. Flame confinement with a metallic shield also improved the efficiency by 4-5% due to a delay in dispersion of flue gases into atmosphere.

Key words: Thermal efficiency, swirl burner, radial burner, emissions

Introduction

Statistical study of energy demand showed that global energy requirement will be increased by a factor of two or three during the current century [1]. Due to such high energy demands, processes of energy utilization should be efficient [2]. Recently, great attention was paid on the efficient combustion processes at industrial and domestic levels to enhance the thermal efficiency and reduce the emissions during combustion [3, 4]. This study focused on enhancing thermal efficiency for domestic gas burner to reduce the rapid depletion of local natural resources. During this experimental study different parameters were investigated such as design of burner (swirl/radial flow), loading height, primary aeration, and semi-confined combustion flame to analyze their effects on thermal efficiency

Methodology

Natural gas was used a fuel which was supplied by Sui Northern Gas Pipeline Limited (SNGPL). Diaphragm gas meter and pressure regulator were used to measure the volume of natural gas in cubic meter (m^3) and to adjust the pressure, respectively. In all experiments, the pressure (P) of natural gas, water load (M), and temperature ramping were 28 mbar, 4.4 kg, and 50 °C (from 30 °C to 80 °C), respectively. A K- type thermo-couple with a range of -270 °C to 1260 °C, coupled with a temperature recorder was used to measure the temperature of water load. Thermo-couple was inserted in water up to the middle of loading vessel through a hole in the lid. Volume of natural gas consumed in m^3 for 50 °C rise in temperature from 30 °C to 80 °C of water load was measured using gas meter. Same procedure was adopted for swirl and radial burners. Stand used to vary loading height.

Results and Analysis

The swirl flow burner exhibited higher thermal efficiency than the radial flow burner at constant supply pressure, flow rate and loading height. This was due to increased heat transfer coefficient at the vessel bottom as a result of the swirling motion which resulted from the prolonged residence time of the combustion products in the vicinity of the vessel bottom. Moreover, improved mixing of gas and air was achieved due to swirling motion. In the temperature range between 30-80 °C, the average thermal efficiency of swirl flow burner was 1.6% greater than radial flow burner.

The thermal efficiency of both swirl and radial burner increased significantly by 4-5% with metallic shield than without shield for the same level of heat input. However, this might result in slight increase in CO emission as the secondary air supply could be slightly suppressed when the burner was enclosed in metallic shield. Most commonly used domestic burners are operated on an open flame, which cause huge loss of energy to the atmosphere and consequently thermal efficiency decreases. Thus, thermal efficiency can be effectively increased by dispersion of flame or flue gas should be delayed which can be achieved by swirl motion and semi-confinement of flame.

In general, for the case of swirl and radial burners, initially the thermal efficiency increased from 34.4% and 31.8% to 38.4% and 36.8% with the increase in loading height from 0.5 inches to 2.5 inches, respectively. Afterwards, the efficiency decreased to 37.3% and 36.3% at the loading height of 4.0 inches, for swirl and radial burners, respectively. For small loading height (i.e., 0.5 inches), complete combustion cannot be achieved since the flame keeps impinging at the bottom of the loading vessel, which resulted in decreased thermal efficiency. With increase in loading height, combustion goes towards completion and allows efficiency to reach a maximum value. However, with the further increase in loading height (optimum value), the flame and combustion gases are cooled to a greater extent by mixing with ambient air before contacting the loading vessel. Thus, the temperature driving force for heat transfer is decreased which decreases the thermal efficiency. At constant pressure and flow rate of gas, the increase of loading height reduces CO emissions as a result of complete combustion (all carbon to CO_2). On the other hand, the decrease in loading height leads to enhancement of flame impingement of the loading vessel. Consequently, incomplete combustion increases due to increased quenching by the load which increases emissions of CO and un-burnt hydrocarbon. Incomplete combustion is an indication that either the primary or secondary air supply is insufficient or the flame is being quenched by the impingement on a cool surface. These emissions of CO and un-burnt carbon particles were also observed as a deposition on the bottom of loading vessel. Deposited carbon particles on the bottom of loading vessel further decreases heat transfer co-efficient and thus contribute to the decrease in efficiency.

The efficiency of the flame with primary air was higher than that of absence of primary air. The deposition of un-burnt carbon and soot particles on the vessel bottom was observed which might decrease heat transfer coefficient affecting the efficiency of the flame burning without the supply of primary air. In this study, the optimum value of efficiency in the presence of primary air was approximately 38.5 % at a loading height of 2.5 inches, whereas for the case when primary air was not being supplied, the optimum value of efficiency was neatly 36.5 % at a loading height of 3.5 inches. The only possible reason for this finding could be the length of flame. When primary air was open, short flame appeared and the optimum value of efficiency was obtained at a loading height of 2.5 inches. However, for the other case when primary air was closed, long flame was observed and the optimum value of efficiency was obtained at higher loading height (i.e., 3.5 inches) relative to the case when primary air was open (i.e., 2.5 inches).

Conclusions

Swirl flow in the burner design promoted mixing of fuel and air and thus contributed to increase in thermal efficiency by 1.6% than the conventional radial flow burner. The maximum thermal efficiency was found to be 38.4% and 36.8% for swirl and radial burners at optimum loading height of 2.5 inches, respectively. Delaying the dispersion of flue gas or the flame into atmosphere by enclosing the flame with a metallic shield increased the thermal efficiency by 4-5% for both swirl and radial burners. However, it could lead to a slight increase in CO emission due to limited secondary air. Primary aeration shortened the flame, increased its strength in terms of temperature, facilitated the completion of combustion reaction and hence, improved the efficiency. Blue and yellow colored flames were observed in the presence and absence of primary aeration, respectively. This study provides necessary framework regarding design modifications and optimization to achieve maximum efficiency for burners used in domestic stoves.

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MATHEMATICAL MODELING OF ABLATION MECHANISM DURING NANOSECOND PULSED ELECTRON BEAM PROCESSING OF THIN FILMS FOR SOLAR CELL APPLICATIONS

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ABSTRACT

Pulsed electron deposition (PED) has emerged as a novel thin film deposition method with salient features for industrial-scale solar cell manufacturing. Target material ablation induced by electron beam consists of various physical stages, beginning with rapid heating, melting, and target surface erosion. Ablation phenomena significantly affect the mass transfer processes, composition, space distribution, and deposition rate of the target material, which has a decisive influence on the structure, properties, and stoichiometry of deposited thin films. In this study, a two-step one-dimensional thermal conduction model is suggested to study the ablation phenomena during zinc oxide target. The surface receding velocity, ablated mass per pulse, ablated depth, and surface temperature are assessed from the solution of the model. Obtained results are in good agreement with the available experimental data in the literature.

Keywords: ablation, thin film, zinc oxide

Introduction

In recent years, intense short electron pulses have received remarkable recognition due to technologically principal uses in different areas ranging from electron beam lithography to thin-film fabrication [1]. Lately, pulsed electron deposition (PED) has emerged as a quite novel and intriguing substitute, owing to various unique characteristics, to the well-known technique of pulsed laser deposition (PLD). During PED, high voltage and current electron pulses are engaged to ablate the small portion of the target surface. In PED, intense electron pulses are produced by a channel-spark (CS) discharge system [2]. The electron beam produced by channel-spark discharge is categorized by high power density (108 W/cm2), and short pulse duration (~100 ns). The beam is directed towards the surface of the target material by low-energy electrons (~10-20 keV), and it diffuses (~1 μm) into a target surface. Beam irradiation initiates rapid target surface vaporization and expansion of plasma plume in a substrate's direction due to non-equilibrium heating. Therefore, high-quality thin films can be fabricated at a relatively lower substrate temperature than other thin film deposition techniques [3]. It has been proven experimentally that PED can be an effective method for the processing of thin films for solar cell applications [4]. Even though PED is rising in experimental advances, the target ablation phenomenon during electron beam irradiation is still entirely unknown. Irradiation of a target material with an electron beam is a complicated process involving beam energy absorption, heating, state change, and target surface removal. Due to short temporal and spatial scales involvement during beam irradiation, surface ablation cannot be easily persuadable to empirical observations as in situ measurements of the phenomena taking place during ablation can be fairly cumbersome. Therefore, due to the complications and inherent limitations associated with ablation phenomena, mathematical modeling can help better understand the mechanism taking place during ablation. In the current study, a two-step thermal model is employed to explain ablation phenomena taking place during nanosecond pulsed electron beam processing of zinc oxide thin films.

Methodology
During nanosecond pulsed electron beam processing of target material, target surface experiences intense heating and rapid state change from the solid state to vapor state [5]. Therefore, target ablation phenomena can be explained by a two-step one-dimensional thermal conduction model. The model exploring ablation induced during nanosecond pulsed electron beam processing of target surface has been defined elsewhere comprehensively in detail [2].
Results and analysis
Surface temperature profiles calculated from the model indicate no explosive boiling (phase explosion) phenomena during PED. Normal vaporization is the most apparent thermal mechanism taking place during the target surface ablation. Accordingly, this indicates that the thin films grown during PED will have a smooth surface without microscopic droplets.

Conclusions
A two-step, a one-dimensional thermal model is suggested to study the ablation mechanism responsible for thin film growth in PED. A finite element method (FEM) is used to model the heat conduction equation to calculate the temperature's spatial and temporal distribution for a zinc oxide target. Ablated mass per pulse, ablated depth, and surface receding velocity are also estimated. Obtained results and relevant experimental data are compared to evaluate the model validity.

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INVESTIGATING PRODUCT/PROCESS AIR OF EVAPORATIVE COOLING SYSTEMS FOR TEMPERATURE AND HUMIDITY ANALYSES

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ABSTRACT

Evaporative cooling is an energy-efficient technique used for cooling purposes in hot and dry climatic regions. In this study, direct and indirect evaporative cooling systems are developed on a lab scale. The study investigates the experimental results of developed systems for Multan climatic conditions. Also, the performance of the systems is checked in terms of wet-bulb effectiveness. Results show that the performance of the direct evaporative cooling system is higher than the performance of the indirect evaporative cooling system.

Keywords: Evaporative cooling, Air-conditioning, Wet-bulb, Pakistan

Introduction

In the modern world, air conditioning is being used extensively for humans as well as non-human applications [1]. The working of 95% of available air conditioning systems is based on the vapor compression (VCAC) technique which consumes high primary energy and causes global warming [2]. Evaporative cooling-based air conditioning (EC) systems are considered energy efficient, and environment friendly for hot and dry regions [3]. Direct and indirect evaporative cooling systems are two different types of EC systems. The author discussed the detailed review of evaporative cooling [4]. In the present study, the performance of developed systems for Multan (Pakistan) is discussed in terms of wet-bulb effectiveness.

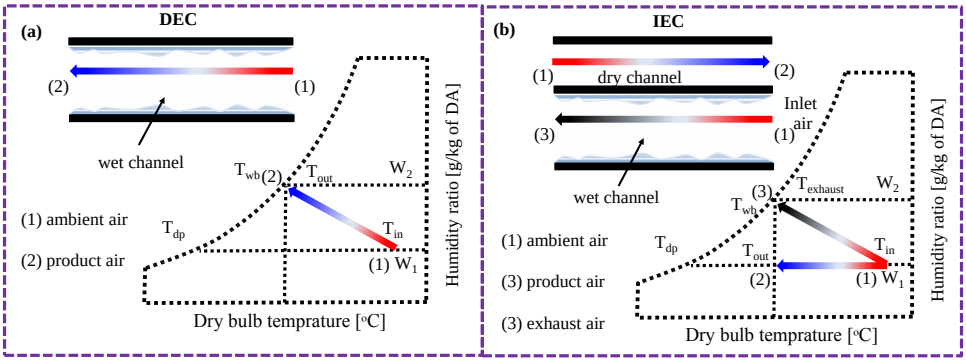

Figure 4 Working principle and psychrometric diagram of (a) DEC system, and (b) IEC system.

Methodology

Evaporative cooling systems are developed with locally available materials on a lab-scale to investigate the performance of the systems for different climatic conditions of Multan Pakistan. In the DEC system, pad material is used as a wet channel. In the IEC system, aluminum sheets coated with felt are used to develop a heat exchanger which consists of wet and dry channels. According to the literature, developed systems can reduce the temperature up to wet-bulb, therefore, the performance of the systems is checked in terms of wet-bulb effectiveness by using wet-bulb effectiveness Eq. (1) [5].

$$\varepsilon_{wb} = \frac{T_{in} - T_{out}}{T_{in} - T_{wb}} \quad (1)$$

Results and Analysis

The present study investigates the performance of the developed evaporative cooling systems for Multan climatic conditions on daily basis data. Figure 2 (a) shows the daily basis variation in

temperature and relative humidity of the DEC and IEC system for May. It shows that the performance of the DEC and IEC system depends on the ambient air temperature. Figure 2(b) shows the wet-bulb effectiveness of developed systems. The effectiveness values of DEC and IEC systems are identical, however, the performance of the systems changed due to the temperature and humidity of ambient air.

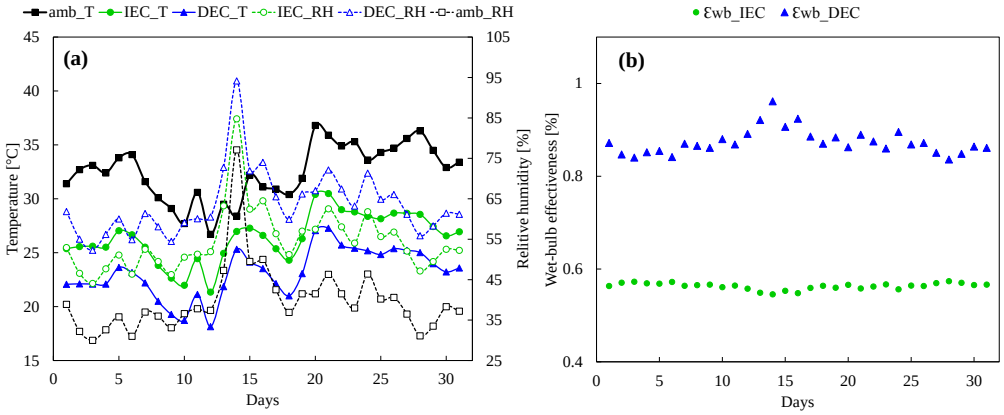

Figure 5 Results of developed evaporative cooling systems: (a) Variation in temperature and relative humidity, (b) wet-bulb effectiveness of the systems.

Conclusions

This study investigates the performance of direct and indirect evaporative cooling systems for climatic conditions of Multan (Pakistan). Results indicate that the developed systems perform better in hot and dry areas. From the result it can be noticed that the performance of the direct evaporative cooling system is high as compared to the indirect evaporative cooling system, however, the DEC system increases the humidity level. The performance of the IEC system is low, but it can be used for achieving constant humidity. The performance of an evaporative cooling system is limited in humid regions. Results also show that the wet-bulb effectiveness range of DEC and IEC system is between 0.75-0.9 and 0.5 to 0.6, respectively.

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PERFORMANCE EVALUATION OF EVAPORATIVE COOLING OPTIONS FOR LIVESTOCK THERMAL COMFORT

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ABSTRACT

The purpose of this research was to perceive the influence of heat stress on milk production and milk yield of foreign cattle breeds. To achieve objectives, three evaporative cooling systems; direct evaporative cooling (DEC), indirect evaporative cooling (IEC) and Maisotsenko cycle evaporative cooling (MEC) systems were investigated for livestock thermal comfort. Highest THI were found in July and August, 86.5 and 85.9 respectively, which indicates higher heat stress during these months. Maximum effectiveness 0.96, 0.68 and 0.55 achieved by DEC, MEC and IEC systems correspondingly. Results concluded that IEC and MEC are feasible for livestock thermal comfort.

Key words: livestock, heat stress zone, temperature, relative humidity, temperature humidity index

Introduction

Livestock sector is not only the major source of foreign exchange earnings, but it is also the largest source of income for the rural population. The increase in ambient temperature causes the increase in body temperature, which results to the heat stress phenomena [1]. Figure 1 Demonstration of evaporative cooling options and psychrometric representation of animal thermal comfort. that ranges from 5°C to 25°C. The optimal growth for livestock can be achieved with accuracy in control environment [2]. The existing energy producing technologies are harmful for the environment and consume large amount of energy [3]. To reduce the energy consumption and to control the global warming potential, three types of evaporative cooling systems such as DEC, IEC and MEC systems are designed as shown in Figure 1. Therefore, the aims of this study are to estimate and to check the feasibility evaporative cooling system for thermal comfort of cattle Pakistan.

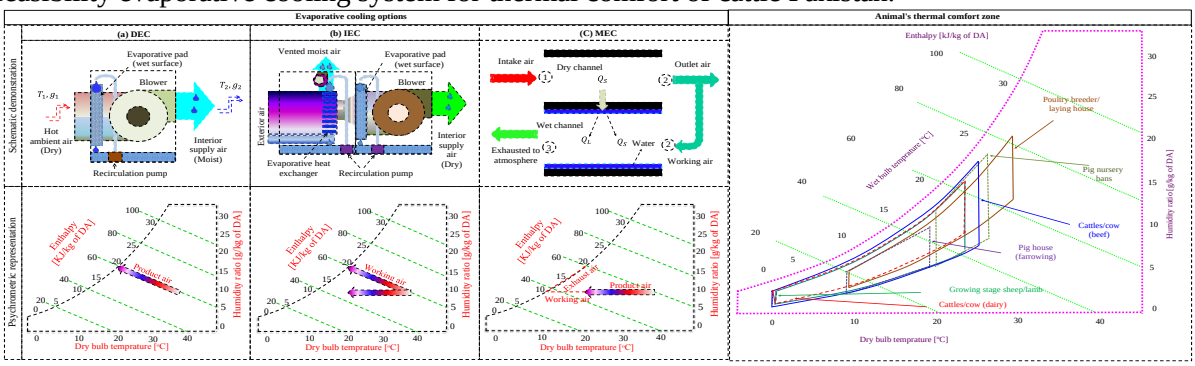

Figure 6. Demonstration of evaporative cooling options and psychrometric representation of animal thermal comfort.

Research Methodology

Thermo neutral zone for livestock application can be calculated by temperature humidity index (THI) It is a relationship between temperature and relative humidity.[4].

$$THI = (1.8T + 32) - [(0.55 - 0.005RH)(1.8T - 26) \quad (1)$$

The performance of direct evaporative cooling and indirect evaporative cooling can be measured by wet bulb effectiveness and the performance of Maisotsenko cycle evaporative cooling system can be calculated by dew point effectiveness.

$$\varepsilon_{wb} = \frac{T_i - T_o}{T_i - T_{wb}} \quad (2)$$

$$\varepsilon_{db} = \frac{T_i - T_o}{T_i - T_{dp}} \quad (3)$$

Where, ε_{wb} shows the wet bulb effectiveness and ε_{dp} represent dew point effectiveness.

Results and Discussions

Figure 2 shows the variation of temperature and humidity achieved by evaporative cooling system on yearly basis. According to Figure 2a MEC system provides a temperature gradient (8°C) whereas the DEC and IEC provided 6.0°C and 4.5°C respectively. According to Figure 2b MEC achieved maximum relative humidity 96.8% whereas it was 73.2 % and 66.1% in case of DEC and IEC systems. Figure 3 represents the variation of temperature humidity index and effectiveness of evaporative cooling system for climatic conditions of Multan. According to Figure 3a highest THI were found in July and August, 86.5 and 85.9 respectively, which indicates higher heat stress during these months. According to Figure 3b the maximum effectiveness 0.96, 0.68 and 0.55 achieved by DEC, MEC and IEC systems correspondingly. The Maisotsenko cycle evaporative cooling system is suitable for livestock application in climatic condition of Multan.

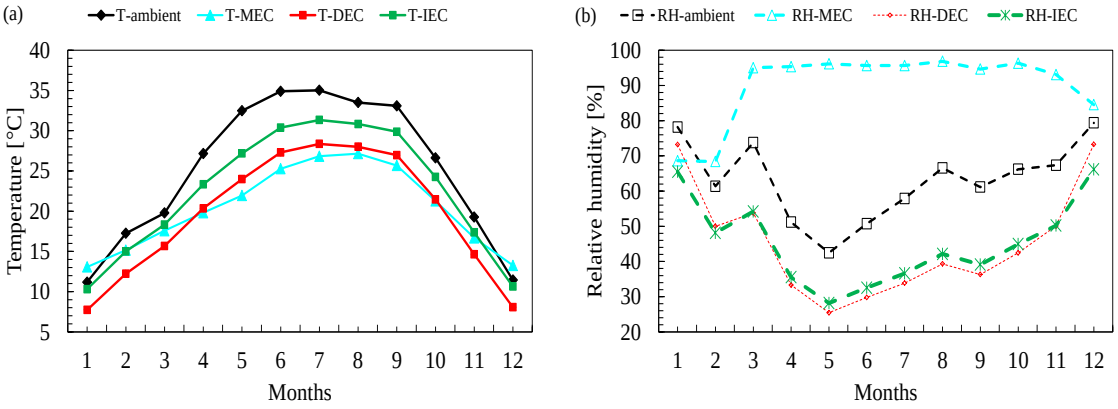

Figure 7. Yearly analysis for the proposed evaporative cooling system (a) Variation of temperature (b) Variation of relative humidity.

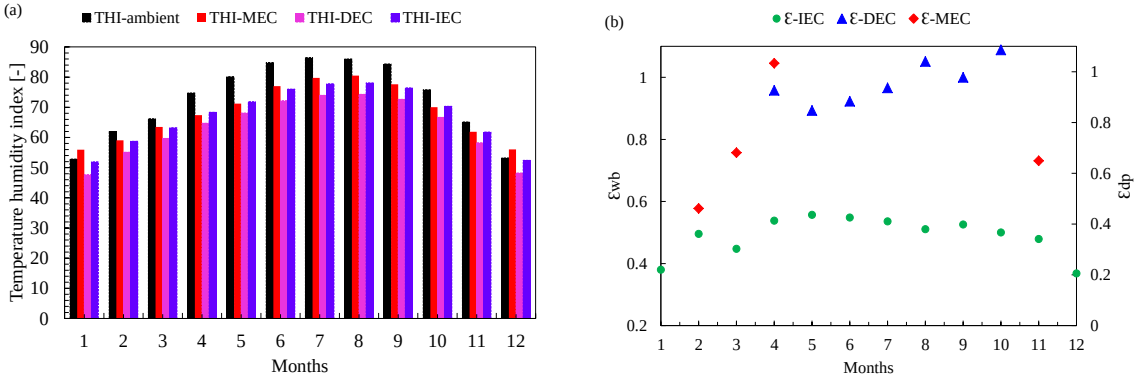

Figure 8. Yearly analysis for the proposed evaporative cooling system (a) variation of temperature humidity index, and (b) variation of effectiveness.

Conclusions

From results it has been concluded that heat stress has strong effect on milk yield and milk composition of foreign cattle breeds in Pakistan. Managing policies are necessary to diminish heat stress and attain ideal dairy animal performance. It has been seen that due to excessive humidity DEC system cannot fulfill the desired thermal comfort conditions for livestock applications. On other hand IEC and MEC systems can complete the air-conditioning needs for livestock application.

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INVESTIGATING DESICCANT DEHUMIDIFICATION SYSTEM FOR THE STORAGE OF GRAPES

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ABSTRACT

Air-conditioning systems play an important role in storage of post-harvest agricultural products like fruits and vegetables. Fresh harvested agricultural products are perishable in nature and has higher rate of decay. To avoid the increasing rate of decay, proper air-conditioning system is required in which the control of the temperature and relative humidity is major concern. In the present study, Maisotsenko cycle assisted desiccant air-conditioning (M-DAC) system has been evaluated for storage of agricultural products by using steady state model. In addition, total soluble solids (i.e., maximum 23.6 ºBrix), physiological weight loss (i.e., maximum 10.81%), acidity (i.e., maximum 0.84%), and firmness (i.e., maximum 0.5 kg) is determined. The results show that temperature (i.e., minimum 9℃) and relative humidity (i.e., maximum 95%) for M-DAC system is feasible for storage of the products.

Keywords: *desiccant, dehumidification, evaporative cooling, agricultural products, storage, feasibility*

Introduction

Agricultural products are perishable in nature and need proper air conditioning system to use them during off-season. In this regard, proper temperature and relative humidity are required. their shelf life decreases with the passage of time [1]. Air conditioning is the process of controlling the temperature and relative humidity for different applications. Different agricultural products have different requirements of temperature and relative humidity [2]. The available vapor compression based air conditioning systems are being used in the storage system but these systems are not environment friendly and energy efficient [3]. Low cost and energy efficient air conditioning systems are evaporative cooling systems and desiccant air conditioning(DAC) system having more potential for the storage of agricultural products and animals thermal comfort [4]. In the present study, experimental investigation of the standalone DAC and M-cycle based DAC is explored to check feasibility for the storage of agricultural products.

Research methodology

For the dehumidification of the air, steady state model has been used. After dehumidification, heat exchanger and M-cycle based evaporative cooler has been used [5].

$$h_2 = 0.1312h_7 + 0.8688h_1 \quad (1)$$

$$RH_2 = 0.9428RH_7 + 0.0572RH_1 \quad (2)$$

$$X_2 = \frac{e^{0.0551t_2\,(0.9428RH_7+0.0572RH_1)} - 1.7976}{18.671} \quad (3)$$

$$T_{3,db} = T_{2,db} - \varepsilon_{HX}\left(T_{2,db} - T_{1,db}\right) \quad (4)$$

$$T_{out} = 6.70 + 0.2630\,(T_{in}) + 0.5298\,(W_{in}) \quad (5)$$

where $T_{3,\,db.}$ is the temperature obtained from heat exchanger and T_{out} is the output temperature of M-Cycle based evaporative cooler and "h" represents enthalpy, "RH" represents relative humidity, "t" represents temperature and X_2 represents the humidity ratio.

Results and discussion

During the performance of experimental system, the obtained results are shown in figures given below.

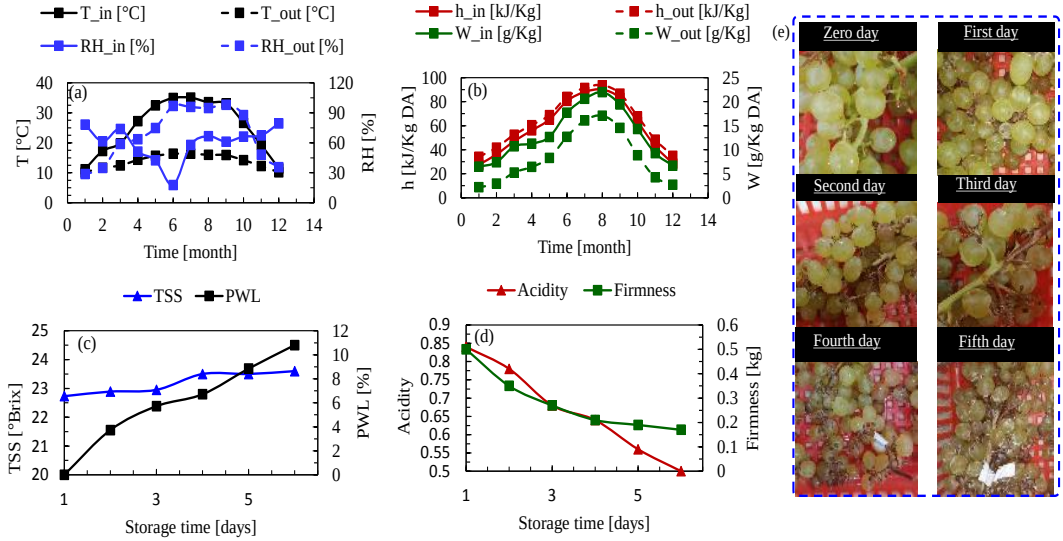

Figure 9 (a)Temperature and relative humidity variations at inlet and outlet points of M-DAC system (b) Humidity ratio and enthalpy profile for M-DAC system (c) variations of TSS and PWL in the grapes during the storage (d) Variations in firmness and acidity of grapes during the storage (e) Visual appearance of grapes during the storage time.

Figure 1(a) shows obtained temperature (i.e., minimum 9℃), and relative humidity (i.e., maximum 95%) profile for M-DAC system. Figure 1(b) represents enthalpy (i.e., maximum 82.97 kJ/kg) and humidity ratio (i.e., maximum 17.07 g/kg-DA obtained at the outlet condition of M-DAC system, Figure 1(c) illustrates the variations in quality parameters like total soluble solids (i.e., maximum 23.6 ^{o}Brix) and physiological weight loss (i.e., maximum 10.81%) during storage of grapes, Figure 1(d) represents the quality parameter of the grapes during the storage time. Quality parameters get change during the storage system. acidity (i.e., maximum 0.84%) and firmness (i.e., 0.5 kg) and Figure 1(e) represent visual appearance of grapes during the storage. Quality of the grapes get decreases with storage time.

Conclusions

Agricultural products are perishable in nature and required optimum temperature/relative humidity conditions for their storage. Conventional air-conditioning systems consumes high primary-energy and could not achieve required conditions for storage of products. In this regard, present study, investigates the performance of M-Cycle assisted desiccant air conditioning (M-DAC) system for agricultural products storage. In addition, total soluble solids (i.e., maximum 23.6 ^{o}Brix), physiological weight loss (i.e., maximum 10.81%), acidity (i.e., maximum 0.84%), and firmness (i.e., maximum 0.5 kg) is determined. The results show that temperature (i.e., minimum 9℃) and relative humidity (i.e., maximum 95%) for M-DAC system is feasible for storage of the products.

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INVESTIGATING EVAPORATIVE COOLING BASED DESICCANT DEHUMIDIFICATION SYSTEM FOR POULTRY HOUSES

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ABSTRACT

Poultry birds are fatally sensitive to environmental temperature-humidity and produces heat (sensible and latent) and face heat stress due to consumption of feed/water. Conventional temperature-humidity control system is highly sophisticated that consumes excessive prime-energy. In this regard, this study investigates energy-efficient Maisotsenko-cycle (M-Cycle) assisted desiccant air-conditioning (M-DAC) option for climatic conditions of Multan. In addition, metabolic, total (i.e., maximum 17.54 J/s), sensible (i.e., maximum 6.80 J/s), and latent heat (i.e., maximum 10.74 J/s) production by the birds is determined. The feasibility of proposed system is exploring from viewpoints of COP and temperature-humidity index (THI) for birds. The results show that M-DAC system achieved maximum COP (i.e., 1.12) and THI permissible limit.

Keywords: desiccant dehumidification, evaporative cooling, poultry houses, heat production, temperature-humidity index

Introduction

Optimum temperature (T) and relative-humidity (RH) control is mandatory for efficient growth of birds because they are highly susceptible to ambient air temperature-humidity. Heat stress effect is shown in Figure 1 reproduced from [1]. Conventional vapor compression-based air-conditioning systems are being used leads to high primary-energy consumption and environmental degradation. The Maisotsenko cycle assisted DAC (M-DAC) system deals with latent load via desiccant dehumidification process and sensible load through the EC.[2]. Objectives of present study is to investigate feasibility of evaporative cooling assisted DAC air-conditioning for poultry houses.

Figure-1. Effect of heat stress on poultry birds

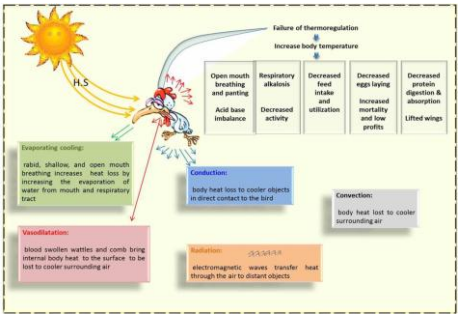
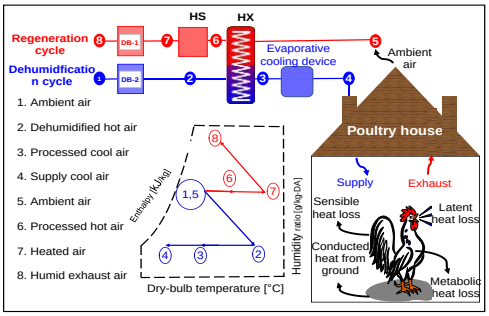


Figure-2. Prposed M-Cycle assisted DAC system



Methodology

The performance of Jurinak Model for desiccant block/wheel is investigated by Equation (1-4) [3]. The sensible HX and M-Cycle cooling device output can be calculated by Equation (5-6) Equation (7-8) is used to calculate coefficient of performance (COP) [4] and THI for birds [5].

$$F_{1,ip} = \frac{\Phi_1}{(T_{ip} + 273.15)^{1.49}} + \Phi_2\left(\frac{w_{ip}}{1000}\right)^{\Phi_3} \quad (1$$

$$F_{2,ip} = \frac{(T_{ip} + 273.15)^{1.49}}{\Phi_4} - \Phi_5\left(\frac{w_{ip}}{1000}\right)^{\Phi_6} \quad (2$$

$$T_{3,db} = T_{2,db} - \varepsilon_{HX}(T_{2,db} - T_{1,db}) \quad (3$$

$$T_{4,db} = 6.70 + 0.2630\left(T_{3,db}\right) + 0.5298\ (X_3) \quad (4)$$

$$COP_{M-DAC} = \frac{h_1 - h_4}{h_7 - h_6} \quad (5)$$

$$THI = 0.85T_{db} + 0.15T_{wb} \quad (6)$$

$$MH = W^{0.75}(307.87 - 15.63 + 0.3105T^2) \quad (7$$

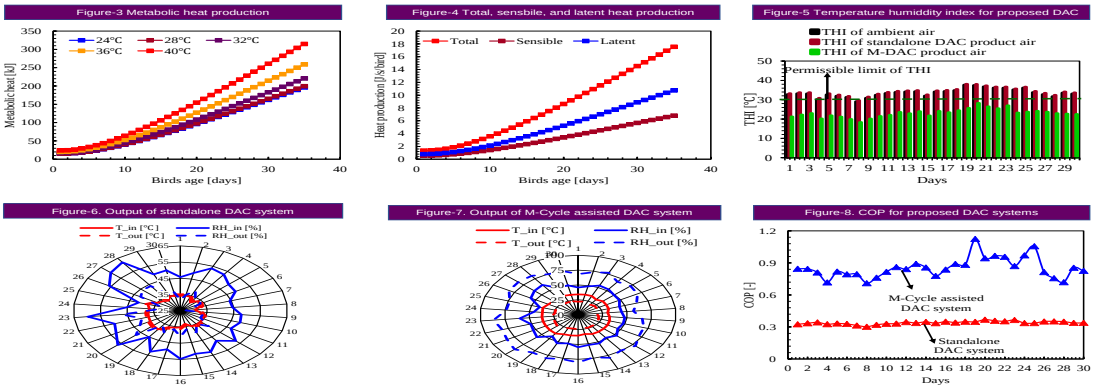
$$Q_{Total} = 10W^{0.75} \quad (8)$$

$$Q_{latent} = q_{water} \times h_{fg} \quad (9$$

$$COP = (h_1 - h_4)/(h_7 - h_6) \quad (10$$

Results and Discussion

Figure 3 shows effect of temperature on metabolic heat production by the birds. Figure 4 shows total (i.e., maximum 17.54 J/s), sensible (i.e., maximum 6.80 J/s), and latent heat loss (i.e., maximum 10.74 J/s) by birds. Figure 5 shows THI of proposed DAC systems and M-DAC systems achieved THI of less than 30℃. Figure 6 shows output of standalone DAC system. Figure 7 shows output of M-Cycle assisted DAC system. Figure 8 shows COP of proposed DAC systems and M-DAC achieved maximum COP of 1.12.



Conclusions

Poultry birds produces sensible/latent heat due to digestion of feed/ water consumption and create heat stress. Heat production is dependent on environmental temperature/humidity. Conventional vapor-compression-based air-conditioning system degrade environment and consumes high primary-energy. This study explores energy-efficient Maisotsenko-cycle assisted DAC (M-DAC) for climatic conditions of Multan. The research methodology is based on thermodynamic analyses of steady-state Jurinak Model from perspectives of COP and THI for birds. In addition, metabolic, total (i.e., maximum 17.54 J/s) sensible (i.e., maximum 6.80 J/s), and latent heat (i.e., maximum 10.74 J/s) production by the birds is determined. The results show feasibility of M-DAC system because it achieved maximum COP (1.12), and recommended THI for birds.

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TOWARDS SUSTAINABLE AND ENERGY EFFICIENT RAILWAYS THROUGH ELECTRIFICATION: THE CASE STUDY OF PAKISTAN RAILWAYS

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ABSTRACT

The use of electric traction in railways is getting popular across the world due to its high efficiency and environmentally sustainable features. Railway electrification has continuously increased in the past decades, and as of 2012, the total electrified track length accounts for nearly 33% of the world rail network, and over 50% of all rail transport was carried by electric traction. In 1969, Pakistan Railways electrified its track from Lahore to Khanewal and added 29 electric locomotives to its fleet. Further extension of the electrified track from Khanewal to Samasata together with the rehabilitation of the existing electrified facilities was proposed for the Railways in 1995. However, due to underinvestment in Railways, poor maintenance, non-induction of new locomotives, insufficient electric power supply, country's energy crisis, and other reasons, the electrification facilities of the railway have been completely disabled since 2009 and the track has been transformed to diesel traction. This study aims to evaluate the performance of electric and diesel locomotives, and the financial l and economic analysis of electrification over Pakistan Railways by analyzing the performance indicators of both Electric and Diesel locomotives available in the Railway Year Books. The analysis shows that the electric locomotives were more efficient as compared to diesel locomotives over Pakistan Railways during the period of 30 years after electrification. Also, the electrification of ML-1 is financially feasible at a discount rate of 12%.

Key words: Railways, Electric Traction, emissions, Energy, Sustainability, Economic Appraisal

Introduction

Electrification of railways is implemented across the globe as a measure to reduce emissions and energy costs. The maintenance cost of the electric locomotives is lesser than equivalent diesel locomotive due to fewer moving parts and lesser vibrations[1]. On the other hand, the electrification infrastructure and equipment installation require high initial investments[2]. Railway electrification has continuously increased in the past decades, and as of 2012, the total electrified track length accounts for nearly 33% of the world rail network, and over 50% of all rail transport was carried by electric traction. In 1969, Pakistan Railways electrified its track from Lahore to Khanewal and added 29 electric locomotives to its fleet. However, due to underinvestment in Railways, poor planning, insufficient power supply from the state grid, and other reasons, the electrification facilities of the railway have been completely inactivated since 2009 and the track has been restored to diesel traction. The Chinese firms working on Railways claimed that the financial benefits of electrification will be about Rs.32 billion per annum through saving on account of fuel, maintenance and operation cost, lesser staff, longer service life, and elimination of on-train power-vans[3]. However, the shortsighted policies of the government are inclined towards short-term goals. Therefore, the infrastructure of the ML-1 project is being planned for the diesel tractions. However, the general trend towards requiring lower emissions and efficient operations has brought the decision-makers to keep the provision of electrification for implementation in the future.

The present literature rarely sheds light on the past performance and current situation of Pakistan Railways. Therefore, there is a dire need to analyze the available data to recommend better options for proper planning of future investments and operation strategies.

Financial and Economic Appraisal

In this section, the financial viability of electrification is presented using cost-benefit analysis. The capital construction and maintenance costs for fixed railroad electrification facilities on ML-1 are estimated using Schwarm et al. (1997), Al-Tony et al. (2000), Pakistan, and Indian Railways Year Books [4-7]. The projected life for the evaluation of the electrification scheme is assumed to be 30 years with five years for construction works. The total electrification cost of ML-1 consists of fixed installations, rolling stock, and maintenance costs. The table presents the estimated capital cost of fixed installations (Rs.52546m), which is expected to be spent equally over five years of construction.

Table 1. Estimated capital costs of fixed installations for electrification of ML-1

Type of installation	Unit	Quantity	Estimated Cost (Rs. million)
Electrification Cost [a]	km	1850	37,000.00
Workshops			15,546.00
Total			52,546.00

Notes: [a] This includes the cost of catenary, substations, controls, and signal and communication system modification for double track.

Table 2. Summary of appraisal results of ML-1 electrification (30-years projected life, 12% discount rate, $1 = Rs.160)

	Items of cost and benefits	Net present value (Rs. Millions)
Costs		
1	Cost of electrification	37,550.00
2	Cost of electric locomotives	133,000.00
3	Operating Cost	16,370.00
4	Maintenance Cost	1,045.00
Total Costs		187,965.00
Benefits		
5	Increase in Passenger Revenue	41,623
6	Increase in Freight Revenue	129,811
Total Financial Benefits		171,433.83
Net Financial Benefits		**-16531.17**
Financial internal rate of return		**10.8%**
7	Time Saved for Road Users	**251**
8	Road Air Pollution Reduction	53
9	Saving in Road Accidents	53
10	Avoidable road vehicles capital cost	8665
11	Reduction of the road vehicles fuel consumption	2270
12	Rail air pollution reduction	532
13	Reduction in rail fuel consumption	5319
Total economic benefits		**188,577.41**
Net economic benefits		**612.41**
Economic internal rate of return		**12.04%**

The results of the financial and economic appraisal are summarized in Table 3. (The detailed analysis is available with authors and will be furnished on request.). The increase in passenger and freight revenue is based on the above analysis and statistics of Indian Railways. The results in Table 5 show that the anticipated financial rate of return would be about 10.8% with a discount rate of 12%. These

results are seen to be acceptable and consistent with the results elsewhere for railway electrification schemes. For instance, the final report of the British Midland Main Railway Line Electrification Study showed that the electrification scheme achieves about 8% financial internal rate of return with a 10% discount rate [8]. Further, the evaluation of electrification of ML-1 based on socio-economic criteria shows that electrification is a feasible scheme with about a 12.04% economic internal rate of return. Currently, the railway operations are not well optimized. The electrified railways have better reliability and punctuality. Therefore, the financial results could be improved through better scheduling and operation optimization.

Conclusions

Pakistan Railways consumes about 160 Million liters of high-speed diesel oil each year. The combustion of fuel roughly adds 0.5 million metric tons of carbon dioxide to the environment. Also, Pakistan Railways is operating low productive workshops to meet the maintenance requirements of diesel locomotives. The performance of electric locomotives had been quite better in the past as compared to diesel locomotives. The heavy diesel locomotives over Pakistan Railways are badly damaging the track infrastructure. Consequently, the Railways is maintaining its depleting track infrastructure through Public Sector Development Funds instead of incurring the development budget to extend facilities to other underdeveloped regions to achieve national socio-economic targets. Besides, the electrification of the ML-1 line is financially and economically feasible especially when the railways is losing billions each year.

The various alternatives of the energy requirements for electric locomotives are required to be studied in future research. Also, a more detailed cost-benefit analysis of various options for electric and diesel locomotive over Pakistan Railways may be the future research direction.

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INVESTIGATING LAB-SCALE UNIT OF THERMOELECTRIC PLATE TO CONVERT HEAT ENERGY INTO MECHANICAL WORK

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ABSTRACT

In recent decade, energy-nexus has become a global concern due to rapid population growth, urbanization, and industrial development. Currently, fossil fuels are main source to contribute global energy production that are continuously degrading environment because of greenhouse gas emissions. In this regard, thermoelectric energy convertors technologies are of greater interest because of their renewable energy features and environment friendly behavior. Therefore, in present study the lab-scale thermoelectric plate-based unit is developed for conversion of heat energy into mechanical work. In addition, temperature, conduction, current density distributions between both ends of the thermoelectric plate is investigated in ANSYS software. The results show thatthe temperature, and voltage distribution from cold side to hot side varies from 22℃ to 452℃, and 0V to 0.008V, respectively. In addition, current density varies between 1.973A/m^{2}to 8.0277e5A/m^2 between both sides of the thermoelectric plate.

Keywords: *Thermoelectric plate,heat energy, mechanical energy, Ansys*

Introduction

One of today's main issues is the supply of safe and non-polluting energy. Currently, fossil fuels account for largest contribution to global energy production[1]. These energy sources are polluting because of emission of greenhouse gases and will be depleted in a few decades [2]. Thermoelectricity is currently emerging as popular and promising alternative energy source among different energy sources for future. Two relatively new material classes are widely recommended for thermoelectric applications which include clathrates[3] and filled skutterudites [4]. The crystal structure of these materials is shown in Figure 1. The thermoelectric energy convertors can transform thermal energy to electrical energy by seebeck effect as shown in Figure 2. The objectives of present study are (i) to develop lab-scale thermoelectric plate to convert heat energy into mechanical work (ii) to see how temperature, voltage, and current distributions occur in thermoelectric plate.

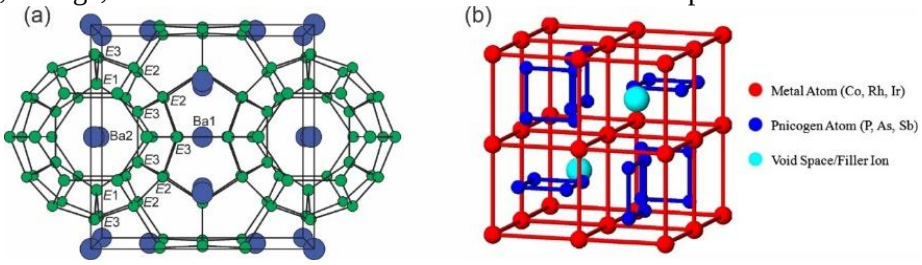

Figure 10. Crystal structure of (**a**)cubic $Ba_8Ga_{16}Si_{30}$, all three E sites are mixed occupied by Ga and Si [3], and (**b**) of filled skutterudite[4].

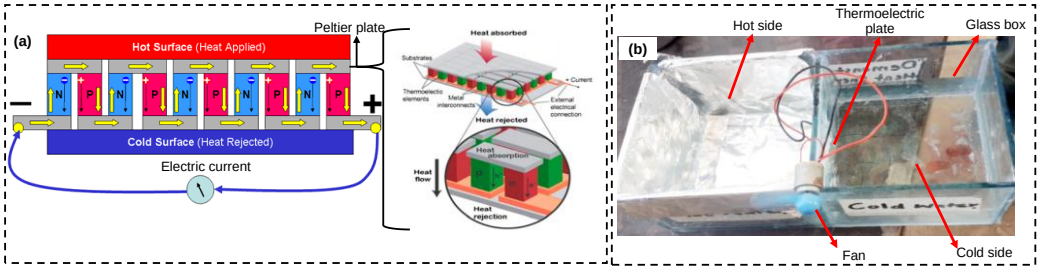

Figure 11.(**a**) working principle of thermoelectric plate[5], and (**b**) lab-scale thermoelectric plate-based unit.

Methodology

In this study lab-scale thermoelectric plate-based unit is developed to convert heat energy into mechanical work. The unit consist of glass box (hot and cold side), thermoelectric plate, and fan as shown in Figure 2(b). In this study, the temperature, conduction, and current distributions between both ends of the Peltier plate was assessed by using ANSYSY software. Peltier plate minimum and maximum temperature was set to 22℃, and 452℃ respectively, as initial boundary conditions to explore the temperature variations inside the Peltier plate.

Results and Discussion

Figure 3(a) and Figure 3(b) shows high and low temperature ends inside plate. Figure 3(c) shows distributions of temperature inside plate. Figure 3(d) and Figure 3(e) shows low and high potential inside plate. Figure 3(f) shows current distributions inside plate.

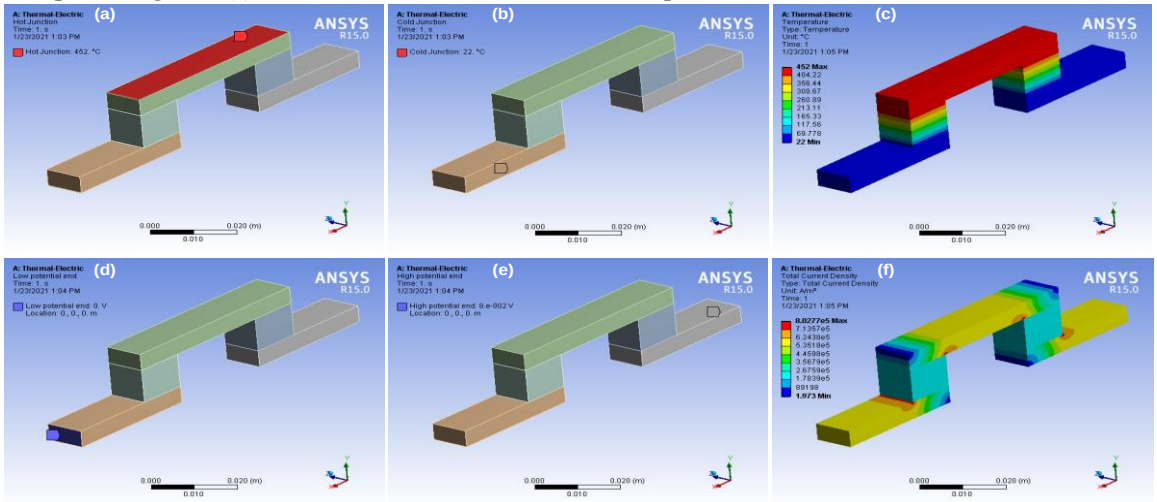

Figure 12. Distributions of (**a**) high temperature (**b**) low temperature, (**c**) temperature at both ends, (**d**) low potential, (**e**) high potential, and (**f**) current inside the Peltier plate.

Conclusions

World's energy demand is continuously increasing day by day and conventional(fossil fuels) source of energy have limited stock. Also, these sources are degrading the environment due to greenhouse gas emissions. Thermoelectric energy convertors are emerging technologies because of environment friendly and renewable features. In this study, thermoelectric based lab-scale unit is developed to transform heat energy into mechanical work. In addition, the temperature, voltage, current distribution between both sides of the thermoelectric plate is investigated in ANSYS software. The result shows that temperature, voltage, and current distribution varies between 22℃ to 452℃, 0V to 0.008V, and 1.973A/m^{2}to 8.0277e5A/m^2 between both sides of the thermoelectric plate.

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DEVELOPING GIS MAPS TO INVESTIGATE THE FEASIBILITY OF EVAPORATIVE COOLING SYSTEMS FOR AGRICULTURAL APPLICATIONS IN PAKISTAN

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ABSTRACT

Present study aims to investigate the applicability of evaporative cooling systems by utilizing geographical information system mapping system. Wet-bulb effectiveness (WBE) of direct and indirect evaporative air-cooling systems was found to be 0.85-0.95 and 0.50-0.65, respectively. Dew point effectiveness of M-cycle based evaporative air-cooling system was found to be 0.45-0.55 for the climatic conditions of Pakistan. Results showed that EC systems were found to be more effective in areas with higher temperatures and lower relative humidity for numerous potential agricultural applications.

Keywords: Evaporative cooling, GIS, mapping, agricultural applications

Introduction

Cooling is a basic need of almost all the sectors of any community. These sectors might include the agriculture sector (in terms of livestock thermal comfort), industrial (processes) sector, residential and commercial building cooling, human thermal comfort, agricultural product storage (cold storage zones)[1]. The direct evaporative cooler is locally available and highly efficient in the case of just cooling not humidity control case[2]. In other words, it has the cooling and humidification (Isenthalpic) process. (DEC) have the limited applicability means when the outside temperature is high and low relative humidity [3]. The indirect evaporative cooling (IEC) and Maisotsenko cycle based evaporative cooler (MEC) is also highly efficient but have the complete humidification and dehumidification control[4]. In IEC we achieve the temperature up to the wet-bulb temperature (W_{BT}). While in the case of (MEC) we achieve the temperature up to the dew point temperature (T_{dp}) that is also cooled sensibly. The humidity control in the (IEC) and (MEC) are majorly important in many sectors[5].

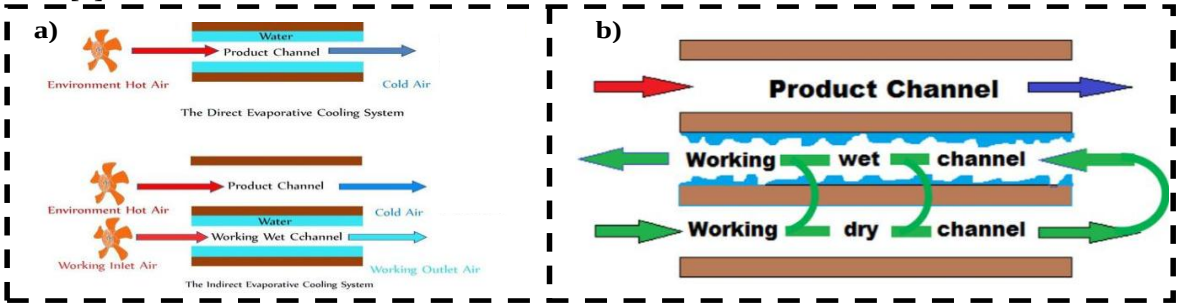

Figure 13. Illustration of evaporative cooling systems (a) wet bulb (b) dew point

Methodology

Climatic data is obtained from the metronome that was in the raw form and further processed to obtain the use and beneficial results. The data was R_{hin} & T_{in} and is further in the form for both cases direct and indirect cooling.

$$\varepsilon_{dewpoint} = (T_{inlet}\,Tout)/(T_{inlet}\text{-}DPT) \quad (1)$$

$$\varepsilon_{wetbulb} = (T_{in}\text{-}T_{out})/\,(T_{in}\text{-}WBT) \quad (2)$$

$$h = 1.006\,T + w\,(2501 + 1.86\,T) \quad (3)$$

Results and Discussion

The potential of evaporative cooling has a great and lies in almost all Pakistan except the Northern areas and Coastal areas while having Baluchistan a greater potential of evaporative cooling. In Punjab, EC has the greatest potential in the Multan city and marginal EC potential in other cities and marginal potential in Sindh in the month of June. The possibility of evaporative cooling has a great and lies in almost all Pakistan except the Northern areas and some areas of Baluchistan (i.e Quetta). In Punjab & Sindh EC have the greatest applicability in the Multan city and marginal EC possibility in other cities and marginal potential in Sindh in the month of January. The map shows that the EC can be applied in the coastal areas of Pakistan as well as limited areas of Pakistan.

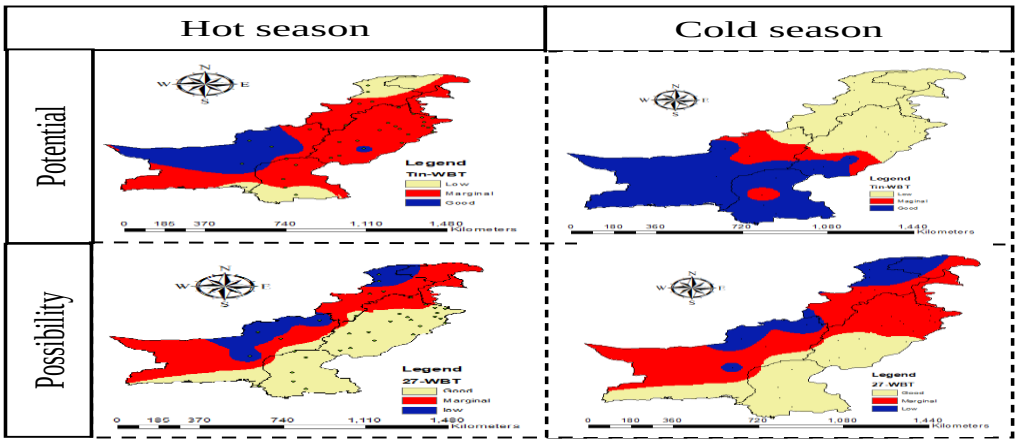

Figure 14. Potential and possibility of evaporative cooling options for hot and cold month of year.

Conclusions:

In the present study, the feasibility of evaporative cooling systems in the two months one month is extremely cold and the other one is extremely hot it can be seen that clearly that the system can be applied in all cases. IEC & MEC can be almost applied throughout Pakistan in all months because its works on the dehumidification. DEC just can be applied just in summer. This study may be helpful to choose an EC system to apply in any sector.

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INVESTIGATION OF KINETIC AND THERMODYNAMIC PARAMETER OF SAPODILLA LEAVES PYROLYSIS BY USING COATS REDFERN METHOD

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ABSTRACT

Determination of the energy potential of indigenous biomass waste is primarily the focus of every country in its quest to meet the energy demand via clean and sustainable sources. Pakistan, being an agricultural country, has huge potential of bioenergy production by agricultural waste [1]. Objective of this study is to investigate the thermo-kinetic behavior of the sapodilla leaves (a waste biomass) with thermogravimetric analyzer to examine its potential utilization for energy production through thermochemical conversion routes. Thermogravimetric results indicated that the Sapodilla leaves pyrolysis may be divided into three stages. Coats Redfern integral model was applied in the 2nd and 3rd mass loss stage to estimate the activation energy and pre-exponential factor from mass loss data using five major reaction mechanism, Chemical Reaction Order (F_1, $F_{1.5}$), Diffusion model (D_1, D_2, D_3) Nucleation and growth model $N_{1.5}$, N_2), Phase Interfacial Reaction model (S_1, S_2), Power law (P). The low-temperature stable components of the Sapodilla leaves degraded in the temperature regime of 250-550 °C while high-temperature stable components decomposed in the temperature range of 550-850 °C. About 45-50wt% degradation was observed in 2nd degradation curve in the temperature range 250-550 °C and about 15-17 wt% degradation was observed in 3rd degradation curve in the temperature range of 550-850 °C.

Key words: waste biomass, sapodilla leaves, thermal degradation, pyrolysis, Kinetic behavior

Introduction

Rapid increase in population of the world coupled with indispensable industrial growth is eating up conventional energy resources at an exponential [2]. Futuristic energy demand by 2040 reports up to 28% increase with a significant contribution coming from Asia, Recognizing the importance of renewable energy resources, not only as an alternate of conventional fossil fuels but also as a remedy to carbon footprints accumulated due to excessive use of fossil fuels in last century, appreciable increase in utilization of renewables in the fuel mix (from 7% currently to 25% in 2040) is expected [3]. Pakistan, being an agriculture-based economy, produces millions of tons of agricultural residues annually; most of which either goes to waste or not handled effectively. This waste could prove an asset for our economy which leaks millions of dollars for importing costly heavy oil in order to meet its energy requirement and still only able to produce 75% of its primary energy demand as reported by International Energy Agency [4].

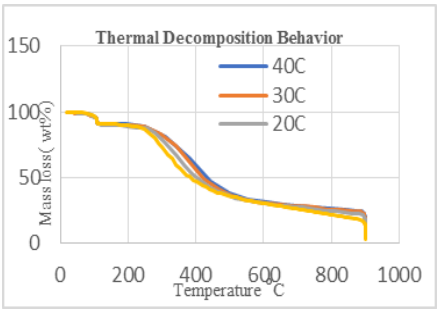
This study focuses on the understanding of thermal kinetic behavior of Sapodilla (Chico) leaves which are profusely available in this part of world with an annual production of about 1350 thousand tons in Pakistan and India. Sapodilla, a fruit having its origin in Mexico and being native to Central America is also abundantly cultivated in coastal areas of Baluchistan as well as many districts of Sindh in Pakistan. Its effective utilization as a source of energy necessitates the understanding of its thermal behavior as well as its kinetic modeling to predict its performance as a source of biofuel.

Methodology

Sapodilla leaves were dried, pulverized and subjected for characterization including proximate analysis and ultimate analysis and higher heating value by ASTM E870 and Thermogravimetric analysis was performed by heating the sample non-isothermally from room temperature to 900 °C at

the heating rates of (10, 20, 30, and 40 °C/min) in inert (N_2) environment by using thermo gravimetric analyzer (Leco TGA 701).

Results and Analysis



Thermal degradation curves obtained for Sapodilla leaves pyrolysis may be divided into three distinct stages based on mass loss rate. Estimation of activation energy and pre-exponential factors using five major reaction mechanisms; (F1, F1.5), (D1, D2, D3), (N1.5, N2), (S1, S2), and (P) was performed by applying Coats Redfern Integral Model on 2nd (temperature regime of 250-550 °C) and 3rd (temperature regime of 550-850 °C) mass loss stages. In every model, activation energy decreased at elevated temperature zone implying an increase in reaction rate constant consequently speeding up the reaction during pyrolysis process. According to the results, first-order reaction model (F1 and F1.5) showed higher E_a with better R^2 for all heating rates. ΔH shows positive value for all reaction mechanism models, which indicated that the energy is required from an external source to convert the sapodilla leaves into an activated complex to cross the potential barrier for its degradation. The magnitude of Gibbs free energy is inversely proportional to the extent of reaction, as the magnitude of Gibbs free energy increases, favorability of decomposition reaction decreases. Among all models (D1, D2, D3) and (N1.5 and N2) showed higher ΔG as compared to (F1, F1.5), (S1, S2), and (P) stage II and stage III. The negative value of ΔS in sapodilla leaves pyrolysis also confirmed that the product is less disordered as compared to reactant and that the disintegration in the activated state has a more well-organized structure than before the thermal disintegration which is in line with earlier reported studies [5].

Conclusion

Lower values of Gibbs free energy for Chemical Reaction Order, Phase Interfacial Reaction, and Power Law models show better application in comparison with Diffusion model and Nucleation and Growth model applied on 2nd and 3rd mass loss stages for thermal degradation behavior of Sapodilla leaves. Moreover, lesser disorder of activated state than the reactants was also indicated by the negative values of entropy change which shows the potential of Sapodilla leaves for thermal conversion processes like pyrolysis, gasification etc.

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ERFORMANCE EVALUATION OF MEMBRANE-BASED ENERGY RECOVERY VENTILATORS: A FUNDAMENTAL STUDY

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ABSTRACT

Indoor air quality can be enhanced by mechanical ventilation. However mechanical ventilation is not cost-effective and indoor air quality also gets distorted i.e.CO_2, VOCs. The extreme ambient condition affects the heating and cooling when introduced to conditioned space. In a heating ventilation air conditioning (HVAC) system exhaust air stream carries a large amount of energy (sensible+ latent) with it. A membrane-based energy recovery ventilator (MERV) recovers the total energy (sensible+ latent) from the exhaust air stream. This study investigates the numerical analysis of membrane materials and MERV systems. the Membrane materials are polyvinylidene fluoride (PVDF), polyether sulfone (PES), and cellulose. MERV systems are ERV-1 ERV-2, and ERV-3 data collected from the CORE Products i.e., Core Energy recovery Ventilator, https://core.life/. The result shows that the PVDF membrane has maximum vapor diffusivity, PES has minimum moisture resistance and cellulose have maximum sorption potential. ERV-2 has maximum sensible ana latent effectiveness, ERV-3 has minimum pressure drop. These results may be helpful for selecting material and system for MERV.

Keywords: Energy recovery ventilators, membrane materials, MERV systems

Introduction and Working of ERV

Heating ventilation air conditioning (HVAC) uses 30 to 40% of the total energy. Green air conditioning is supported by using desiccant materials energy [1]can be recovered and recovery ventilators are the device that recovers the heat and moisture from the exhaust air. Approximately ERV can recover 66% sensible 59% of latent energy, respectively [2]. This paper focusses the numerical analysis of the membrane materials and MERV system to improve the indoor quality. MERV systems data collected from Core products named as ERV-1, ERV-2, and ERV-3 while their catalogue their names are ERV-389, ERV-450, and ERV-488, respectively [3]. Exhaust air stream carries a large amount of total energy with it. Membrane-based energy recovery ventilator (MERV) recovers total sensible and latent energy from the exhaust air stream. Feed air stream carries the air from the atmosphere and transfers this air to the conditioned space and vice versa in the case of Sweep air stream. Feed and sweep air streams pass through the MERV exchanges their total energy.

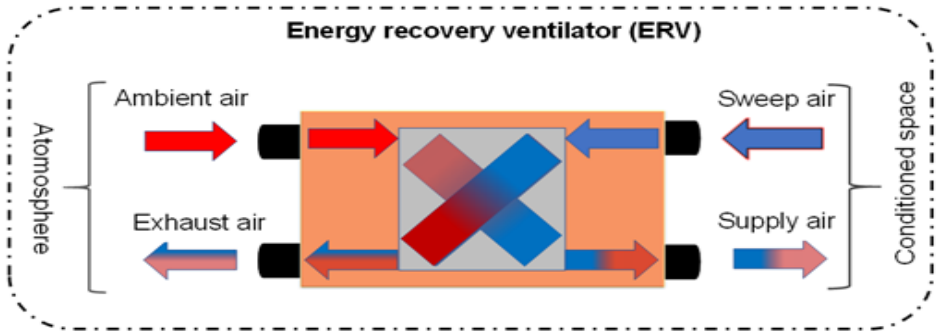

Fig.1 Typical working of energy recovery ventilator

Methodology and Results

Materials play a crucial role in the performance of MERV. membrane properties include vapor diffusivity, sorption (water uptake), total resistance to airflow rate, and physical properties (thickness,

diameter) of the membrane. The performance of the MERV system depends upon the pressure drop, airflow rate, size, and diameter of the fan. The system is selected as per the application.

$$\theta = \frac{\dot{\omega}_{max}}{1 - C + \frac{C}{\phi}} \tag{1}$$

$$D_{wm} = \frac{\delta(w_{mw} - w_{ma})}{R_m(\theta_{mw} - \theta_{ma})} \tag{2}$$

$$R_{tot} = R_c + R_m + R_g$$

$$\varepsilon_{tot} = \frac{m_s(H_{si} - H_{so})}{m_{min}(H_{si} - H_{ei})} = \frac{m_e(H_{eo} - H_{ei})}{m_{min}(H_{si} - H_{ei})} \tag{3}$$

Fig 2a shows that the cellulose membrane the maximum sorption potential then PES and PVDF membrane materials. Fig 2b demonstrates that the cellulose membrane shows the maximum fluctuations in the resistance as the flow increases while PVDF and PES does not affect by flow variation. Fig 2c shows that PVDF have the maximum moisture diffusivity then PES and PVDF membrane. potential then PES and PVDF membrane materials. Fig 2d, e,f shows that the ERV-2 shows maximum sensible and latent effectiveness while ERV-3 have minimum pressure drop.

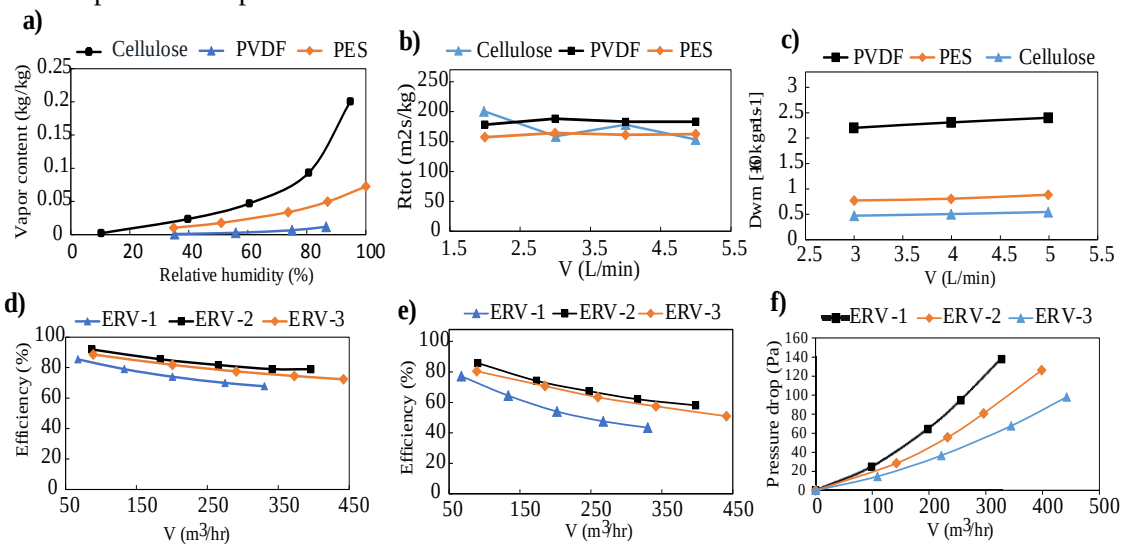

Fig.2 Sorption potential, Total moisture resistance and diffusivity of membrane materials. Sensible effectiveness latent effectiveness and pressure drop of ERV-1, ERV-2, ERV-3. [3]–[5]

Conclusion

Numerical studies were conducted to investigate the membrane properties and system effectiveness. Numerical analysis was conducted on three materials and three MERV systems PVDF, PES, and cellulose: ERV-1, ERV-2, and ERV-3, respectively. By comparing the membrane material PVDF shows the maximum moisture diffusivity than PES and cellulose. Moreover, cellulose membrane shows greater variability in moisture resistance than PVDF and PES. Also, cellulose membrane maximum sorption potential than PES and PVDF membranes. By comparing MERV systems ERV-2 shows the maximum sensible and latent effectiveness then ERV-3 and ERV-1. ERV-3 shows the minimum pressure drop then ERV-2 and ERV-1.

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STUDY ON CO_2 SEPARATION FROM FLUE GASES BY ADSORPTION

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ABSTRACT

This study aims to investigate the CO_2 adsorption potential of porous materials for mitigating the carbon concentration in the atmosphere. Porous materials have become the point of interest for researchers in the last few years. This is due to their distinct physical and chemical properties, and their wide applications in industries, air conditioning systems and gas separation technologies especially for CO_2 capture and conversion. Several types of research have been conducted for the advancements in the design and application of these materials for CO_2 capture. In this regard, major porous adsorbents like zeolites, metal-organic framework (MOFs), and porous organic polymers (POPs) are explored and discussed technically. Their structural properties like surface geometry, specific surface area, pore-volume, chemical linkage/bonding, and pore size are deliberated thoroughly. Furthermore, the effects of these properties on their efficiency, adsorption capacity, CO_2 selectivity and material recyclability are also studied. Due to structural features, MOFs were found to perform better in humid conditions than the other two classes of porous materials while zeolites were more attractive in dry environment scenarios. Finally, comprehensive conclusions are made based on a literature survey, and interesting areas for future research are identified.

Key words: CO_2 separation, flue gases, adsorption,

Introduction

Carbon Capture/Separation and Storage (CCS) is one of the auspicious technologies that could reduce carbon concentration in the atmosphere. CCS involves CO_2 capture and transferring it to the site where it could be stored in high pressure [1]. The first crucial task in a CCS system is the CO_2 capture that can be accomplished by one of the three processes i.e. Pre-combustion, Oxy-combustion and Post-combustion CO_2 capture [2]. The working principle of these processes is illustrated in Fig. 1(a) [1]. Post-combustion CO_2 capture system works on the principle of gas separation in which carbon dioxide gas is separated from a stream of flue gasses [3]. The separation of CO_2 is accomplished by physisorption using porous adsorbent material and/or chemisorption using amine solutions e.g. diethanolamine (DEA) and mono-ethanolamine (MEA). Physical adsorbents have attracted attention of the researchers since last few years due to their better performance and economic feasibility in post-combustion carbon capture. This study aims to investigate the potential of physical adsorbent materials for the post-combustion CO_2 capture.

CO_2 capture/separation by adsorption

Physisorption technique of CO_2 capture is used in post-combustion carbon capture where CO_2 is adsorbed on the surface of porous material from a mixture of flue gasses [4]. The schematic diagram of physisorption process for CO_2 capture is shown in Fig. 1(b). The adsorbed carbon is desorbed from the material's surface to regenerate the material for future use. There are three types of regeneration processes commonly used to regenerate the adsorbent materials i.e. pressure swing adsorption, temperature swing adsorption and vacuum swing adsorption [5].

MOFs can perform better than other porous materials zeolites in low pressure scenario due to their high volume to weight ratios which increase their adsorption capacity [1]. Another important property of the MOFs is their high CO_2 selectivity than other adsorbent materials. For example a study [6] revealed that a specific MOF showed better selectivity for CO_2 uptake (29.1) than that for CO (19.5) and CH_4 (25.9). It can perform better at lower temperature, humid conditions and post-combustion

CO_2 capture scenario. Zeolites are found to be water sensitive and their adsorption capacity reduces in the presence of water [1]. Nano-porous zeolites show excellent behavior towards CO_2 adsorption due to high surface area, larger pore volume and a number of metal active sites [7]. Generally, porous zeolites attract CO_2 molecule due to Van der Waals forces, depicting the physisorption phenomenon with low regeneration heat requirements. The zeolites perform better in dry conditions with low heat for regeneration. Porous organic polymers (POPs) have potential towards CO_2 adsorption due to their low density, easily changeable pore structures, high specific surface areas, good physicochemical stability, variable surface morphology, and divergence in the mixture [8]. There are numerous classes of the POPs having different parental functional groups. Each class shows variant behavior toward CO_2 capture.

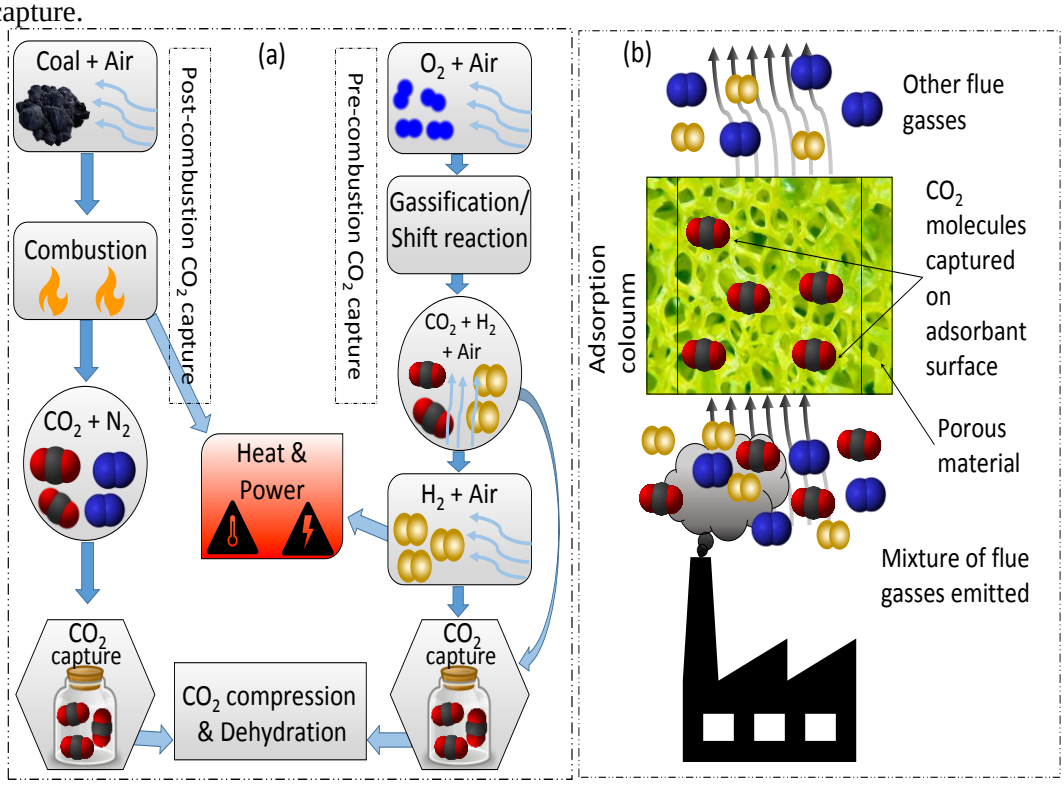

Fig. 1. Schematics of (a) process flow in pre-combustion and post-combustion CO_2 capture scenarios [1], (b) CO_2 adsorption from the mixture of flue gasses at the surface of porous materials in post-combustion scenario.

Conclusions

This review provides an update on recent progress in post-combustion CO_2 capture through physical adsorption using porous materials. Different porous materials were investigated technically on the basis of their adsorption capacities. It can be concluded that metal organic frameworks (MOFs) can perform better in terms of CO_2 adsorption in humid conditions while zeolites were found to be more attractive in dry conditions. Moreover, the heat of adsorption of zeolites is comparatively lesser in physisorption than that in chemisorption or humid conditions. POPs have a wide range of polymers that have potential in CO_2 capture industry but their functionalization is more interesting to enhance their adsorption capacity. Future research should focus on this area of interest for cost effective and sustainable development of CO_2 capture industry.

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A SHORT REVIEW ON PERSONAL COOLING GARMENTS FOR LABORERS

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ABSTRACT

Working in hot climatic conditions for a long time may cause various heat-related diseases, decrease in work productivity and excessive sweating which ultimately cause dehydration. Excessive heat stress to the human body results in heat stroke, heat exhaustion and heat cramps. Microclimate cooling will be a terrific solution to the problem specially in the conditions where engineering and administrative solutions are not feasible. This study aims to discuss and compare different types of personal cooling garments (cooling vest) based on their working principle, cooling process, and their applicability in different climatic conditions. Liquid cooling garments (LCGs) were found to perform better in terms of cooling efficiency and are suitable for the workers with protective clothing. On the other hand, phase change material (PCM) based cooling vests are preferred in some scenarios due to ease in wearing and mobility.

Key words: personal cooling garments, microclimate cooling, phase change material (PCM)

Introduction

Laborer working in hot environment for long hours are prone to heat-related diseases like heat stroke, heat cramps and exhaustion. It may also harm mental functionality which leads to the poor decision-taking and work management [1]. It gets worse when the laborer is working in the environment where protective clothing is required, such as firefighters and gas utility workers. Furthermore, the bulky design, weight and rigidness of the protective clothing will cause increase in internal (metabolic) heat consequently decrease in physical performance mainly due to many layers of protective clothing. In this scenario, sweat evaporation is not possible to cool body itself [2]. Human thermoregulations serve dual purpose of managing internal temperature as well as external heat dissipation. The normal body temperature (i.e. 37°C) is maintained by balancing the heat produced and lost [2]. The following study aims to address the feasibility of personal cooling garments identified by various researchers for working in hot environments.

Methodology

In this study, a comprehensive literature review was conducted to find out potential applications and feasibility of cooling garments for laborer working in hot climatic conditions. Based on the literature survey, personal cooling garments were classified as Fluid Cooled Garments (FCGs)/Liquid Cooling Garments (LCGs), Phase Change Garments (PCMs), and Air-Cooled Garments (ACGs). LCGs works on the principle of conductive cooling, whereas ACGs utilize evaporative cooling and PCMs used latent heat storage for the cooling effect.

Discussion

Liquid-cooled garment

Liquid Cooled Garments (LCGs) are the garments which utilize water or any other aqueous solution to act as a coolant. It is one of the most widely used cooling system. LCGs depend on the heat sink connected to the cooling garment. The coolant is circulated inside tubes by a battery driven pump, compressor, or an air pressure vessel, embedded into the garment. Schematic of a typical Liquid - cooled garment is shown in the Fig. 1 (a). When the liquid is heated in cooling the body temperature, it is re-circulated to the heat basin where it is re-cooled [2]. Literature reveals that liquid cooling system is the most effective cooling technique to use with protective clothing mostly due to its ability to cover torso and limbs [3].

Air-cooled garment (ACGs)

ACGs utilizes the human body natural cooling mechanism i.e., sweat evaporation. It is reported that, evaporation of 1 liter of sweat transfers 2400kJ of energy to the neighboring environment [4]. In ACGs technique, it is achieved using powered air which is cooled before it entered the garment or with the use of ambient air. Air coil absorption in an ice-water basin is considered as the most

effective method for heat exchange. Vortex tube is also used to reduce inlet air temperature by separating high density cool air from the warm air. A typical ACG is shown in the Fig. 1(b). Sweat evaporation is directly affected by the effective (exposed) area, permeability of the clothing, and the vapor pressure difference between skin and ambient environment.

Phase change material (PCM)

Phase change material (PCM) uses latent heat storage of a material. PCM garments depend on the material to absorb heat produced by the body, during phase change, mostly from solid to liquid. As, PCM garments does not need a power source for working i.e., to move the coolant, this type of garments is also known as passive cooling systems shown in Fig. 1 (c). PCM garments are consider mobile and easy to wear, among microclimate cooling system [5]. Commonly used PCMs in personal cooling garments include frozen water, paraffin wax, dry ice, and frozen aqueous solutions.

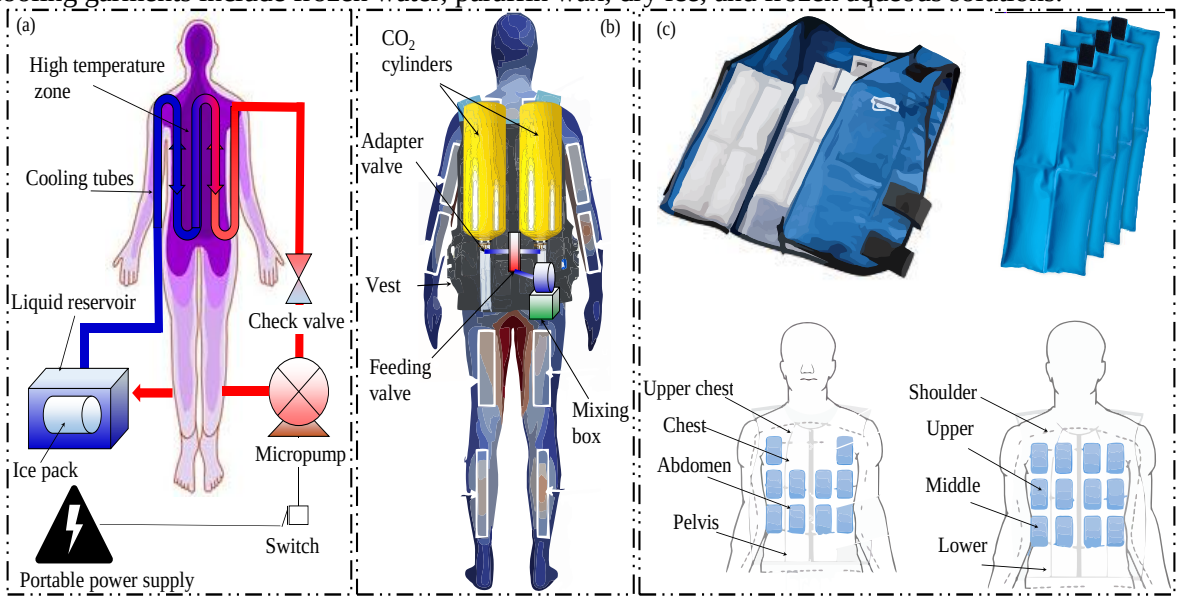

Fig. 2. Schematic illustration of (a) liquid cooling garments(LCGs) [6], (b) air-cooled garments (ACGs) [7], and phase change material (PCM) based cooling garments [8].

Conclusions

It is concluded that personal cooling garments can be the most feasible solution for providing thermal comfort to laborer. It may also enhance the working performance of laborer with protective clothing.

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EFFECT OF FLUID FLOW RATE ON THE TEMPERATURE ACHIEVED IN A MULTI-FOCUSED CONCENTRATOR WITH CAVITY RECEIVER

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ABSTRACT

An unprecedented challenge in the 21st century is to fulfill outgrowing world's energy demand with sustainable, eco-friendly and economically viable energy resources. Being clean and the most abundant energy resource on the earth, solar energy draws a great deal of attention for electricity generation. In this work, a novel multi-focused concentrator with cavity receiver is modeled and simulated using Ansys 19.1. As a light source, a 7 KW xenon arc lamp was used to acquire the magnitude and distribution of incident radiation flux using Tracepro®. Peak flux of magnitude 3500 KW/m^2 was achieved on aperture of 20 mm diameter. The average air temperature was 2650.76 K at a flow rate of 10 L/min. By increasing flow rates to 20 L/min, 30 L/min and 40 L/min respectively, it decreased to 1471.47 K, 1076.28 K and 887.89 K. The desired temperature of a fluid can be achieved in industrial process heating applications by changing its flow rate accordingly.

Key words: Cavity receiver, multi-focused concentrator, solar thermal

Introduction

In Renewable energy, solar energy to get solar fuels is a prominent technique of harnessing energy from the sun. Production of solar fuels obviously needs a high energy demand which in turns comes from the heat energy of the solar radiation. The optical methodology is adapted to concentrate the solar radiations on to the reactor. The reactor in concentrated solar power systems has a vital role to produce solar fuels and hence the flow regimes inside the solar cavity receiver and the geometry of the reactor shows an imperative part to get temperature uniformity. J. Sarwar et al. [1] performed experimental and numerical analysis to estimate the temperature distribution of solar cavity receiver using variable aperture size. A great promise between experimental and theoretical temperature was found with a minor variance of ± 0.2% error. The study revealed that by variable aperture size a constant temperature can be maintained in the cavity and power can be minimized to half in case of variable aperture. The effect of varying flux distribution in the cavity and optimum length of the focal point is studied by Daabo, Mahmoud et al. 2016 [2] in this regard research considered the effect of concentrator receiver walls, absorptivity, receiver position, receiver cavity shapes, and uniformity factor.

Karimi, R., T.T. Gheinani, and V. Madadi Avargan et al. [3] state that increase of the flow of the HTF the radiation heat transfer rate decreases. The radiation heat losses decrease by 12.5% with the decrease in the emissivity by 60%. Larger the size of the aperture of the receiver more will be the radiation losses. Hamed Abedini Najafabadi, Nesrin Ozalp, et al. [4] dimension of the reactor, flow rate, and insulation were optimized for the design of solar cavity receiver.

Methodology

Multi-focused Concentrator was developed using Tracepro® which was coupled with cavity in the Fluent module of Ansys 19.1 using K-epsilon (K-ε) turbulence model to simulate thermal and flow analysis. As a light source, a 7 KW xenon arc lamp was used to acquire the magnitude and

distribution of incident radiation flux. Temperature, velocity profiles and various plots were obtained from simulation.

Results and Analysis

Grid independence study was carried out. An aperture of size 20x20 mm was used with four air flow rates of 10, 20, 30, and 40 L/min. As it is obvious the cavity wall average temperature was decreased by increasing the flow rate. The average air temperature was 2650.76 K at flow rate of 10 L/min. It decreased to 1471.47 K, 1076.28 K and 887.89 K by increasing flow rates to 20 L/min, 30 L/min and 40 L/min respectively. It showed that convective heat transfer is more prominent at higher flow rates. Temperature profiles were analyzed for different flow rates in radial direction the temperature of air is not appreciably changing as compared to axial directions. By reversing the flow directions temperature was increased in the middle of cavity.

Conclusions

This simulation showed the way to understand the fluid flow and heat transfer phenomena. Using Kepsilon (K-ε) turbulence model, a new multi-focused concentrator with a cavity receiver is modelled and simulated, and this model has been found suitable for performing such types of solar cavity thermal analysis. Changing the fluid flow rate has a significant effect on the fluid temperature inside the cavity and temperature distribution as well. Also, reversing the flow direction has negative impact on temperature uniformity but it increases the fluid temperature. This high-temperature cavity fluid can be used in industrial process heating applications and also for thermal cracking of different fluids for environmentally friendly thermal fuel power generation. There is still space for optimization by studying the effects of aperture diameter, incident insolation, cavity receiver geometry and flow rate simultaneously to achieve the desired fluid temperature.

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ZERO-ENERGY COOLING CHAMBER FOR POST-HARVEST AGRICULTURAL PRODUCTS STORAGE

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ABSTRACT

A rectangular zero-energy cooling chamber was constructed to extend the storage life of fresh vegetables and fruits. The zero-energy cooling chamber works on the principles of evaporative cooling and decreases temperature and increases relative humidity inside of the chamber. Locally available materials like clay bricks, cement, sand, jute cloth and bamboo sticks are used for construction of chamber and its overhead cover. The studied cooling chamber can be successfully used for short term postharvest storage of agricultural products by smallholding farmers. It lower the inside temperature and increase the relative humidity which is favorable for most of fresh harvested agricultural products.

Key words: cooling, agricultural, storage

Introduction

Agricultural products (fruits and vegetables) are important portion of balanced diet for the development of human body. The perishable agricultural products are rich in vitamins, minerals and provide fibers for proper food digestion. These products perform respiration, transpiration and fermentation, and may spoil soon after harvest due to higher moisture content (60-95%) [1]. They are harvested during the short duration in a year. But the need of these products remains throughout the year. The storage these perishable products is one of the critical problems especially at farm level of our country [2]. Deterioration of agricultural products during the peak season is very high due to poor processing, insufficient and inefficient storage facilities. Farmers get lower price of their agricultural products during the peak season. But, after season agricultural products have higher price. Mostly, agricultural products require low temperature and higher humidity. Refrigeration is one of technique for preservation of post-harvest. It is hazard to environment due to emission of chlorofluorocarbons, and usage of 15% electricity produced in the world [3]. A Zero-energy cool chamber (ZEC) was developed for on-farm storage of agricultural products. The environmentally friendly ZEC does not require secondary energy for its operation.

Methodology

The experimental setup of ZEC is constructed at Department of Agricultural Engineering, Bahauddin Zakariya University (30°15′49″N, 71°30′35″E), Multan, Pakistan. The outer and inner wall of ZEC having dimension Length (L) =1.52 m, width (B) =1.07 m and height (H) = 0.61 m and Length (L) = 1.11 m, width (B) = 0.49 m and height (H) =0.61m, respectively. The leaved space 4 inches (0.1016m) between the two walls filled with uniform sand.

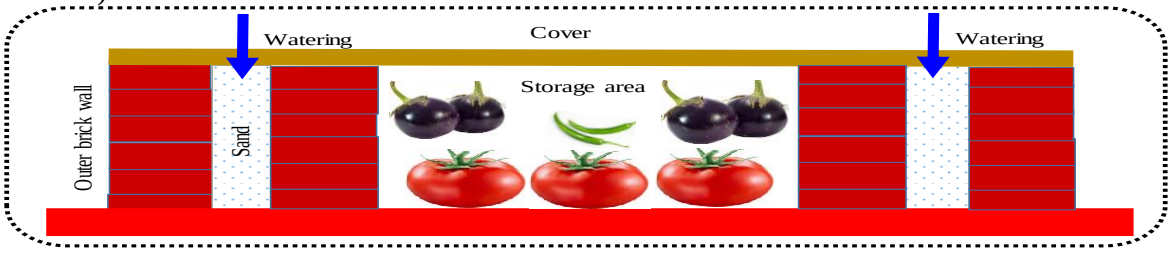

Figure 15 Schematic of zero-energy cooling chamber

The performance of ZEC is mainly investigated with inside and outside temperature and relative humidity of ZEC. Temperature and RH in the chamber, outside and room are measured through the

temperature/humidity sensor (US) HTC-1. The cooling efficiency is calculated by Equation (1) as determined by [4].

$$\text{Cooling efficiency} = \frac{T_{db} - T_{ZEC}}{T_{db} - T_{wb}} \times 100 \quad (1)$$

Results and discussion

This section includes thermodynamic investigation of constructed zero energy cool chamber (ZEC). The variation in temperature (T) and relative humidity (RH) for zero energy cool chamber (ZEC), outside (OS) and room temperature (RM) conditions are measured, which is used in measuring the efficiency of ZEC with respect to other conditions. ZEC maintained the surrounded environment condition which is favorable to maintain the freshness of agricultural products. The variation in temperature and relative humidity in ZEC, OS and RM are explained in given profile Figure 2 and 3. The Figure 2 explains the variation of temperature in ZEC, OS and RM. The highest (30.5°C) and lowest temperature (28°C) were observed inside of the ZEC with the average temperature value recorded (29.18°C) inside of the chamber. The maximum (42°C) and minimum temperature (39.5°C) recorded OS of the chamber with average value of (40.5°C). The result shown in Figure 3 described that the OS temperature is accumulatively higher than RM and ZEC. In that comparison, the ZEC is working efficiently to decrease the temperature as compared with OS and RM. The average difference in temperature of (12°C) observed in between OS and ZEC. Similar reduction of 10°C temperature inside the chamber as compared to ambient condition studied by [5]. ZEC increase the relative humidity from minimum OS 36% to maximum of inside 98-99%. On the average the difference in relative humidity have been recorded 62% respectively. The decrease in temperature and increase in relative humidity inside ZEC with respect to Outside (OS) conditions, due to evaporation through media, are used to calculate the cooling efficiency of ZEC through Equation 1. Inside and outside condition of ZEC with their temperature and relative humidity and effectiveness details are given in Table 1.

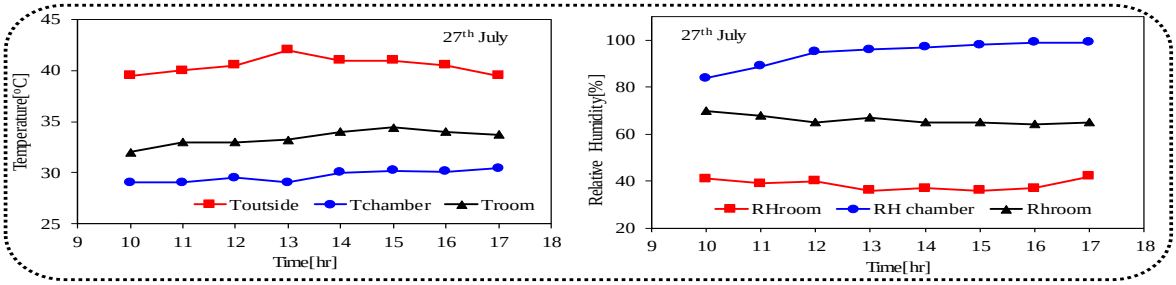

Figure 16 Variation in temperature and relative humidity

Table 3 Cooling efficiency of Zero-Energy Cooling Chamber

Time	$T_{outside}$	$T_{chamber}$	$RH_{outside}$	$RH_{chamber}$	Cooling Efficiency
10	39.5	29	41	84	87.5
11	40	29	39	89	89.7
12	40.5	28.5	40	95	90.8
13	42	28	36	96	96.1
14	41	29	37	97	92.1
15	41	29.5	36	98	86.5
16	40.5	30.1	37	99	80.6
17	39.5	30.4	42	99	79.8

Conclusions

ZEC constructed with locally available material has potential for short-term post-harvest storage of agricultural products at farm. ZEC temperature remained lower throughout the testing period as compared to outside and room conditions. On the other hand, its relative humidity measured higher

than other studied conditions (outside and room). It is concluded that ZEC decreases the temperature up to 10-12^{o}C as compared to outside. Its relative humidity remained mostly above 85-90%. The results clearly indicating that it is useful in the study area to set up an inside environment for short-term preservation of farm products especially during warmer days of season.

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EFFECT OF FLUID FLOW RATE ON THE TEMPERATURE ACHIEVED IN A MULTI-FOCUSED CONCENTRATOR WITH CAVITY RECEIVER

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ANALYSIS OF POWER CONSUMPTION FOR THE DRYING OF VARIOUS CLASSES OF PAKISTANI LIGNITE COAL

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ABSTRACT

Coal has been considered as a cheap source of electricity and it adds around 41 % in the total electricity production of the world. It has been proved that coal has maximum potential for the production of electricity in future, but, emissions of greenhouse gases such as carbon dioxide are major obstacles during power generation from coal. Integrated gasification combined cycle (IGCC) technology has ability to utilize low-quality fuels with reduced emissions. Slurry feed and dry feed are two important technologies of an IGCC system. It has been proved that low rank or high moisture coals are more capable with dry feed gasifiers. Pakistan can benefit from dry feed technology of IGCC to cope with its energy requirement by utilizing available reserves of low-quality lignite coal. Drying of the high moisture coal to make it able to be processed in dry feed gasifier is an important step. In this study, power consumption during the drying of the average, high and very high moisture Pakistani coals has been studied.

Key words: Dry feed, IGCC, low-quality coal, energy

Introduction

The fast industrial growth and improved living standards has led to an ever-increasing world energy demand, especially electric power. Fossil fuels are still considered for power generation by many developing countries. Coal is still considered a cheap and major source of electricity generation, and has huge potential in future [1]. However, emissions of harmful greenhouse gases (GHGs) from coal combustion, such as CO_2 are of major concern. Pakistan has huge reserves of low-quality coal, estimated up to 175 billion tonnes, located in the Thar Desert of Sindh. Other lignite coal reserves are present in in Lakhra, Sonda, Indus East coalfields in Sindh [2].

Environmental pollution is a big challenge in power generation using coal. Advanced power generation technologies are important to be considered which can help mitigate the effect of emissions to the environment. Integrated gasification combined cycle (IGCC) technology has ability to utilize low-quality fuels with reduced emissions. Slurry feed and dry feed are two important technologies employed in IGCC power generation system. It has been proved that low-quality or high moisture coals are more capable with dry feed gasifiers [3].

IGCC Power plants consume a lot of energy e.g. compression of air, nitrogen and oxygen in ASU, CO_2 compression, acid gas removal section etc. are major contributor in auxiliary power consumption. Drying of the wet coal is also important to be considered if dry feed technology of IGCC system has to be used. Lowering the energy consumption of IGCC plant is one essential key to increase the overall efficiency of the IGCC plant.

Superheating steam heating (commonly known as WTA) technology for coal drying is an important consideration to enhance the overall efficiency of the plant [4]. In this study, the WTA fluidized bed has been simulated in Aspen Plus® to estimate the feasibility of the local coal in power generation. Total power consumption analysis on coals of various moisture levels has been performed.

Methodology

The model is developed in Aspen Plus® for drying process of IGCC system. WTA, which utilizes superheated steam drying process by vapor recompression technology has been considered. The WTA dryer has been simulated using RStoic and Flash2 blocks in Aspen Plus®. Latent heat exchange from superheated steam to coal in dryer, and preheating of the coal using sensible heat of the condensate

have been simulated using heater blocks. The calculator block has been used to control the moisture level in the downstream coal. The SOLIDS physical property method has been used to model drying reaction in RStoic and Flash2. Upstream milling up to 100 micrometer has been performed in separate hierarchy block. Locally available Thar coal with moisture level of up to 50% has been considered for predicting the feasibility of indigenous resources by performing power consumption analysis for the drying of coal. The coal is dried from 35-50% moisture content down to 12% moisture for the different classes of coal. Power consumption for the drying of coal, entering at the rate of 407.02 ton/hr has been estimated, using a validated model [5].

Results and Analysis

Results for three Pakistani coals, Thar Lignite A (TL-A) with 35% moisture, Thar Lignite B (TL-B) with 44.92% moisture and Thar lignite C (TL-C) with 50.24% moisture have been presented in Fig. 3. All coals have been dried up to 12% moisture level using superheated steam. Power consumption during vapor compression for TL-A to achieve the target was 9.41 MW_e, for TL-B the consumed power was 13.46 MW_e and for TL-C up to 15.62 MW_e electrical power was consumed during drying. An IGCC power plant of up to 500 MW_{net} capacity based on low-quality coals, consumes approx. 200 MW_e auxiliary power [5]. Drying process consumes up to 15 MW_e, if flow rate of 407.02 ton/hr of lignite coal is considered, as seen in Fig. 3. The assumed flow of coal is sufficient for the IGCC plant of capacity up to 500 $MW_{e,\ net}$. This study provides a guideline for decision makers for the feasibility studies of Pakistani coal for power generation. Power consumption for the ND lignite in Fig. 3, is presented for comparison purpose [5].

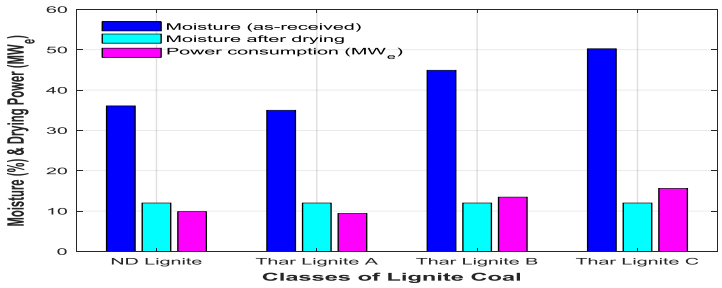

Fig. 3. Power consumption for the drying of the different classes of Thar lignite coal

Conclusions

Three Pakistani lignite coals have been used for the estimation of power consumption in drying. Power consumption increased with the moisture contents to be separated. Less than 15 MW_e power was required for drying the coal such that it could be used in dry feed gasifier of an IGCC system.

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EFFECT OF ADDITIVES ON STRUCTURAL AND THERMAL PROPERTIES OF SOY-BASED POLYURETHANE FOAMS

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ABSTRACT

Bio-based polyols can replace petroleum-based polyols for producing a wide range of polyurethane (PU) products. Bio-based polyols are derived from abundant and renewable bio-resources. However, their utilization is limited due to the complex molecular structure. This study aims to fabricate PU foams by substituting the petroleum-based polyether polyols with soy-based polyols. The prepared PU foam samples were fabricated using nanoclay based additives that lead to significantly different mechanical and thermal properties and increased the flame retardancy of the foam samples. The resulting foam samples exhibited higher compressive properties, tensile properties and comparable thermal insulation properties ~~as~~ compared to commercial insulation materials.

Keywords: Green Composites, Bio-based Insulation,

Introduction

Polyurethane (PU) foam is a widely used material in construction, automobile, and packaging industries due to its high strength to weight ratio and high thermal insulation property. It can be synthesized as both flexible and rigid foam depending on its density and cell size. Rigid PU foam accounts for approximately 23% of all types of PU production and is a versatile material with easily tunable properties [1, 2]. PU foams are typically synthesized by reacting diisocyanate with polyol in the presence of a catalyst, a blowing agent, and a surfactant to achieve the desired morphology. Foam properties are direct a consequence of its chemical structure and cross-linking density. Both the functionalities of isocyanate and the hydroxyl number of the polyol can alter the cross-link density of the polymer network. Consequently, a higher number of functionalities leads to a more rigid structure [3]. With increasing environmental concerns and instability in prices and the supply of petroleum, efforts to replace petroleum-based products with renewable products have gained a lot of traction. However, the complex molecular structure of plant oils often leads to poor mechanical properties of the polymers produced. Various surfactants and other additives are often used in the polymers to reduce the surface tension and aid the chemical reaction leading to better mechanical properties [4,5]. Often times, the additives used are toxic, and are under the scrutiny of regulatory authorities in Europe and North America for their use in household products. In this study, we investigated ecofriendly nanoclay based additives to fabricate PU foams, and their impact on the mechanical and thermal foam properties.

Methodology

The foam samples were manufactured using a two-part PU resin. Component A is a blend of diphenylmethane diisocyanate (MDI) and polymeric methylene diphenyl diisocyanate (pMDI) procured from Huntsman International LLC (Auburn Hills MI). Component B is soy-based polyol HB230 obtained from MCPU Polymer Engineering LLC (Pittsburg, KS). The surfactant used was Xiameter OFX-0193 obtained from Dow Corning (Auburn, MI) and dibutyltin dilaurate (DBTL) catalyst was purchased from Sigma-Aldrich (St. Louis, MO). Distilled water was used as a blowing agent. The fire-retardant nanoclays (NC) used were Cloisite Na+, and Cloisite Ca++, obtained from BYK Gardner (Columbia, MD). The NC used had a particle size of <25μm, and had optimized surface properties for exfoliation in aqueous systems. The NC was dried in an oven to remove any moisture before being used in the fabrication of soy-based PU foams. The foam samples were fabricated by blending the above mentioned reactants, using varying amounts of NC from 2 g to 20 g, per 100 g of polyol. The fabricated samples were cut into the required size and tested for tensile

strength, compressive strength, dimensional stability, moisture absorption, thermal stability, flame retardancy, and thermal insulation according to ASTM standards.

Results and Analysis

The fabricated samples were tested for the following properties: Tensile Strength, Compressive Strength, Thermal Insulation (R-Value), and Moisture Absorption. The samples were also analyzed for their thermal stability using Thermogravimetric Analysis. It was observed in Scanning Electron Microscopy (SEM) images that varying amounts of NC, resulted in differences in the cell size of various samples. It was observed that with the higher amount of NC, the cell size was reduced, and the cell wall thickness qwas also reduced. The cell size also impacts the thermal insulation of the foam samples, where smaller cells result in better insulation. Finally, the samples were tested for flammability using ASTM standard D4986-18. It was observed that adding Cloisite Ca++ helped in reducing the flammability of the foam samples by 28% as compared to the control samples.

Conclusions

It was observed that the addition of ecofriendly NC into the PU foam resulted in reduction of the surface tension of the reactant polymer mixture. With lower surface tension, the cell size of the foams was also reduced. Additionally, the foams with smaller cells had higher load-bearing capacity, due to the cell morphology being more uniform compared to the bigger cells. Finally, smaller cells were less damaged, resulting in the closed-cell structure. The closed-cell foams had better R-Values compared to foams with damaged cells.

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$LA_{0.75}SR_{0.25}CR_{0.5}MN_{0.5}O_3$/GRAPHENE OXIDE-BASED COMPOSITE ELECTRODES FOR ENERGY STORAGE APPLICATIONS

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ABSTRACT

This study aims to produce $La_{0.75}Sr_{0.25}Mn_{0.5}Cr_{0.5}O_3$ (LSCM)/graphene oxide (GO)-based composite electrode for energy storage applications. Perovskite was synthesized by solution combustion method. Graphene was synthesized by improved Hummers' method. Synthesized active material was coated on porous Ni foam by vacuum centrifuge mixing. Effect of GO content on specific capacitance (SC) of LSCM was studied by varying GO content from 1-7 wt. %. As synthesized perovskite and GO were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), atomic force microscopy (AFM) and Fourier transform infrared spectroscopy (FTIR). Electrochemical characterization was carried out by cyclic voltammetry (CV), electrochemical impedance spectroscopy (EIS) and cyclic charge discharge (CCD) in 3M KOH. Electrochemical characterization revealed that LSCM electrode showed maximum SC of 751 F/g at 1 mV/s. By increasing GO content from 1 to 5 wt. % capacitance was increased to 930 F/g, 1137 F/g and 1223 F/g respectively. EIS revealed that LSCM-5%GO electrode showed lowest charge transfer resistance. GCD revealed that LSCM-5%GO electrode showed 83 % charge retention at 1 A/g.

Key words: Perovskite; graphene oxide; supercapacitor

Introduction

A vast growth in the industries and improved technologies have increased energy consumption, so energy demands are increasing rapidly. Major issue of the era is to develop feasible, economical and sustainable energy sources to fulfill energy needs [1]. Batteries are useful solution for energy storage but these have several limitations such as high cost of components, limited capacity and limited cyclic life [2]. Supercapacitors are important alternative for batteries, which use physico-chemical processes to store energy. Supercapacitors have various advantages over batteries, i.e. lower cost, higher power density, high temperature applicability and longer cyclic life [3]. ABO_3 (A and B are metal ions) type oxides with perovskite structure have recently emerged as the best candidate due to their high specific capacitance and large operating potential window [4-6]. Additionally, perovskites are better candidate for supercapacitor material because multiple metal ions are available in its microstructure. It induce different charge storage mechanisms to perovskite material which enhance charge storage performance of supercapacitor [7, 8]. An important method to overcome limitations of perovskite material are development of composite electrodes. Composite electrodes can be developed by incorporating conductive nano fillers with perovskite e.g. graphene oxide (GO), reduced graphene oxide (RGO), carbon nanotubes (CNTs), carbon nano fibers (CNFs) etc. Graphene is a 2D single atomic graphite layer arranged in a honeycomb structure [9]. It possess high specific surface area of 2630 m^2 g^{-1} [10, 11], and theoretical areal capacitance of 21 μF cm^{-2} [12]. These interesting properties make graphene based materials favorable for SC applications [13]. Due to its excellent properties, graphene is an important material to enhance conductivity and performance of perovskite materials for supercapacitor applications. This study aims to produce LSCM/GO-based composite electrodes for supercapacitors. Furthermore, effect of GO content on specific capacitance of LSCM was studied by varying GO content from 1-7 wt. %.

Methodology

LSCM was studied by solution combustion method reported elsewhere [14]. Briefly, stoichiometric ratios of all nitrates and citric acid were dissolved in DI water separately. All solutions were mixed and magnetically stirred for 30 minutes. Solution mixture was refluxed at 80 °C for 1 hour to obtain

violet color solution. Solution was evaporated at 110 °C to obtain porous gel. Gel was converted into fine powder by using mortar and pestle. Fine powder was calcined in air at 1100 °C for 3 hours. Calcined gel was annealed to room temperature to obtain fine LSCM powder.
GO was synthesized by improved Hummers' method. Porous Ni foam was cut into 1 x 1 cm pieces and activated by sonication in ethanol for 2 hours followed by drying at 110 °C for 1 hour. Active material slurry was prepared by adding 80 % active material, 10 % carbon black (CB) and 10 % polyvinylidene fluoride (PVDF). All contents were taken in appropriate amounts and mixed in vacuum centrifuge mixture at 2000 rpm for 2 minutes. Ni foam samples were placed in slurry and coated at 2000 rpm for 20 seconds to obtain uniform coating on Ni foam samples. Samples were dried in oven at 80 °C for 3 hours.
Results and Analysis
XRD analysis showed absence of impurities in perovskite structure. SEM analysis showed that LSCM has irregularly shaped particles. CV analysis revealed that pure LSCM showed maximum SC of 751 F/g at 1 mV/s in 3 M KOH. Furthermore, CV analysis revealed that addition of GO enhanced SC of LSCM by ca. 50 % at 5 wt. % of GO. LSCM-5%GO electrode showed maximum SC of 1223 F/g at 1 mV/s in 3 M KOH. EIS revealed that LSCM-5%GO electrode showed lowest charge transfer resistance among other electrodes. GCD revealed that LSCM-5%GO electrode showed 83 % charge retention at 1 A/g current density.

Conclusions

Electrochemical characterization of LSCM-GO composites revealed that LSCM with 5 wt. % showed maximum SC among all other composite electrodes along with superior capacitance retention.

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DESIGN OF AIR-SOURCE HEAT PUMP (ASHP) BASED TES-PCM SYSTEM FOR SINGLE-FAMILY HOUSES IN SWEDEN.

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ABSTRACT

Thermal energy storage with integration of phase change materials has proven the ability to replace sensible storage due to its influential latent heat of fusion. This study focuses on theoretical design of air source heat pump for a single-family residential house in the Nordic climate of Sweden. The results from the sensitivity analysis show that the heat pump capacity rises with increase in compressor size, and the energy savings based on thermal storage are enhanced with larger storage tank. The final energy savings achieved per winter season are in range of 10-15% under set parameters in this model.

Key words: Thermal energy storage, Phase change material, Space heating, Sensible heat storage, Latent heat storage, Air source heat pump, Single family house, Energy savings.

Introduction

The buildings have recently turned into one of the largest consumers of electricity, heating and cooling. The heavier reliance on oil and gas in the past decades to meet these needs has led scientists and researchers to shift their focus towards renewables. The challenges with renewables include intermittency and cost inefficiency. This activates energy storage to become integral part of renewable energy technologies. In the building and industrial sector, the use of adequate thermal energy storage (TES) systems presents high potential in energy conservation [1]. The objectives of this study are to: conduct comprehensive literature review of thermal storage and PCM technologies; write modelling code in the Engineering Equation Solver (EES) for the analysis; select appropriate electricity source and equipment for space heating into building; and design the system that has the highest potential for energy savings.

Methodology

In this model an old double-storey single family residential house (constructed pre-1960) is considered in the city of 'Stockholm' in Sweden. The building is designed for a short thermal time constant, a feature of thermally light buildings constructed in wooden and non-concrete materials. The ventilation system is a balanced ventilation system with an installed heat recovery of 60% recovery efficiency. The desired supply ventilation system to the room is 16-18 °C. The physical dimensions of the house are given as per table-1 below:

Table-1 Dimensions of the house

Living area (A_L)	128	m^2
Roof area (A_R)	128	m^2
Floor area (A_F), double-storey	63x2	m^2
Walls area (A_W)	80	m^2
Windows area (A_{window})	22	m^2
Doors area (A_{door})	4	m^2

Table-2 Heat Transfer Coefficient of the building components

$U_{,roof}$	0,20	W/m^2-K
$U_{,floor}$	0,25	W/m^2-K
$U_{,walls}$	0,47	W/m^2-K
$U_{,windows}$	1,62	W/m^2-K
$U_{,doors}$	2,10	W/m^2-K

The heating load calculations are performed to design the heating system involving heat losses, gains, and building as a whole. The summary is given below:

$$\sum UA = 137{,}71\ \frac{W}{K} \tag{1.1}$$

$$\Lambda = \sum UA + [\rho_{air} * C_{p,air} * \dot{V}_{ven} * (1 - \eta_{HEX})] + (\rho_{air} * C_{p,air} * \dot{V}_{inf}) = 214{,}90\ \frac{W}{K} \tag{1.2}$$

The thermal mass (∑mCp) of the building is the driving factor as in which temperature to use to design the heating capacity of the proposed heating system. In Sweden, the Design Outdoor Temperature (DOT) is used as determined by SS-EN ISO 15927-5 [2]. The peak heating load was estimated as:

$$\dot{Q}_{heating} = 8{,}60 \text{ kW} \tag{1.3}$$

The annual heating load was calculated using degree-days concept:

$$\dot{Q}_{annual} = 18{,}41 \ MWh \tag{1.4}$$

After computing the building heating demands, the design of the air source heat pump was performed. The chosen refrigerant was propane (R290) in the heat pump operating under vapour compression cycle.

$$\dot{Q}_{hp} = 5{,}16 \ kW \tag{1.5}$$

$$\dot{E}_{el} = 2{,}30 \ kW \tag{1.6}$$

$$COP_{hp} = 2{,}13 \tag{1.7}$$

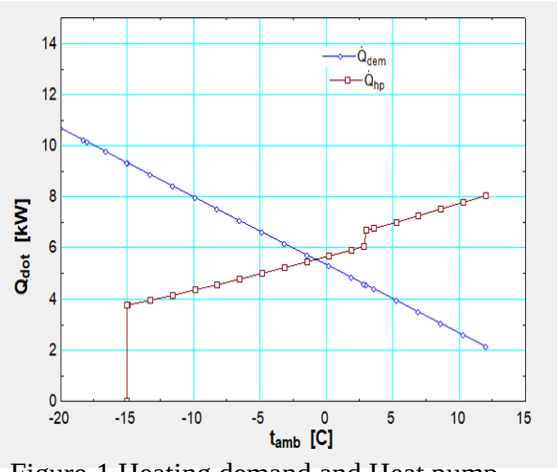

Figure-1 Heating demand and Heat pump capacity against ambient temperature

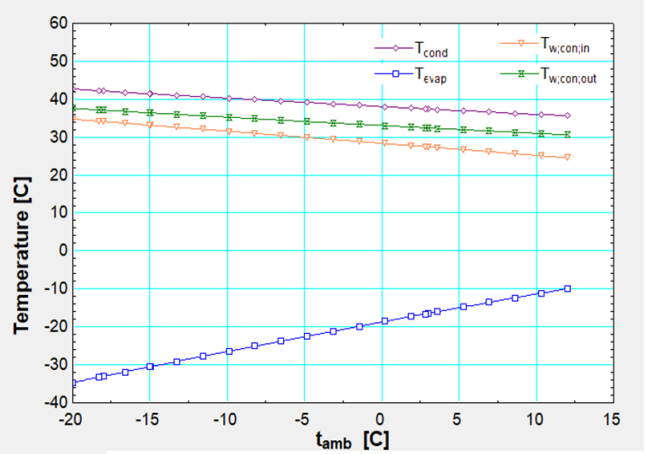

Figure-2 Temperature profiles from the Heat pump process vs ambient temperature

Results and Analysis

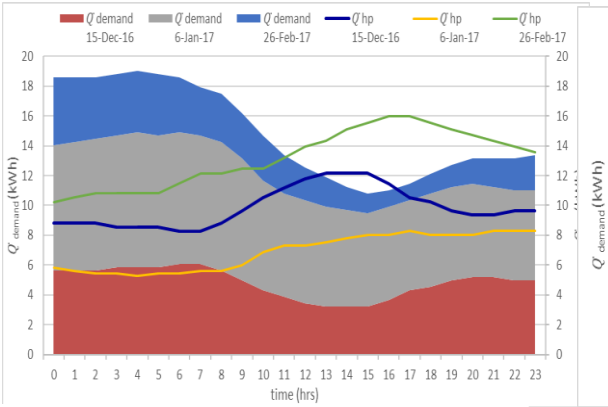

Figure-3 Heating demand and ASHP capacity -vs- clock time for three selected days

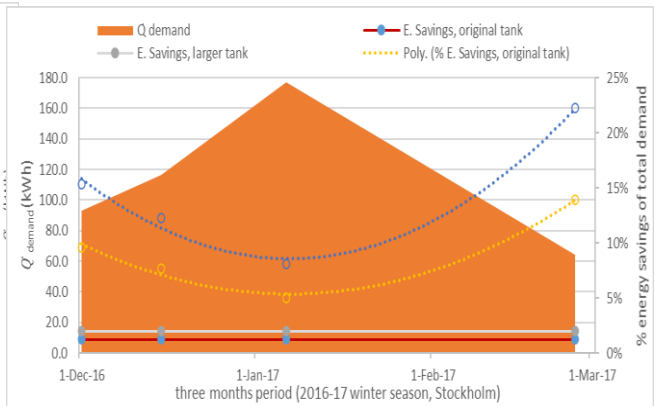

Figure-4 Energy savings per winter season

Conclusions

Table-3 Energy saving calculations

Sr #	Parameter	15-Dec-16	6-Jan-17	26-Feb-17
1	$\dot{Q}_{demand}$	116.17	176.85	64.13
2	$\dot{Q}_{hp,\ capacity}$	236.86	165.83	316.15
3	$\dot{Q}_{hp,\ design}$	236.86	107.38	316.15
4	$\dot{E}_{el,\ comp}$	87.99	46.46	96.74
5	$\dot{E}_{el,\ aux}$	0.00	90.25	0.00
6	$\dot{E}_{el,\ total}$	87.99	136.70	96.74
7	$\dot{Q}_{gen}$	236.86	197.63	316.15
8	E. Savings, original tank	8.92	8.92	8.92
9	E. Savings, larger tank	14.25	14.25	14.25
10	% E. Savings, original tank	7.68%	5.04%	13.90%
11	% E. Savings, larger tank	12.27%	8.06%	22.22%

This sensitivity analysis for energy savings shows around 10-15% average saving value over the entire season of selected time period in Stockholm. The larger size compressor and tank has implications to costs. The chosen bigger size tank stimulates the need to reassess the space occupancy requirement of the tank equipment to be placed in the house.

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DESIGN AND ANALYSIS OF CSP PARABOLIC TROUGH SUPPORT STRUCTURE

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ABSTRACT

Solar energy, unlimited and clean energy, is the main goal for the future development of energy systems. A solar parabolic trough is one of the main technologies used to harness solar energy. This is a commercial form of solar thermal technology vastly used in the world. However, due to the high torque, less thermal efficiency and greater investment costs, parabolic troughs are restricted to be used in the development of solar thermal energy production systems. Thus, a reduction in the component's cost and improvement in technologies is an important problem that must be addressed in order to increase the production of solar thermal trough plants. The construction of the supporting structure of the trough includes complex scientific concepts, CFD analysis based on extreme wind force consideration, as well as conducting finite element analysis to form a rigid structure with an optimum number of elements in the mainframe. In comparison to other designs, the design of the torque box shows less deformation in the structure. As a result, more mounting elements can be connected to one drive, which will reduce the total number of drives as well as connecting high-temperature fluid lines, thereby reducing the heat losses. Regarding the use of materials, weight loss will be a priority and the presented design will possess the potential to reduce costs as well.

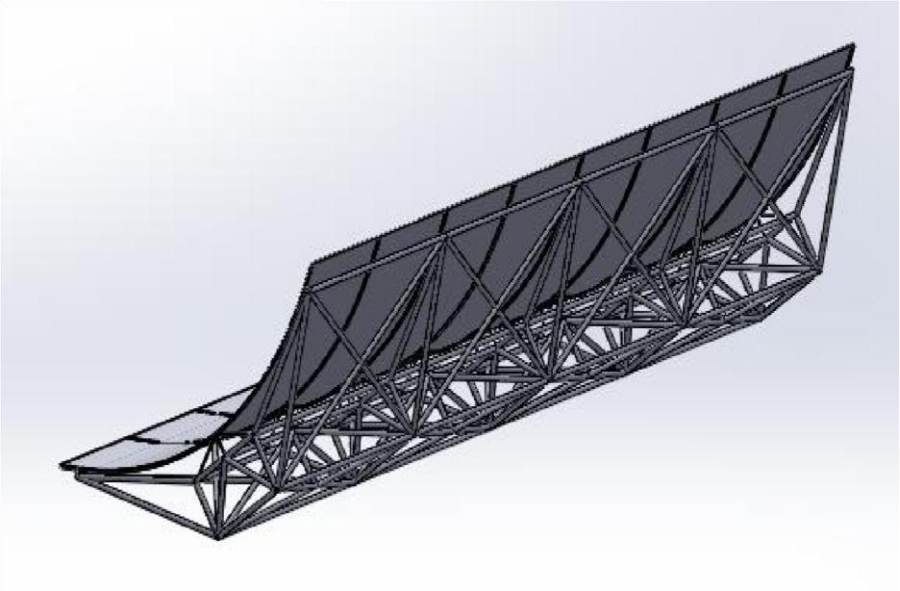

Figure 1 CAD model of Parabolic trough structure

The main idea of this paper is the design and development of a trough structure. 3D modelling will be carried out using CAD software and analysis of the modelled structure will be conducted in Finite Element Analysis (FEM)software. Design that will be imported from the CAD model in solid works will be used to make a line model in ANSYS for future analysis. The trough will be designed for harsh weather conditions. It will be designed to withstand a maximum wind load of 44m/sec, for a stable and sustainable structure. Based on these analyses an optimal structural design will be put forth in this paper.

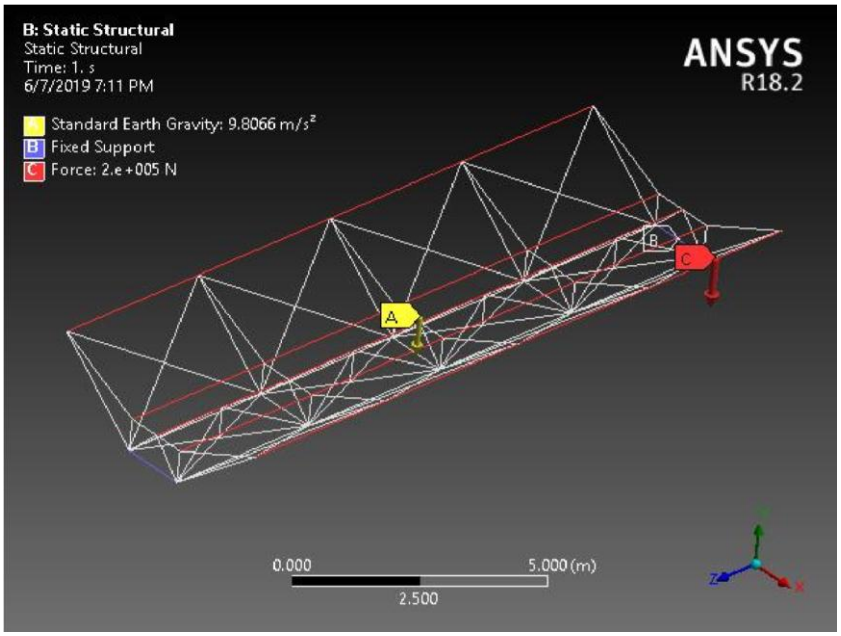

Figure 2 CAE model of parabolic trough

This is a MS Word-type document. Please carefully read the additional guidelines for the Word template. The extended abstract consists of a short abstract, 3-5 keywords, followed by a brief introduction, methodology, results and conclusions.

Key words: *Parabolic trough, solar concentrated technologies, Structure analysis*

HYDROGEN DIFFUSION AND TRAPPING IN DIFFERENT HEAT TREATED MICROSTRUCTURES OF A42CrMo4 STEEL

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ABSTRACT

The increasing use of hydrogen in contact with medium and high-strength steels has led to numerous investigations being carried out in order to know the influence of this element on their mechanical properties. Hydrogen can be absorbed by steel during fabrication (electroplating, electrochemical machining, pickling, welding, etc.) and during its service (off-shore structures, hydrogen pipes and vessels, etc.) and influences its behavior and mechanical properties, giving rise to the phenomenon of hydrogen embrittlement. In fact, a large number of structural breaks due to hydrogen have occurred. These breaks occur under stresses lower than the design stress, they are fragile in appearance and very difficult to predict, in such a way that the structures that work in the presence of hydrogen must be designed with materials capable of withstanding the embrittlement effect it produces, bearing in mind that the deterioration of mechanical properties (loss in ductility, reduction of fracture toughness, reduction in strength and crack growth enhancement) is known to increase with the strength of the steel. The sensitivity to HE increases with the strength of the steel due to the presence of more microstructural defects (hydrogen traps), that eventually increase hydrogen solubility and decrease hydrogen diffusivity in the steel.
In this context, the aim of this work is to study hydrogen solubility and diffusivity in a heat treated 42CrMo4 steel in order to find the steel grades that could minimize HE when used in contact with a hydrogenated environment. Consequently, a wide variety of laboratory heat treatments have been performed, producing different microstructures, with a broad range of yield strength levels. Electrochemical hydrogen permeation tests have been performed in a modified Devanathan and Stachursky double cell, allowing the determination of the apparent and lattice hydrogen diffusion coefficients, the hydrogen concentration in the steel and the density of hydrogen traps. This technique has been combined with scanning electron microscopy (SEM) so as to fully understand the interactions between hydrogen atoms and the steel microstructure.
In general, the results show that an increment in the strength of the steel is associated with a lower diffusivity and a greater trap density, which increases the susceptibility to HE.
Keywords: Hydrogen embrittlement, 42CrMo4 steel, heat treatments, hydrogen diffusion, hydrogen permeation tests.

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OPTIMIZATION OF PERHYDROPOLYSILAZANE (PHPS) FILM PROCESSING METHODS AND MOISTURE PERMEATION FOR A POTENTIAL ENCAPSULANT OF ORGANIC SOLAR CELLS

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ABSTRACT

Currently, wide usage of Polysilazanes as an alternative route to produce dense, homogeneous, and defect free silica films is observed. We can produce a dense and homogenous SiO^2 films from PHPS liquid precursors and can be utilized as a potential barrier against diffusion of gases. For this reason, PHPS are widely being used for various applications, more specifically in Organic light emitting diodes (OLED) displays, semiconductor industry, and for packaging purposes. One of the important reasons using PHPS coating is their volume expansion, that is due to their rise of molecular weight during the conversion of PHPS to silica, owing to its reaction with air and moisture, thus exhibiting very low susceptibility to crack formation and shrinkage. In this paper, we have demonstrated the process optimization of the curing times of the PHPS in terms of curing methods, curing environment as well as deep UV irradiation along with simultaneous heating of the substrate. The quickest curing was achieved when the layers were irradiated with deep UV at smaller distances along with heating at 100^{o}C. The cured layers were further characterized in term of WVTR against different film thickness, the lowest WVTR was exhibited by the films having thickness of 400 nm. The WVTR was further decreased by creating multilayers of PHPS and lowest WVTR of 10^{-3} g/m^2.day was achieved with three consecutive PHPS layers. This result clearly puts PHPS as a suited candidate for encapsulation of organic solar cells.

Key words: Polysilazanes, moisture permeability, thin films, solar cell encapsulation, transparency

Introduction

In 1964 Krüger and Rochow [1] introduces the concept of polysilazanes, by making a reaction of chlorosilanes with ammonia which generated tetrameric cyclosilazanes. This product was then treated at high temperature with a catalyst to form a polysilazane with high molecular weight. Complete cured PHPS remains optically clear and transparent and yield a very smooth surface [2].

For completely curing the Polysilazane to yield silica different methods are being used that are [3]:

a) Thermal curing
b) Curing in the presence of catalyst
c) Deep UV curing
d) Combination of the methods.

In the literature, various types of coating techniques, curing methods, and strategies have been reported to improve the barrier characteristics of Polysilazane derived coatings. It is further reported that the barrier performance of Polysilazane against moisture and oxygen mainly depends on the completeness of the curing process of the PHPS coating, thickness of the layer, number of defects present in the layer and number of coating layers [4].

Morlier et al., for the protection of organic solar cells, modified the structure of the barrier and produced stack of 5 barrier layers on PET, consisting of one PVA layer sandwiched between two PHPS layers on each side (PET/PHPS/PHPS/PVA/PHPS/PHPS) and laminated organic solar cells

(P3HT:PCBM) device with this barrier. The performance of this encapsulation film was compared with bare PET and a commercial barrier. It was observed that devices encapsulated with PET degraded faster because PET is a relatively poor barrier against moisture and oxygen. In contrast, the devices encapsulated with PHPS or the commercial barrier remained stable. This suggests that PHPS has a potential to be used as an encapsulation for the OSCs [3]. On one hand, increasing the number of layers enhances the barrier properties, but on the other hand also induces brittleness and chances of defects within the film [5]. Adding an organic layer between the SiO2 layers seems to be advantageous. It does not only enhance the flexibility of the coating but also decouples the growth of fractures and surface defects [6]. Channa et al. [2] reported that the flexibility of multilayer structures depends on the choice of the organic interlayers and their thickness. They prepared multilayered structures comprising alternating layers of PHPS and organic interlayers (epoxy and acrylate) and found that the performance of the multilayer structure having acrylate interlayers was much better in terms of bendability than epoxy.

Conclusions

A highly transparent thin film of SiO2 was obtained by curing of Polysilazanes. A lowest moisture permeation of 10-3 g/m2.day was obtained at given condition of 40°C and 90%Rh. SEM cross section also confirmed that the obtained thin film was defect less and hence produced lowest permeability. The processing time and obtained permeability clearly suggests that the PHPS is ideally suited encapsulant material for the encapsulation of organic solar cells.

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DEVELOPMENT AND TESTING OF A SOLAR WATER ABSORBER WITH TRIANGULAR CHANNELS

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ABSTRACT

Experimental studies showed that by increasing the collector surface area, the heat collecting capacity of the collector can be enhanced, but this will not be done by increasing the geometry but by modifying the formation of collector channels. The surface area can be increased for both the flat plate and tubular type evacuated solar collector when v-corrugated solar collector formation is used, because at the same time, two surfaces of the v-corrugated collector will remain exposed for heat collection. More surface area exposure to the sun will result in an enhancement of the efficiency of the collector that will increase the overall efficiency of the system. In the present study, the design, development and testing of a domestic solar water heating system using a v-corrugated type configuration of absorber has been presented. The results show that the highest temperature achieved is 64^{o}C at the minimum flow rate.

Key words: v-corrugated channels, solar absorber, domestic water heating, wavy channel arrangement, radiation intensity

Introduction

Fossil fuels are utilized for domestic water heating. This is often costly and may not be a viable option for longer periods of time in future especially for an energy deficient country like Pakistan. The alternative is to make use of renewable energy sources like solar thermal energy. However, the solar water heating systems developed so far are intermittent and may not be used for off-solar conditions like nighttime. In addition, the existing design of solar absorbers does not produce enough temperature for energy to be stored for long hours. Therefore, this study is an attempt to address the aforementioned concerns by introducing a novel absorber. Corrugated type solar collectors have enhanced surface area, thereby enhancing heat collection from solar radiation as compared to flat plate solar collector (FPSC) [1]. Various corrugations are developed for research purposes to enhance surface area, sometime in "V" shape or wavy shape channel arrangement. Corrugated solar collector resembles FPSC in frame size, they can also have an internal collector storage system. This collector is not readily available in the market as FPSC or evacuated solar collectors are widely applied to water heating and other domestic and commercial uses. Similar to flat plate type collectors, this collector is glazed at front and insulated on both sides and back [2].

Methodology

The major component of the entire system is the solar absorber. After finalizing the design and procurement of the material, the development of the solar absorber was undertaken at first. It incorporates a collector frame, supporting stand, v-corrugated channels and the accessories. The v-corrugated channels were made using copper sheets of thickness 0.7mm. The length of each channel was set to 39 inches having an equilateral triangular cross section of 2 inches each side. After fabrication channels were painted black to enhance their thermal absorbing capacity. During fabrication and complete assembly of the developed absorber is shown in Fig. 1.

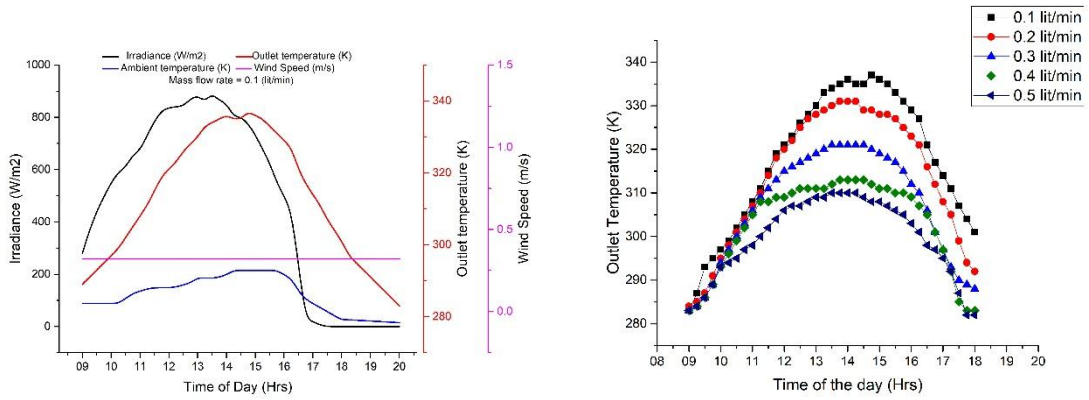
Results and Analysis

Currently, the solar absorber is operated manually, and channels are connected in series with each other. Pressure at the inlet of solar collector can vary from 0 to 5 bar, depending on the position of manual valve at inlet, static pressure both at inlet and outlet of solar collector can be measured using analogue static pressure gauges. Analogue temperature gauges are installed both at inlet and outlet to measure the temperature. Flow rate can vary from 0.1 lit/min to 3 lit/min and is measured manually. Anemometer is used to measure the air velocity in m/sec that varies from .1 m/sec to 2 m/sec. Solar

flux meter is used to measure the solar irradiation. After testing the solar collector for six consecutive days, the results are plotted against time of the day and are shown in Fig. 2. The highest temperature that is achieved for minimum flow rate of 0.01 lit/min is 64℃.

(a) (b)

Fig. 1 The developed and installed solar absorber with corrugated channels



(a) (b)

Fig. 2 Results of solar absorber testing (a) for the whole day (11th Jan 2021), (b) effect of mass flow rate on the outlet water temperature

Conclusions

The proposed configuration of the absorber is very effective in heat transfer and thus can be used for the purpose of solar water domestic heating applications.

Acknowledgement
The authors acknowledge the support of the Higher Education Commission (HEC), Pakistan under research project No. 9114/KPK/ NRPU/R&D/HEC/2017.

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METAMORPHOSIS OF ENERGY

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ABSTRACT

This research paper depicts its nature by acting as an actuary, which not only provides power to the selected educational fraternity, moreover, it also provides an additional layer of security to the institution under consideration by using image recognition to determine every single individual entering inside the campus and it also requires to clean the wastewater so it could be used for electricity production. However, to show prudent nature towards nature humans need to stop using overzealous behaviour. water! One of the most abundant yet most valuable resources available to mankind. Its Uses are vast to the extent where it can be used to produce green electricity, therefore, the consideration which human beings being following the footsteps of our ancestors i.e., being ascetic and dreams of avarice have certainly fallen into the abyss of darkness. It is due to our global destruction that clean water is certainly not available abundantly anymore. This global destruction has finally reached a crescendo. This proposed research incorporates creating a clean and green power solution for areas across Pakistan having contaminated water but no source of electricity. In the current dilemma, Pakistan is in a state where electricity is not widely spread across the boundaries, because, there are still small villages where is no electricity supply. Currently, with all the technical knowledge that would lead this proposed research ca properly clearing gaping wide problem.

Keywords: *Micro kinetic Turbine, Pelton Turbine,* Electrical Power Management, Power System Analysis, Image recognition, High voltage control

Introduction

Micro hydropower plants are delineating to produce electrical or mechanical power based on the need for energy of the surrounding areas. In a typical MHS (Micro Hydropower System) the water from the source is rerouted by a weir through an opening intake into a canal[1]. A settling basin might sometimes be used to sediment the foreign particles from the water. The canal is delineated along the contours of the landscape available to conserve the elevation of the reroute water. The water then enters the fore-bay tank and passes through the penstock pipes which are connected at a lower elevation level to the turbine. The turning shaft of the turbine is then used to operate and generate electricity[2]. The machinery or appliances which are enlivened by the hydro scheme are called the load.

Methodology

In the proposed research, we are using all the knowledge available to us by the work done by previous eminent engineers and then formulating a more strategic approach to obtain a desirable answer. In our research, we obtained several results from different research papers and came to these conclusions. The sewerage water available to us is not in abundant quantity i.e. its flow is not of the same intensity throughout the year. We observed that the flow of this water increases during the monsoon season and is also fast usually in August, March and July and In these seasons the supply of water is immensely

strong and should be considered useful. So, by this analysis, it has been observed that we need a turbine that we have a water supply of less flow speed and the applied turbine should also robust enough to bear strong flows, so that, for this using a Pelton type turbine because this turbine can easily work will less flow rate but for this purpose, we need to make the flow rate to a constant rate [4][5]. This could be achieved by constructing a larger head that allows a stable flow of water even when the supply is low.

Data available obtained after research, the use of the Turbine explained that several approaches can be taken to conclude. The turbines conventionally used are considered due to the presence of a vast amount of water and this approach cannot be applied in places where water is not present in the majority. So, this study enables us to understand which turbines suit the need of the vast majority. The accurate amount of water collected from rain and available from dams and rivers needs to be attributed. This would allow us to understand the tenacity of this situation and give a suitable solution for this research

Conclusions

In our proposed research work, we highlighted there three major positive outcomes from the project. Therefore, we would be able to enhance the quality of the sewerage water that intends to harm the environment by polluting all clean water from several areas across the country. Moreover, the proposed system would allow us to obtain a clean and green source of electrical energy that intends to supply electricity to those particular areas, where no supply of electricity is available hence, its full extent to save electrical bill costs. One of the major outcomes is that this proposed research work expresses its true potential by showing its commercial nature i.e. this system also have some commercial impact and can generate a reasonable amount of money in the form of net metering

Parking is one of the major issues all around the world, therefore, this proposed system provides an excellent autonomous solution for all the people using the facility under study.

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SITE SELECTION FOR HYBRID ENERGY SYSTEM USING GIS AND MULTI-CRITERIA DECISION ANALYSIS (AHP) IN AJK

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Abstract

AJK region is blessed with immense potential of renewable energy and provides a bulk of its energy to mainland Pakistan. Yet, it fails to fulfill its own electricity requirements, especially in remote areas due to unreliable transmission system. The purpose of this study is to identify and compare the suitable sites in this region that have promising renewable energy potential in the form of solar, wind, and hydropower which can be utilized to establish On-grid/stand alone, hybrid (solar/wind/hydro/diesel/ battery) energy systems. Eleven different sites in this region were studied having renewable energy potential. The geological features of the sites were taken using ArcMap and data related to renewable energy potential was acquired from AJKPDO and NASA's database. Then, these sites were compared on the basis of these criteria using Analytical Hierarchy Process (AHP). The resulting scores gained by the sites demonstrate the suitability of each site for the hybrid energy system.

Key words: Hybrid Energy System, ArcMap, AJKPDO, AHP.

Introduction

The world is seeing an increasing demand in the energy and power sector and meeting those everincreasing requirements in a sustainable way is one of the biggest challenges. With each passing day, the fossil fuels are depleting, and at this rate, the fossil fuel resources will be exhausted or will at least become extremely scarce so that it will become unfeasible and uneconomical for a developing country like Pakistan. This, combined with the drastic effects that these fossil fuels have on our environment and ecology has pushed science to explore other sources that do not deplete and also have minimal hazards when it comes to our environment. Renewable energy sources are the options that are being looked at as a possible solution. The purpose of this study is to make an effort to integrate more renewable energy potential into the energy mix, due to the increase in demand as Pakistan is witnessing rapid growth in population as well as growth in the industrial and commercial sector. Most of Pakistan's power production is fossil fuel-based so shifting focus on renewable energy has become all the more important.

The AJK region is blessed with a lot of renewable potential the main component of which is hydropower [1]. Plenty of areas with solar and wind potential are also present in the region that are yet to be utilized to their maximum potential. The suitable site selection for these clean energy resources is a great solution to meet the increasing power demand of the area. Sites having multiple energy sources can be utilized to set-up On-Grid or Off-Grid Hybrid power stations which can serve as a clean, sustainable and economical power source for the region [2].

Multiple factors are decisive in defining suitability of the sites that are under consideration or comparison. This study focuses to combine Geographical Information System (GIS) with Analytic Hierarchy Process (AHP) to help us prioritize the suitable sites on the basis of available data and parameters related to solar, wind, and hydropower, and select the most suitable options out of the available ones[3][4].

Methodology

Two tools were utilized in the decision-making process. First for the selected sites' data acquisition and extraction we have used GIS (Geographic Information Systems) and for evaluation and comparison of the

Flow-Chart of the methodology here shows the main steps of the research work:

Figure 1 Methodology Flow-Chart Diagram

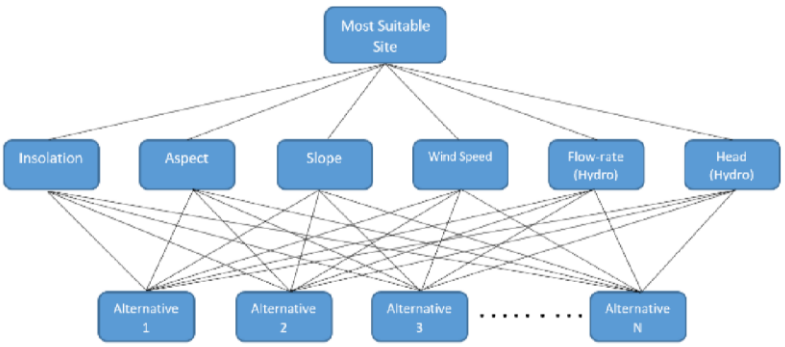

Figure 2 AHP 3-Level Hierarchy Diagram

data we have used the AHP (Analytic Hierarchy Process) which is a Multi Criteria Decision Analysis (MCDA) tool.

The Hydro Power Plants (HPPs) sites data-set which comprised of location, head, and flow-rate of each site was acquired through the AJK Power Development Organization (AJKPDO) and Private Power Cell (PPC) Muzaffarabad. These sites included functional, under development, and identified HPP sites for the future. The adjoining areas of these sites were studied for their Solar and Wind potential which were located near some considerable population or villages.

Results and Analysis

Sites Gulpur and Sharian got the highest and second-highest scores respectively. These scores show us the most suitable and least suitable sites out of the given ones. We can select a number of sites based on their obtained scores after performing AHP.

Figure 3 Scores achieved by the sites under study.

Conclusions

In this study the tools AHP and GIS are utilized for selecting potential sites of Hybrid Power Plants in the state of AJK. The AHP is utilized to prioritize the available sites by evaluating the importance and determining the weights of criteria that are specifically shortlisted for the region. The multi criteria decision analysis (AHP) methodology used along with GIS is very efficient and precise for swift and effective estimation of Hybrid (PV/Wind/Hydro/Diesel-Gen/Battery) Power Plant site selection and their prioritization based on the criteria. This study can serve as the basis for mainstreaming and integration of solar and wind power into the already existing hydropower resources of this region. This will be a reliable and sustainable system of electrifying the region which mostly consists of population dispersed in remote villages. The focus will shift from conventional energy resources to renewable energy resources. This will pave a way for more and more renewable energy integration

into the system and less dependency on fossil fuels. Hence it will have positive implications not only on our power sector but also on the environment.

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HYBRID THERMAL MANAGEMENT OF PIN-FIN HEAT SINKS

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ABSTRACT

The Micro and Nano level technological advancements are responsible for reduction in size and weight of Electronic Devices (ED). The dissipation of generated excessive heat, during their working cycle, becomes necessary to avoid damages, reduction in working potential and critical life of expensive electronic components. Therefore, efficient Thermal Management of these ED is a major issue. The objectives of this research project is to design and analyze the thermal performance of various phase change materials (PCMs) based heat sinks, having different fins configurations including circular, rectangular and triangular shapes. The main purpose is to lower cooling time of PCM using different forced convection configurations (axial flow, cross flow, reverse flow). A flexy glass cavity was designed and joined by chloroform in order to control the leakage. Three types of the cavities were designed in order to examine the in and out flow of air and three types of aluminum pin fins heat sink were manufactured which had base thickness of 4mm and fins height of 57 mm. A 50*50 mm fan of 12 v DC and a fan controller was used for varying air flow in forced convection. Silicon pad heater of 100*100 mm dimensions, having a 50 Watts limit, was used as heat generating source. A DC power supply was used for input power to heater and a data logger, connected to laptop, was used to measure the different reading of thermocouples. The PCMs (paraffin) were used because of their high density and high latent heat capacities to enhance heat absorption and consequently increase operational time of the ED within optimum temperature. Silicon pad heater was fixed at the base of cavity, an aluminum sheet of 2 mm thickness was used for protection of heater. Pin fins heat sink were adjusted in such a way that its fins were inside the cavity and base of heat sink was at the top of the cavity. The experimentation was done by varying the parameters. In first phase, only PCM was used to check how much heat dissipate from the source. In second phase both PCM and aluminum pin fins heat sink for heat dissipation were used. In third phase, the combination of PCM, heat sink and fan for force convection was experimented. The thermal performance of heat sink was examined by using the three different configurations of heat sink at different power levels (5 w, 10 w and 15 w) in the absence of PCMs and with PCMs and their thermal performance was considered by using simple convection and then by using forced convection methods. In forced convection method, three types of air flow configurations; axial flow, cross flow and reverse flow, were applied. Finally all the experimental results were analyzed and examined for best hybrid combination of air flow and heat sink. The selected combination would give the prolong operation time of the ED.

AN INSIGHT OF LITHIUM RESOURCES, MINING, ENVIRONMENTAL ASPECTS, AND WAY FORWARD

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ABSTRACT

Lithium-ion batteries are generally used for electric cars, ceramics, electronic gadgets, appliances, and equipment. Lithium is a good business nowadays and regarded as the new gold rush. Unlike gold, the proven lithium deposits are scarce and there is a need to keep a track of future lithium requirements and available resources. The global resources estimate shows a total resource of over 39 million tons, depleting at the rate of 50 thousand tons per year. The lithium batteries are being recycled as well to meet the supply. With the advancement in electric cars and other appliances, the battery industry is growing at a rapid rate. This work presents an overview of the global lithium deposits, mining, processing, and environmental concerns. This work also presents a discussion on recycling and future demands. In the later part, a way forward for proposed to meet the future Lithium needs.

Key words: lithium-ion, battery, mining, resources, processing.

Introduction

Lithium-ion (Li-ion) batteries are being used in most electric vehicles (Ev), personal and commercial equipment. They are generally known as high energy density, high power density, environment friendly, and give good service life [1]. Li-ion batteries can store much more energy than any other technologies available [1]. These batteries were initially used in the 90s when major companies like Sony introduced the commercial product [2]. Many countries are now focusing and taking steps towards cleaner and renewable energy solutions. One such step is by increasing EVs and reliance on batteries for energy storage. Keeping in view the EV market, an estimate shows that more than 35 million EVs will be on road globally by the year 2030 [3]. There is a marked improvement in the demands of Li-ion batteries. So far the cost of Li-ion battery has been increasing since the 90s due to the gap in supply and demands. As per EV specifications, 15kg of refined lithium metal is present in a single EV battery with a capacity of 100-kilowatt-hour/year. With 35 million EVs produced per year, there will be a demand for at least 500,000 tons of refined lithium per year.

Now that Li-ion batteries are dominating the battery industry, it is necessary to assess the available mineable resources, mining and processing technologies available, recycling potential, and its impact on the environment. This research work presents an overview of the lithium supply chain, sustainability, and environmental impact. A strategy is presented to cope with future challenges for the global community.

Lithium Resources

The documented global lithium production is 82,000 tons per year [4], with the current demands it is concluded that the reserves will be enough for more than 365 years (Figure 1). Table 1 shows country-wise data of Lithium reserves, resources, and production per year. The Mine-ability of these reserves is questionable. The best available lithium grade in these reserves is 2.6%, which needs to be processed and refined to >99%. Although technology is evolving for lithium extraction and processing there is a need to devise cost-cutting options during mining, processing, and refining to meet global demands. The current proven mineable resources are depleting and these will be enough for the next 10 to 12 years. There is a need to develop innovative solutions to help mine out deeper low-grade ore bodies and processing techniques.

The lithium business is still in its initial phase and strategic resource exploitation and consumption will be beneficial in the longer run. Although there have been some reports showing reserves

estimates and resources, it is still very early to conclude on future mining, exploration, and processing.

Table 4: Data of lithium mining and reserves in tons by country [4]

Country	Reserves	Resources	Production/year
Pakistan	*	0	0
Argentina	850000	6500000	3000
Australia	1500000	1700000	13000
Bolivia	*	9000000	0
Brazil	4800	180000	400
Chile	7500000	7500000	13000
China	3500000	5400000	5000
Portugal	60000	*	570
US	38000	5500000	1000
Zimbabwe	23000	*	1000
Others	*	4000000	*
Total	13519000	39780000	36000

* Data not available

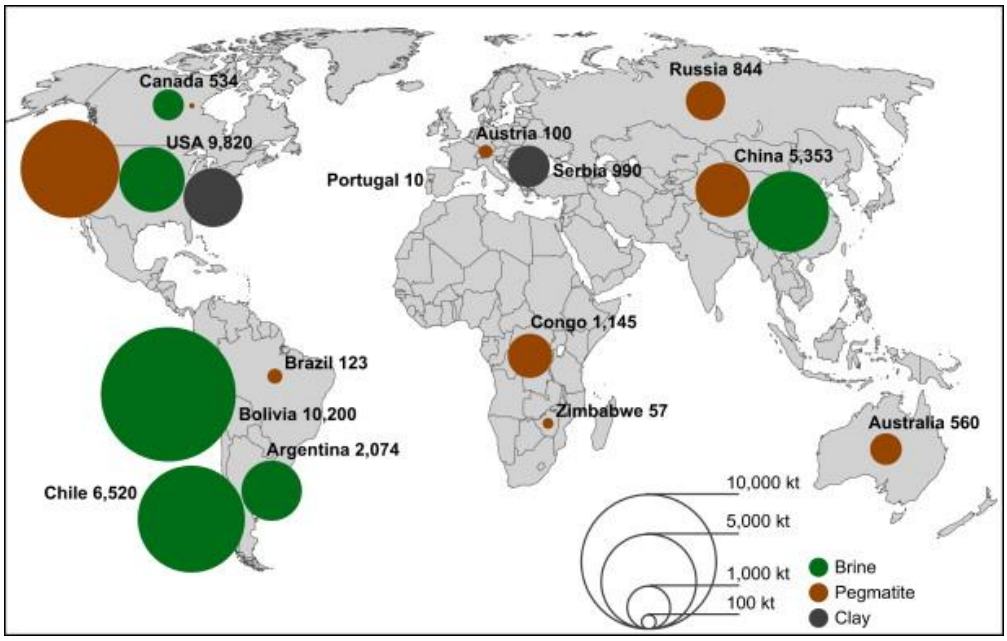

Figure 17: Lithium deposits around the world [5]

Lithium Mining, Processing Technologies and Environmental Impact

Lithium mining starts with the discovery of the reserves and developing feasibility studies incorporating mining, processing costs, legal and political aspects, rate of returns, forecasts, and market trends. This follows the establishment of final mine designs, plans, scheduling, and operations. The next step starts the operation and Lithium production begins.

Lithium ore is present in the hard igneous rock known as pegmatite. Mining of near-surface deposits is carried out by developing the open-pit mining method. Underground mines of lithium use the sublevel open stoping method. Drilling and blasting operations help fragment the ore body for material handling. The ore haulage and processing is the next step. The processing involves comminution, separation, beneficiation, thickening. The other method of obtaining lithium is from brine lakes in deserts. The process starts with pumping, removal of impurities, settling, filtering,

heating or evaporation, precipitation, and thickening/drying. The end product is Lithium Carbonate (see Figure 2).

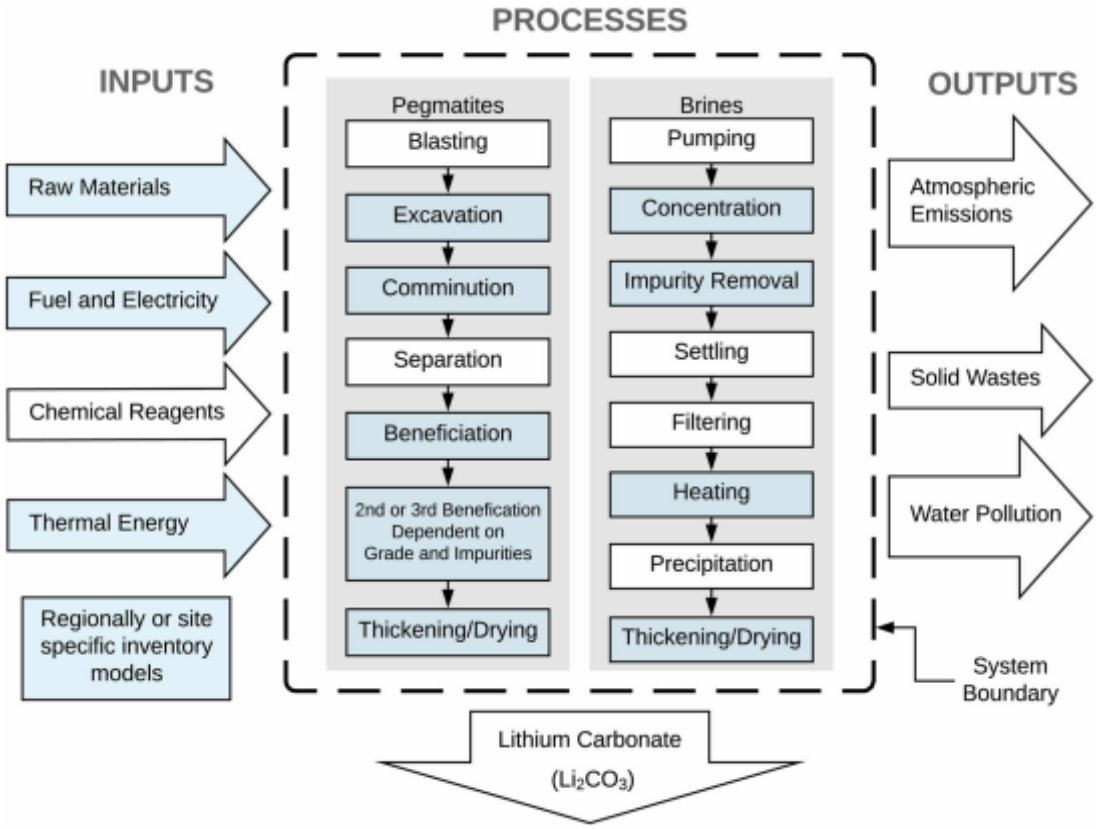

Figure 18: Lithium mining and processing process [6]

As can be seen from Figure 2, the output of the process also includes nuisance like atmospheric emissions, solid waste, and water pollution [7, 8]. This is owing to the inputs of the process. Lithium processing alters the freshwater course and adds to groundwater contamination. It's hazardous to the human lives and the ecology of a region. Chemicals penetrate through plastic barriers and pollute the environment [8]. Processing also affects other aspects of the region such as aquatic life, microbes, landscape, and sedimentation process. The impact of mining from evaporation ponds is less than mining Lithium from hard rock or other metals [7]. It is better to improve the sustainability of mining operations while considering environmental aspects.

Discussion and Way forward

The question is the sustainability of lithium resources translating into the supply to meet the future demands. There is a need to explore lithium in remote regions and in the sea bed. With the currently available mineable reserves, the demands can only be met up to the year 2030. After that recycling will be the only choice. The mining and processing business comes with hazards as a package. There is a need to improve and optimize the mining and processing scheme. Exploration is an important part and searches for Lithium must be extended to remote regions around the globe.

The market of Li-ion batteries is still very young, and it's a perfect time to set the policies and standards right for the future. Obviously, fossil fuels will not last long and there will be a transformation of the system. As of now, the demands are huge considering that the significant population of the world is yet to own EVs. But as soon as the transformation of the system will happen there will be a huge demand for batteries for EVs. The resources available are not enough to cope up with the demands. There is a need to reinforce the R&D to get raw materials, processes, and refinement methods. Also, there is a need to further optimize the use of Lithium-ion in battery designs

and other processes. There is a need to find alternatives to passenger vehicles although they are much better than IC engine cars.
The recycling of lithium is another domain and is necessary for a sustainable solution [6]. Also, there are environmental hazards associated with recycling batteries. Several authors are working on developing alternatives of Li-ion in batteries [9]. This can also be a good way of developing a workable solution.

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ENDOSCOPIC TEMPERATURE IMAGING IN A PORT-FUEL INJECTED GASOLINE ENGINE VIA ANISOLE-LIF

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ABSTRACT

The photo-physical properties of anisole indicate its high potential as a fuel tracer for LIF imaging in engines. High fluorescence quantum yield and large absorption cross-section result in high signal intensity. This is particularly beneficial for endoscopic imaging systems, which typically have worse light collection efficiency than traditional lens/camera systems in fully optically accessible engines. In this work, we exploit the strong anisole-LIF signal to determine gas-phase temperature based on single-shot images in an all-metal gasoline engine accessed by an advanced UV endoscope system. Two ICCD cameras with different band-pass filters acquire simultaneous single-shot LIF images. First, LIF of anisole was compared to that of toluene, which we used in previous work. The signal-to-noise ratio of anisole is much higher. Second, the temperature dependent red-shift of the anisole fluorescence spectrum is exploited for ratiometric two-color temperature imaging.The available spectroscopic data was used to develop several signal-ratio models, which were calibrated in-situ. Models with 2-step exponential interpolation show good agreement with the adiabatic temperature compared to linear or 3D-surface exponential interpolation. Later, the gas-phase temperature images based on single-shots were obtained using one selected model, showing a near-uniform and a stratified temperature distribution during the compression stroke and gas exchange process respectively.

Keywords: Internal combustion engines, Endoscope, Optical diagnostics, Laser-induced fluorescence, Temperature imaging.

Introduction

Tracer-based laser-induced fluorescence (LIF) has been widely used as a non-intrusive diagnostic for quantitative measurement of fuel concentration, temperature and fuel/air ratio in combustion applications [1]. LIF has also been used to detect the flame front by negative-LIF technique in [2], and to investigate the formation and evaporation of piston fuel films [3]. The effect of tracer quantity added into the non-fluorescent base fuel can generate substantial systematic error due to different physical properties, and hence prevent the accurate quantification of LIF signals [1]. Toluene has been well investigated as a tracer for LIF applications [4], and used as a tracer for LIF measurements in combustion engines [3, 5, 6]. Recently, anisole (methoxybenzene, $CH_3OC_6H_5$, boiling point 154°C) was characterized spectroscopically for engine-relevant pressures and temperatures [4] and emerged as a potentially advantageous alternative to toluene [4]. The absorption cross-section of anisole when excited at 300 K with 266 nm laser is 1×10^{-17} cm^2, which is two orders of magnitude larger than the absorption cross-section of toluene [4]. Therefore, anisole may produce higher level of LIF signal per volume than toluene, which may enable better quantitative measurements, while having less effect on the combustion process due to the lower concentration.

This work is a direct extension of the work of Goschütz [2], who investigated if the previously reported endoscopic two-color LIF-thermometry [7] could be improved to single-shot imaging by substituting anisole for toluene. Anisole-LIF spectra exhibit a red-shift with increasing temperature and oxygen partial pressure (p_{O2}) which was exploited for temperature measurements using two-color

thermometry. This temperature and p_{O2} dependence of the anisole-LIF spectra was used to devise a signal model to determine the gas-phase temperature from the pixel wise red/blue signal ratio and $p_{O2,}$ with latter determined from the in-cylinder pressure. This signal model was then calibrated in-situ. An appropriate interpolation function for the spectroscopic data in the signal model is an issue. A 2nd order polynomial function by Luong et. al. [6], and a three-parameter exponential function by Kranz et. al. [8] are few of the many possible functions reported in the literature. In this work, different mathematical interpolations were used. These models can be categorized mainly as 2-step fit function, fitting separately for oxygen partial pressure and temperature, and a single 3D surface fit function incorporating the effect of both parameters on the signal ratio. Each category had further variations in terms of the function governing the effect of temperature on the signal ratio. These models were then used to determine temperatures along the compression stroke, and the results were compared to the adiabatic core temperature. Finally, one selected model was used to visualize temperature stratification and mixing of fresh charge and internally-recirculated exhaust gas during the gas-exchange process.

Conclusions

Anisole, due to its photo-physical properties, is a strong candidate for its use as a tracer in LIF diagnostics in combustion engines. Toluene is one of the best-characterized tracers, but anisole yields much higher signal levels when both tracers' concentration was limited by laser absorption, which here was the case for 20% toluene vs. 2.5% anisole. The anisole-LIF signal was 10 times higher in early compression stroke and 4 times higher in late compression stroke. Due to higher signal of anisole LIF, small structures of the turbulent flame burning into the anisole/isooctane-mixture were clearly visible after ignition.

Later, anisole was used for ratiometric 2-color LIF thermometry, a technique we had implemented endoscopically before with toluene, but without achieving good quality single shot images [5]. Different signal models were used to convert the red/blue LIF signal ratio from anisole-LIF images to temperature in the compression stroke, which was compared to the adiabatic pressure-based temperature. It was found that the 3D surface fit functions greatly overdetermined the temperatures in the late compression stroke. The 2-step fit functions with exponential temperature-dependent part yielded temperatures closer to the adiabatic temperature until ignition, but with some deviation when the oxygen partial pressure in the cylinder increased beyond that in available spectroscopic data.

The 2-step fit function with exponential temperature-dependent part was then used to visualize the spatial temperature distribution at different crank angles during the compression stroke. As expected for the port-fuel-injected operation, the temperature was found to be uniform across the FOV, with later crank angles showing more noise because of lower signal due to pressure quenching. The spatial temperature distribution around the gas-exchange TDC were also visualized. Residual gas mixture was observed moving along the in-cylinder tumble at crank angles shortly before TDC with measured temperatures close to the exhaust gas temperature. A clear temperature stratification was observed when fresh charge started entering in the cylinder with temperature decreasing with progressing intake stroke, similar to what was observed in our previous work with toluene LIF [5].

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PLASTIC WASTE GASIFICATION: AN ALTERNATIVE ENERGY RESOURCE FOR POWER PRODUCTION IN TEN MAJOR CITIES OF PAKISTAN

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ABSTRACT

As a developing country Pakistan is facing energy crisis and municipal solid waste pollution problems, in which plastic being a non-degradable waste is a main concern. Plastics consist of long chain hydrocarbons, which contains useful energy. The aim of the study is to identify the power production potential in waste plastic. Gasification being more efficient among all the waste to energy technologies should be employed to harvest the useful energy content from waste plastic. The plastic waste production is determined for the ten major cities using previous literature, among them Karachi being largest city produces 1461.56 tons/day. The useful energy content of the waste plastic determined through bomb calorimeter, proximate analysis and ultimate analysis are 44.325, 44.61 and 45.127 MJ/kg, respectively. Karachi being the largest country has highest power production potential of 314.92 MW and all ten cities combinedly have 662.30 MW capacity.

Key words: *Gasification, Plastic waste, Electric Power potential*

Introduction

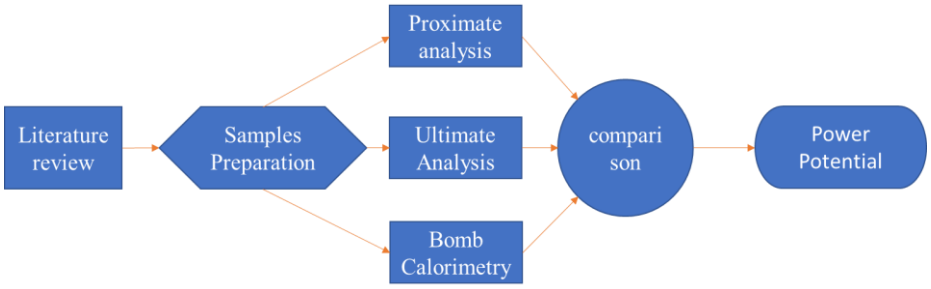
Pakistan is facing serious challenges with rapid economic development, population growth and significant urbanization in the collection and disposal of its municipal solid waste (MSW). To prevent severe environmental issues, the safe disposal of MSW has gained a lot of interest. Landfill is most widely used in most developing countries, because it seems easy and inexpensive, but it occupies a lot of land and leachate can cause soil and groundwater pollution even long after the landfill is closed [1]. Waste generation will more than double in lower income countries over the next 25 years. The current population of Pakistan is 225,199,937.00 with an average growth rate of 2%. Pakistan produces approximately 50.828 million tons of solid waste a year, with a rise of more than 2 percent annually [2]. The Government of Pakistan estimated that 91,176 tons of solid waste is produced per day. More than 14,150 tons of municipal waste is produced daily in Karachi, Pakistan's largest city [3]. The MSW of Pakistan consist of 30 % food waste, 14 %-yard waste and 12 % plastic waste. This 44 % combinedly called as Bio waste can be converted to energy as a methane product using environment friendly natural process called Anaerobic digestion. However, the plastic content being non degradable cannot be utilized by anaerobic digestion process. To convert waste plastic into useful energy content thermo-chemical cracking process are used, these are incineration, pyrolysis and gasification. Gasification has many advantages over pyrolysis and incineration in terms of environmental pollution, flexibility of usage of fuel and efficiency for power production [4].

Gasification is the conversion of heterogeneous solid waste mixture to syngas at high temperatures in range of 750 C to 1200 C, with a limited oxygen supply reaction process. The main products obtained are carbon mono oxide, hydrogen and small amount of methane, carbon dioxide and nitrogen etc. The gasification process consists of five major steps for power production. Preparation of the feed stock: The waste plastic is first washed to remove any contaminants. The rejected materials are removed which cannot be processed and then it is dried by high temperature air to eliminate any moisture present. The dried feed is then feed to the reaction chamber. Gasification chamber: This is a high temperature chamber having limited supply of oxygen. The plastic waste is heated in limited oxygen supply to produce Syngas, oil and char. Slag removal: In this stage slag is removed from the combustion chamber to ensure the maximum heat transfer to the feed, this is operated in batch process. Scrubber: The gas in the scrubber is cleaned and slag or sticky materials are removed. The

gas is purified for its usage. Power Production unit: The scrubbed gas is combusted in combined cycle power plant. The integrated gasification combined cycle power plant has efficiency rating up to 42% [4].

Methodology

Plastic waste generation data is collected through previous published data for ten major cities of Pakistan, Karachi, Lahore, Faisalabad, Gujranwala, Rawalpindi, Peshawar, Multan, Hyderabad, Islamabad and Quetta. Plastic waste samples are collected at three different locations of each city. 2 mm samples were prepared size using shredder of 2 mm mesh. The heating value is determined using three different tests, these are proximate analysis (Traditional equation), ultimate analysis (REM model) and bomb calorimetry and comparison of these values is done for verification. Power production potential in megawatts is calculated by multiplying the plastic waste produced per hour with HHV of fuel and efficiency of technology and divide by 3600 for conversion to seconds.



Results and Analysis

Experiments		Results	Region	Population	Waste Plastic tons per day	Power Potential MW
Proximate analysis	MC%	0.315	Karachi	16,459,000	1461.5592	314.9203
	VM%	99.1875	Lahore	13,095,000	630.1314	135.7736
	FC%	0.15	Faisalabad	3,542,000	225.016176	48.4840
	Ash%	0.3475	Gujranwala	2,290,000	126.408	27.2370
	HHV	44.6155	Rawalpindi	2,281,000	87.5904	18.8730
Ultimate analysis	C%	85.7075	Peshawar	2,273,000	136.38	29.3856
	H%	12.7275	Multan	2,060,000	131.016	28.2300
	O%	0.625	Hyderabad	1,887,000	147.186	31.7140
	N%	0.5125	Islamabad	1,164,000	83.808	18.0580
	HHV	45.1277	Quetta	1,129,000	44.7084	9.63326
HHV (Bomb calorimetry)		44.325	Ten Cities together	46,180,000	3073.803576	662.3086

Conclusions

It is concluded that the waste plastic in Pakistan contains very useful content of energy of 44.325 MJ/kg. Karachi being the largest country has the highest power production capacity of 314.9203 MW. The technology of IGCC should be implemented in the cities while priority should be given to the cities which are most populated to eliminate energy crisis and plastic waste pollution problems.

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REDUCING STEAM LOSSES BY CHANGING GASKET MATERIAL

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ABSTRACT

This research is carried out due to increasing steam leakages in the gaskets which were being utilized to retain steam in the dome type presses for vulcanization of tyres. A unique method for the preparation of Rubber Dome gasket seals employed using Rehnogran PCZ-70/IIR (combination of a thermo-reactive alkylphenol resin with zinc oxide 70% elastomeric binder IIR and dispersing agents 30%). This material is used for enhancing its physical properties including Rheology, Mooney viscosity, Tensile Strength and Hardness. The conventional method utilizes only octyl phenol resin and new gaskets are prepared by using Rehnogran material and then properties are evaluated and compared to the new material utilized. The data has been collected after preparing different sizes of gaskets of both material and samples of number of leakages has been recorded and compared. It is found that Rehnogran a better substitute of octyl phenol resin in the manufacturing of gaskets.

Key words: energy, steam, curing, gasket, tyre

Introduction

Reducing Steam leakages from the Dome gaskets was a challenge in batch operation because tire industry utilizes Tire cuing press for vulcanization[1] of green tires to convert them into cured tire i.e. finished product. Tire curing presses utilizes dome gaskets to hold high up to 240Psi in it. If there is a leakage in Dome gasket it could lead to steam loss and ultimately company's loss in terms of money.

In lieu of the following problem statement I have searched a lot of research papers and study them. In view of the previous papers it is found that very few works had been done in this regard. Some have predicated the degradation models where they have calculated the degradation rate of gaskets with respect of time and concentration of contaminants. Some have work on the leakage rate of gasket with respect to roughness of matting surfaces and calculated the amount of leakages in the system[2]. Other have work on the calculation of life of rubber gaskets but it is important to know about the life to proper utilize it with in the time period and replace it before it expires because it can save the most of the resources which have been lost after the loss or rupture of the gasket after achieving its maximum life. Other have some experiments with raw materials for example carbon black and stearic acid amount was increased to calculate the behavior of the gasket and it was found that stiffness has been increased but it can be utilized on certain places where hard gaskets are required[3].

Methodology

We selected adding new curing agent to increase cross linking of butyl rubber. We search market there are many available solutions in according to compound and nature of process. We selected Rehnogran PCZ-70/IIR (combination of a thermo-reactive alkyl phenol resin with zinc oxide 70% elastomeric binder IIR and dispersing agents 30%).

We can divide our methodology on the four steps

i. Quantitative analysis of data has been selected because we have a quantitative objective to reduce the leakages, we have reviewed it from the Literature that in this type of study we have to show the comparison of data from both type of gasket material used. That's why prepared gaskets from both material and perform physical test to check the applicability of the materials.

ii. The experimental data was collected after preparing gaskets of both materials and using them in the tire curing presses and fixing the appropriate sizes of gaskets in each of them. Then collecting the no of leakages taking samples. From where taken after 3 days of each sample taken. In this study 04 samples taken of each size of gasket and each type.

iii. The experimental data is then analyzed in view of the physical tests perform and mostly from the amount of leakages data shown from each material gasket. Then the Steam losses were calculated the show the clear of the scenario.

iv. Comparative data from Phenol formaldehyde and Rehnogran material shown in form of steam losses from each material and shows the clear difference between both material performances.

Results

Following were the results of physical properties comparison of old and new gasket compound prepared.

Properties	*From Phenol formaldehyde compound*	*From Rehnogran Resin compound*
Viscosity Mooney M_L (1+4) @ 100°C	65	76
Oscillating Rheometer M_L (dNm)	9.9	10.1
Oscillating Rheometer M_H (dNm)	34.4	40.2
Oscillating Rheometer T_{90} (min)	29.2	37.1
Strength tensile (MPa)	14	17
Elongation (%)	198	146
Hardness Shore A	66	71

Following were the results in form of steam loss per day by both type of gaskets.

Gasket Type	*Steam loss by Phenolic resin gaskets in lbs.*	*Steam loss by Rehnogran resin gaskets in lbs.*
14 ft. length gaskets	175526.83	43529.73
16.5 ft. length gaskets	83651.13	7659.04
18 ft. length gaskets	11172.64	5809.45
20 ft. length gaskets	9394.36	1855.21
22 ft. length gaskets	38851.83	26804.01

Conclusion

The purpose of this research was to reduce the leakages and by using rehnogran PCZ-70 our ultimate goal was achieved and leakages were reduced by approximately 50%. In addition this combination of compound can also be used in same type of sealing purposes for example rubber o rings used in mechanical seals.

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PERFORMANCE ANALYSIS OF 4 STOKE PETROL ENGINE USING BUTANOL ISOMERS

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ABSTRACT

Biofuels are one of the most important fuel additives in gasoline engines. The fractional usage of these fuels in parallel with air fuel mixture provide multiple benefits. The butanol blend biofuel is used in petrol engine and the analysis of engine is done through dynamometers. Butanol isomers, iso butanol and n butanol are selected for analyzing the performance of petrol vehicle which is maintained run over a specified range of rpm, both of the butanol isomers fuels show remarkable improvements in terms of power and engine performance parameters which include (Torque, BHP, Engine efficiency and Specific Fuel consumption).

Key words: Bio fuel, Petrol engine, Energy conservation

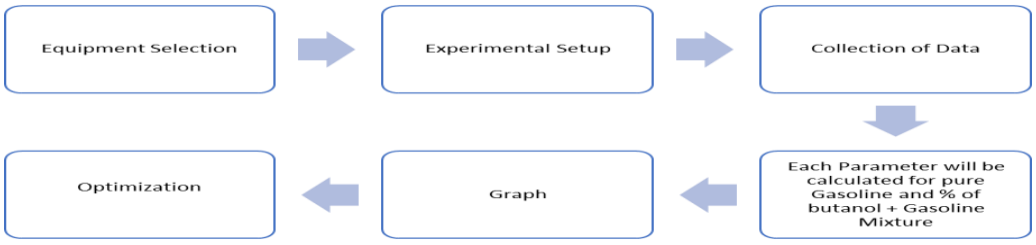
Introduction

Rapid demand of energy in automotive sector have been increased significantly over the past years. This rapid demand is met either via fuel additives or through the use of electric vehicles. The use of fuels additives is getting more and more common over the years.

Butanol isomers have properties very similar to petrol and are available readily they can be manufactured artificially unlike fossil fuels which are present in limited amounts and are being used for a longer time period [1].

Methodology

4 stoke petrol engine is attached to an engine test bed to determine power performance parameters. The parameters are recorded via analyzer which is installed in a regular engine test bed. More clear explanation of the process is shown with the help of a flow chart attached below:



Results and Analysis

Performance of engine is analyzed using engine testing bed and the variation in recorded in Brake horse power BHP, Torque, Engine efficiency and Specific fuel consumption.

Conclusions

Butanol isomers proved to be an ideal alternative fuel for optimizing engine performance and controlling engine exhaust pollution for currently present technology in automotive sector.

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EFFECT OF THERMAL PERFORMANCE ON SINTERED COPPER WICKED HEAT PIPES USING TIO_2 NANOFLUID

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ABSTRACT

Efficient cooling system is the major requirement of electronic industry. Therefore improvement in thermal management system or to introduce efficient thermal management system is the main focus of the scientists and engineers. For this purpose different techniques are used. Heat pipe has the maximum heat transfer ability. In this research, Sintered copper wicked heat pipe is used due to its high level of capillary action and low thermal resistance of copper wick. Different techniques has been employed to increase the thermal performance of Sintered copper wicked heat pipe. One of the important technique is to introduce the nanofluids in the heat pipe. The experiment was done at different heat loads with simple heat pipe and (Tio2+DI water) nanofluid filled heat pipe and results was compared. The temperature difference 42.27% and 4.15% was recorded at evaporator and condenser section. Compared to Tio_2 filled heat pipe 85.54% reduction rate was observed at 20W.

Key words: Heat pipe, Nanofluid, Heat transfer coefficient

Introduction

Electronic components play an important role in every sector of industry last few years. Efficient cooling system is the major requirement of electronic industry due to the generation and rejection of heat for their reliable operation [1]. Therefore, many researches are focused to improve their thermal performance system. According the report of US air force about 55% abortion of devices due to the heat production [2]. Heat pipe has greater application in electronic industries, refrigeration and Colling systems [3]. Different types of nanofluids are used as working fluids in the heat pipe. By mixing nano particles in the base solution make nanofluids. Do et al [4] used Nanofluid Aluminum oxide (Al2o3) as a working fluid in heat pipe and compared the results with the heat pipe which was experienced with distilled water, concluded 40% reduction in thermal resistance in evaporator-adiabatic section of pipe using 3.0 vol% concentration of Nanofluid

Methodology

Research methodology include experimentation on heat pipe filled with Tio2 with DI water and compared with simple heat pipe. A wire type heater is wounded on the evaporator section and power was given by the power supply to heat the evaporator section of heat pipe. Five thermocouples are connected to the heat pipe and one was at the atmosphere for temperature measurements. Test is carried out by using DI water and Tio2 0.01 wt% nanofluid as a working fluid in heat pipe. Before starting the each test heat pipe is evacuated at ~0.007 torr in vertical position and a significant quantity of working fluid is filled in heat pipe. The charging quantity of working fluid is ~40% of the total volume of evaporator section which is found to be optimum. The input power (Q_{in}) in evaporator section increased from 4W to 20W at a step of 4W. Temperatures are measured of thermocouples at several minutes related to every input power.

Figure 19Experimental Setup

Results and Discussion

The thermal performance measured by using the wicked sintered heat pipe using nanofluid and DI water. The wall temperature of heat pipe with time measured at different heat inputs (4W, 8W, 12W, 16W and 20 W) at an angle of 90c^{o} at the evaporator section.

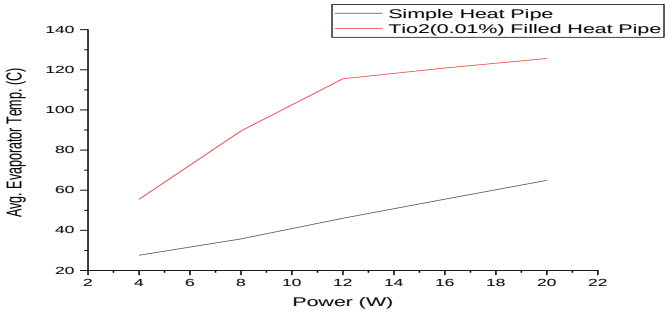

Figure 20Avg. Evaporator temperature at different watts of simple heat pipe and Tio2 filled heat pipe

Conclusions

In this research thermal performance was checked of the simple heat pipe and nanofluid filled heat pipe and compared the results. The temperature difference 42.27% was observed at the evaporator section of the heat pipe at 20W. Compared to Tio_2 filled heat pipe 85.54% reduction rate was observed at 20W. This showed that at low power nanofluids are not favorable for thermal performance in heat pipe. It should be operated at higher power to get good results in the future.

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PERFORMANCE ANALYSIS OF A HYBRID PHOTOVOLTAIC THERMAL (PV/T) SYSTEM

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ABSTRACT

The gradual increase in the temperature of the photovoltaic panel decreases its efficiency. To eliminate this problem, a thermal collector is attached to the photovoltaic panel to remove heat. It has been found that photovoltaic cell cooling increases the output of electricity and allows the extra heat to be absorbed by the working fluid.
The study includes an experimental investigation of Photovoltaic panel using a rectangular microchannel cooling technique. Water is used as a cooling fluid. An outdoor cooling system was designed to carry out experimentation. A 30 W monocrystalline crystalline photovoltaic panel was selected and rectangular microchannels made of aluminum were attached for heat extraction. The thermal collector is composed of an 8 mm thick microchannel plate of aluminum. The microchannel plate includes 29 channels of 3×3 mm cross-section. The other parts of the test rig include an infrared thermometer, Solar irradiation meter, and multimeter.
K-type thermocouples were installed at inlet and outlet to measure temperature variation in water temperature. Results were drawn against different temperatures and flow rates. An optimum value of the flow rate was found to be 3 L/min. The temperature of the photovoltaic panel decreases with this cooling technique and a significant improvement in photovoltaic cell efficiency was observed.

Key words: Thermal collectors, Photovoltaic panel efficiency, Rectangular microchannel cooling technique.

Introduction

Nowadays, the world is facing the challenge of how to reduce energy consumption produced via fossil fuels, because of its adverse impacts on the environment and price volatility [1]. One of the approaches is to increase renewable energy resources like solar as an alternative source to protect the environment. By the application of a combined photovoltaic and thermal system, we can obtain a higher efficiency by utilizing both at the same time [2]. Photons in the sunlight strikes on the photovoltaic module and photons of certain wavelengths are captured and consequently, electrons start to move and electricity is generated. During this process PV module gets heat up and, in the consequence, its electrical efficiency starts to reduce, and due to higher temperatures, its life span becomes shorter [3–5]. This paper focuses on overcoming the problem of gradual increase in temperature of the PV module and finding a way to increase its life and electrical efficiency.

Methodology

The experimental setup consisted of a 30W solar panel installed at the Department of Mechanical, Mechatronics and Manufacturing Engineering, University of Engineering and Technology Lahore, New Campus. The solar panel is oriented towards bulbs and adjusted parallel to the horizontal axis. The heat exchanger setup is consisting of aluminum plate with straight channels and its results are compared with the uncooled panel. The dimensions of the aluminum plates installed to the back of PV panels are 670×350×10 mm^3. The depth and width of the channels used are 5 mm. The spacing between grooves is 10 mm. An AC pump of 0.5 Hp is installed to feed the PV/T solar systems with the required flow rate of water. The flow rates are adjusted through the flow meters and the installed valves, which can be regulated to obtain the required flow rates. Aluminum is used for making microchannel. Thermal paste is used to attach microchannel to the solar plate. A 12V pump is used

for fluid flow, having a variable flow rate. An Arduino based thermocouple module is used which records temperature data in a USD card. Constant pressure at the inlet of PV panels is maintained and measured using manometers. In the experiments, current, and voltage of PV, solar panel, ambient air, inlet, and outlet water temperatures, wind speed, and solar irradiation are noted. Two flow meters have been used to record the flow rate directed to cooling PV panels. To measure the temperature at different points on the system thermocouples are used. Two thermocouples are attached to the PV module to measure the temperature at the inlet and outlet. Two thermocouples are installed on the inlet and outlet of the storage tank. Two digital differential pressure transducers are used for measuring the pressure drop of water between the water inlet and outlet from the PV module.

Results and Analysis

Experimentation was carried out at the solar radiation intensity of 198 W/m^2. Water was used as working fluid and temperatures at inlet and outlet were recorded. Experimentation was done from 10:00 hours to 15:00 hours. . It was noted that there was an increase in inlet and outlet temperature and electrical and thermal efficiencies were also increased by 2% and 4% respectively. The storage tank had 5 liters that were circulated to extract heat from the solar panel.

Conclusions

An experimental investigation was carried out to evaluate the electrical and thermal efficiency of a PV/T system having rectangular micro channels and water as a working fluid. Results showed that heat extraction from the solar panel increases the efficiency of the system. An increase in electrical and thermal efficiency was recorded, after heat removal from the solar panel, depicting that the PV/T system has great potential in the future. The use of micro channels also results in greater surface contact which leads to more heat removal. So, at the flow rate of 3L/min electrical efficiency increased by 2% from 14.5% to 16.5%. while thermal efficiency increased by 4% from 22% to 26%. Other configurations of this heat exchanger can also be used for heat removal which varies from geometry to geometry. For Future investigations, an efficient heat exchanger can also be attached to the solar panel for enhanced performance. Nano fluids with high heat capacity are highly encouraged to use as the working fluid.

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MODELLING, SIMULATION AND ADVANCED EXERGY ANALYSIS OF THE KOT ADDU COMBINED CYCLE POWER PLANT'S ENERGY BLOCK 1

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ABSTRACT

The combined use of the first and second law of thermodynamics in the form of an exergy analysis is imperative for in depth power plant performance evaluations. Owing to the complexities of such analyses, most power producers only utilize a first law analysis. These complexities can be overcome by using commercial tools. This paper presents the modelling, simulation, and an advanced exergy analysis using the concept of functional exergy efficiency at baseload with dual fuel usage, for the Kot Addu Power Company's Energy Block 1 combined cycle power plant. The models developed have been validated with real design data, resulting in the first law and exergy efficiencies to be 49.47% and 47.15% for furnace oil, and 49.93% and 47.89% for natural gas. The developed model has prospective capabilities for detailed power plant performance monitoring, and analyses for repowering.

Key words: CCGT, Advanced Exergy, Exergy

Introduction

Combined Cycle Gas Turbine (CCGT) power plants represent one of the most efficient and versatile technologies to generate electricity from fossil fuels. A first law of thermodynamics analysis is unable to highlight degradations to a large extent, and a combined first and second law of thermodynamics analysis is required for complete analysis, often termed as an exergy analysis. Exergy analyses highlight exergy destructions, exergy efficiencies and losses due to environment and internal irreversibilities of components [1]. Advanced exergy analyses utilize the concepts of unavoidable and avoidable exergy destruction, and endogenous and exogenous exergy destruction to give an in-depth analyses of a system.

This study aims to perform an advanced exergy analysis of the CCGT power plant in terms of functional exergy efficiency when it is operated with natural gas and Furnace Oil (FO) as fuels. The main objectives of this study include:

- An effective system modeling of the CCGT at baseload in the thermal flow sheeting software Cycle-Tempo by using the acquired power plant data for model validation.
- A comparison of performance with the two fuels in terms of exergy efficiencies and destructions (overall and component-wise), with the thermodynamic elaboration of the results.
- To generate a simulation case for further detailed power plant diagnostics and repowering.

Modelling and Simulation

The Kot Addu Power Company Ltd. (KAPCO)'s Energy Block 1 has a rated generation capacity of 409 MW at baseload. It comprises of 2 Siemens v94.2 Gas Turbines (GTs) of rated capacities of 130 MW and 1 Steam Turbine (ST) of a rated capacity of 149 MW paired in a 2x1 configuration. It can operate on three fuels: natural gas, FO (low or high Sulphur), and high-speed diesel. The Heat Recovery Steam Generators (HRSGs) in the power plant are of the dual-pressure type without supplementary firing. Only the high-pressure (HP) steam is used to drive the ST, while the low-pressure (LP) steam is used for deaeration and feedwater heating in the common feedwater tank, which acts as open feedwater heater. The HRSGs are of vertical gas flow assisted circulation type, with horizontal heat exchanger tubes for water/steam flow – a common design in the early days of CCGT development till the 1990s. Cycle-Tempo computes thermodynamic properties, gas compositions and mass flows in energy systems. Components in the flowsheet model are referred to

as apparatuses. The Lower Heating Value (LHV) of fuel is used for calculations. The following steps are performed by Cycle-Tempo for solving a system, details of which can be found in [2].

1. Checking of input data for accuracy and creation of a system matrix for mass flow calculations using mass and energy balances.
2. Determination of fluid types and compositions using built-in apparatus routines and input data.
3. Calculation of pressures, temperatures, and enthalpies in an iterative process until all properties are known using built-in apparatus routines and input data.
4. Solving the system matrix for mass flows using the Gauss Elimination Method, with the enthalpies calculated in step 3.
5. Checking the accuracy of every fluid composition and mass flow using a minimum of 2 iterations. The relative and absolute differences of each are compared to a break off criterion. In case of an error, step 3 and onwards are repeated.
6. Calculation of relevant fluid compositions in the solution of mass flows and using the mass flows and fluid compositions to calculate the unknown pressures, temperatures, and enthalpies.
7. Calculation of heat and work, and exergy analysis.

Exergy Calculations

Cycle-Tempo calculates two types of exergy efficiencies namely, universal exergy efficiency and functional exergy efficiency. The universal exergy efficiency is the ratio of the outgoing exergy to the incoming exergy. It can be insensitive to changes within the system, especially when part of the incoming flows undergoes a change or when all flows undergo a minor change. The exergy loss is then small compared to the incoming exergy flow. This introduces the term 'ballast' flows; flows that are fed to the process but are not involved in the conversion process. The functional exergy efficiency accounts for these changes and ignores the ballast flows.

An advanced exergy analysis involves splitting the exergy destruction into exogenous and endogenous parts. The splitting of exergy efficiencies into universal and functional terms constitutes an advanced exergy analysis. The universal exergy efficiency has a semblance to the exogenous exergy destruction as both involve inefficiencies that are a consequence of the component itself and the incoming flows from other components in the system. The functional exergy efficiency shows a semblance to the endogenous exergy destruction, as both remove the inefficiencies incoming from other components. The functional exergy efficiency achieves this by neglecting the ballast flows [2].

Results and Conclusions

The detailed analysis of the CCGT plant indicates an overall reduction of performance when it operates on FO instead of natural gas. The gross energy and exergy efficiencies of the system are 49.93%, 47.89% for natural gas-based operations and 49.47%, 47.64% for FO based operations, respectively. The energy and exergy efficiencies have dropped by 0.46% and 0.25%. due to FO being a lower quality fuel. The exergy destruction for FO based operations has increased with exceptions of the GT compressors and combustors, HP ST, Condenser, HP Economizer and Superheaters. The highest exergy destruction occurs in the combustors and can be validated by [3]. A slight rise in functional exergy efficiency of certain components in FO based operations is observed due to the change in operating points and steam mass flow rate. The continuous use of FO results in the degradation, corrosion and fouling of GT turbine blades and the HRSG [4]. This continuous degradation will enhance the difference in exergy losses between FO and natural gas operations, increasing loss of performance and inducing malfunctions. The simulated cases serve as reference point for further detailed diagnostic studies of the power plant. Since the design case data was used for these simulations, detailed quantification of losses can be done by running the above cases for the current degraded operating points of the power plant.

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OPTOELECTRONIC ANALYSIS OF BISMUTH SULPHIDE AND COPPER DOPED BISMUTH SULPHIDE THIN FILMS

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ABSTRACT

Bismuth Sulphide (Bi_2S_3), having optimal band gap range and high absorption coefficient is an attractive candidate for photovoltaic applications. Motivated by the optimization of semiconducting behavior by extrinsic doping; structural, morphological and optoelectronic properties of Cu doped Bi_2S_3 thin films are studied in current study. Charge carrier concentration, carrier mobility and electrical conductivity, which describe the fate of optoelectronic behavior are evaluated in correlation with extrinsic as well as worth mentioning intrinsic defects of Bi_2S_3. Results showed that all the deposited films were found to be appreciated absorbers in the UV-Vis. region. Parental intrinsic defects of orthorhombic Bi_2S_3 make it n-type and Cu^{2+} also prefer to act as donor by generating electron carriers in Bi_2S_3. Deductions from the spectrophotometer showed that values of refractive index (*n*) ranged between 1.4-1.8 and extinction co-efficient (*k*) 0.12-0.42. PL analysis showed strong characteristic peak of Bi_2S_3 at 555 nm and intensity decreased down gradually by increasing Cu^{2+} content.This is a MS Word-type document. Please carefully read the additional guidelines for the Word template. The extended abstract consists of a short abstract, 3-5 keywords, followed by a brief introduction, methodology, results and conclusions.

Key words: charge transport properties, chemical bath deposition, doping, intrinsic and extrinsic defects

Introduction

Although choices of materials for photovoltaic applications are diverse; but exploration of efficient as well as cost effective photovoltaic materials is still a hotspot for both theoretical and applied researchers [1]. In this coarse, emergence of the pervoskite ($CH_3NH_3PbI_3$) is an important breakthrough with solar cell efficiency exceeding than 22% [2, 3]. Owing to the relativistic effects of Pb, $CH_3NH_3PbI_3$ has low carrier effective masses and hence superior carrier mobility. Bi, an environment friendly element is a neighbor of Pb in periodic table having same electronic configuration i.e. $5d^{10}6s^26p^0$ for Bi^{3+} and Pb^{+2} hence, Bi based semiconductors are projected to exhibit excellent charge transport properties [4, 5]. Bismuth Sulphide (Bi_2S_3), a member of chalcogen family has orthorhombic crystal structure with 20 atoms in the primitive cell [6]. It has polymer like structure aligned as ribbons of $(Bi_4S_6)_n$, bounded with each other by the vander Waals forces. Bi_2S_3 has optimal bandgap in the range of 1.2-1.7 eV and absorption coefficient $>10^4$ cm^{-1}. But efficiency of the Bi_2S_3 based solar cells is not as good as pervoskite or Si, CdTe and $Cu(In,Ga)Se_2$ based solar cells due to poor charge transport properties of Bi_2S_3. Modification in behavior of Bi_2S_3 is critically important for improving its optoelectronic performance. Doping has found to have profound effect on charge transport behavior of semiconductors by increasing carrier concentration and their lifetime. Doping of Bi_2S_3 by extrinsic elements has been reported previously, but their influence on charge carrier generation and their mobility is not well discussed, thereby restraining the knowledge based improvement in Bi_2S_3 solar cell devices. In this paper, modification in the optoelectronic behavior of Bi_2S_3 thin films by extrinsic doping of Cu^{2+} is evaluated, by considering the worth mentioning influence of intrinsic defects.

Methodology

Commercially available microscopic glass slides were washed in dilute nitric acid for one hour and were cleaned in ultrasonic cleaner with acetone followed by isoproponal alcohol and used as substrate. Traditional chemical bath deposition method was used for deposition of undoped and Cu^{2+} doped thin films [7, 8]. Cu^{2+} doped derivatives having general formula $Bi_{2-x}Cu_xS_3$ (x=0.0-1.0) were prepared by adding stoichiometric quantities of $Cu(NO_3)_2.3H_2O$ and $Bi(NO_3)_3.5H_2O$ salts. Films were deposited for six hours and were dried in air at room temperature.

Results and Analysis

Thickness of the films decreases by incorporation of Cu^{+2} due to strong Cu-EDTA complex formation with high quite high formation constants as compared to Bi-EDTA complex. XRD patterns of binary and ternary Bi_2S_3 thin films are shown in Figure 1. and reveal that the material belongs to bismuthinite phase of bismuth sulphide. Absence of any Cu^{2+} related peaks validate the uniform distribution of Cu^{2+} in Bi_2S_3 nanoparticles. In Bi_2S_3 nanocrystals, Cu^{+2} resides at the interstitial sites, rather than substituting of Bi^{3+} due to low formation energies of the interstitial sites 0.2-0.7 eV versus high substitutional energies. EDX analysis depicts the sulphur deficient nature of the deposited thin films. Noticeable difference in the morphology of the deposited samples at different dopant concentrations is related to the difference in growth mechanisms due to stoichiometry of the copper and bismuth

Strong absorption in the visible region validates their potential for photovoltaic applications

In Bi2S3, top part of the valence band is composed of 3p states of S and 6s and 6p states of Bi (mixture of the bonding states of 3p of S + 6p of Bi hybridization and anti-bonding states of 3p of S + 6s of Bi hybridization), while bottom part of the conduction band is composed of anti-bonding state of 3p of S + 6p of Bi. As films are S deficient, Bi-S bonds are broken and Bi dangling bonds, which are basically Bi 6p states, localized near the broken Bi-S bond hence inducing defect levels in the bandgap [9]. Band gap values obtained for the deposited samples are between 1.2-1.4 eV, acceptable as visible light absorbers. PL intensity was found to be decreased with the increasing Cu^{2+} impurity due to intrinsic and extrinsic defects.

All the films analyzed in this study are n-type, as Bi, S antisite defects as well as S vacancies make Bi2S3 weakly n-type . Extrinsic defects induced by Cu^{2+} incorporation makes the films more n-type. S interstitial as well as S vacancies which are electron donors have much lower formation energies than the other acceptor defects. Mobility values reported for undoped Bi_2S_3 (x=0) films are 47.7 cm^2/v s are higher than the reported value i.e. 28 cm^2/v s.

Regarding the dependence of all optoelectronic, structural and morphological properties on the thickness of thin films, comparative analysis at constant thickness by optimizing time period for samples with different dopant content would be more valuable to locate the both intrinsic and extrinsic defects

Conclusions

In brief, Bi_2S_3 and $Bi_{2-x}Cu_xS_3$ (x=0-1.0) thin films having good lateral homogeneity, with energy band gap 1.2-1.4 eV were successfully grown through chemical bath deposition. Concentration of the dopant is found to have significant effect on the performance of the material. All the deposited films were found to be appreciated absorber in the UV-Vis. Regions. Considering all results, we concluded that the all these characteristic parameters were found to be effected by Cu^{2+} content in ternary chalcogenide. Intrinsic and extrinsic effects generating levels of defects in the bandgap acted as electron-hole recombination centers, decreased the minority carrier lifetime, which is an important reason for low efficiency of the Bi_2S_3 based solar cells.

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STUDY ON THE POTENTIAL OF WASTE TO ENERGY TECHNOLOGICAL APPLICATION AT SELECTED TOURIST DESTINATION OF KPK PAKISTAN

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ABSTRACT

Waste-to-energy (WTE) can be an option for sustainable solid waste management. The aim of the present study was to explore waste-to-energy as a waste management option at tourist destinations. In this study, the physicochemical characteristics of solid waste was gathered through proximate analysis based on the American Society of Testing and Materials (ASTM) standard. The higher heating value (HHV) and lower heating value (LHV), Energy recovery potential was determined through model equations. Bomb calorimeter was used to determine the higher heating value (HHV). To improve the calorific value additives such as spent tea leaves, wood coal and used oil were added. Physical composition analysis of MSW showed the following trend food waste 53.28 % > Yard waste 14.30% >Plastic waste 12.63%. The energy recovery potential of MSW calculated using lower calorific value (LCV) was found to be 1090 kWh/t from wet putrescible products, 1029 kWh/t from dry combustible wastes and 953 kWh/t from plastic. Energy recovery potential calculated using gross calorific value (GCV) was found to be 1093.26 kWh/t for wet putrescible, 1406.85 kWh/t for dry combustible and 2399.80 kWh/t for plastic at conversion efficiency of 25%. Additive materials when mixed in different proportion with waste showed that higher heating value increased proportionately with additives amount. The waste has potential for thermal energy conversion applications, but it has high moisture content which is a problem.

Key words: waste-to-energy, energy recovery potential, calorific value

Introduction

Generation rate of solid waste increasing rapidly, the World Bank estimates that the world generates 1.3 billion tons of waste annually, and by 2025, this number will increase to 2.2 billion tons per year [1]. The negative effects of tourism include the deterioration of natural resources, and the increase in the amount of solid waste. Increased tourist flow and rapid development of tourism industry have led to a generation of huge quantity of solid waste at tourist destinations [2]. Some tourist areas face problems of limited land for disposal of solid waste [3]. Major challenge is to design good policies to manage municipal solid waste (MSW) generated by the increase in tourist inbound flow [4]. Waste-to-energy (WTE), is an option for sustainable solid waste management, it is one of the most environmentally sustainable and economically feasible solution and important renewable energy sources in the future [5].

Methodology

Study Area

Study area was Abbottabad. Abbottabad has been attracting tourists, because it is the main transit point to all major tourist areas in Pakistan, such as, Ayubia, Naran and Nathiagali.

Waste Composition Analysis

Waste composition analysis was done by manual sorting of waste and using sampling techniques followed by ASTM D-5231-92(2003). The physical and chemical properties of solid waste was determined through proximate analysis.

Improve Calorific Value of Municipal Solid Waste

Calorific value was increased by adding low cost additive materials. In our study calorific value of waste was enhanced by adding wood coal, tea waste and used oil as additive material in selective proportions.

Bomb Calorimeter for Determination of HHV

The SDAC6000 automatic isoperibol oxygen bomb calorimeter was used to determine the calorific value of waste samples.

Results and Analysis

Table 1. Physico-chemical characteristics of MSW of Abbottabad city and Additives

Proximate Analysis	**MSW Samples**			**Additives**		
	Wet putrescible products	**Dry combustible**	**Plastic products**	**Tea Waste**	**Wood Coal**	**Used Oil**
Moisture content[a] (%)	65	45	19	35	0	-
Moisture content[c] (%)	11.2	8.9	0.4	7.5	0	-
Volatile matter[b] (%)	85	80	73	78.5	32	-
Ash content[b] (%)	1.5	6.6	1.06	4.3	2.4	-
Fixed carbon[b] (%)	2.3	4.5	25.54	9.7	65.6	-
LHV(Kcal/kg) calculated from Equation (1)	3759.43	3549.14	3285.61	3490.2	1453.2	-
HHV(kcal/kg) calculated from Equation (2)	3486.48	3582	4537.2	3820.8	6447.6	-
***HHV(kcal/kg)**	2733.16	3517.14	5999.52	3952.32	6993.43	7642.1
***ERP (kWh/t)**	1090	1029	953			
****ERP (kWh/t)**	1093.26	1406.85	2399.80			

[a] wet basis, [b] Dry basis, [c] Air dried for 48hrs * Bomb Calorimeter value of Higher Heating Value LHV=44.75VM-5.85W+21.2 (1), HHV = 0.196FC + 14.119 (2), LHV- lower heating value, *ERP (Energy Recovery Potential) = (LCV) x W x 1.16, **ERP= GCV×W×1.6

The study asses the municipal solid waste composition and characteristics in four different sites of Abbottabad. Food waste is the major dominant component out of total MSW, the second largest dominant component in all sites was yard waste. The study shows that high moisture content is an obstacle for waste to be used in thermal technological application. However, an additive may help to reduce this drawback. In general, the amount of additive added increased the calorific value of waste. Based on economic and non-toxic reasons spent tea waste is recommended additive. The best suitable technology option to treat MSW to energy is biological conversion or landfill gas utilization.

Conclusions

The waste moisture content is an obstacle for its waste to energy options. A suitable additive will help to overcome this deficiency. Further studied is needed to find a suitable low-cost additive.

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ACHIEVING SUSTAINABILITY IN THE ACADEMIC INSTITUTES OF PAKISTAN VIA IMPLEMENTATION OF SDG 6 AND 7 – A CASE STUDY OF GC UNIVERSITY, LAHORE

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ABSTRACT

Pakistan being an emerging country is rapidly moving towards industrialization. With limited natural resources and economic constraints, this rapid development and massive increase in population has lead Pakistan towards massive energy crisis. To bridge this gap, government has been trying to upgrade the energy generation but despite all these efforts, government couldn't meet the demand. Demand side management on other hand proposes most significant solution, which is retrofitting the existing buildings. Retrofitting fans, lights and AC units in one public building "Government college university (GCU) Lahore", has been carried out in this research work. Retrofitting resulted in total reduction in the electrical load of 362.7kW, which includes 192.8kW from retrofitting of lights, 86kW from retrofitting of fans and 83.8kW from retrofitting of air-conditioners. The expected annual energy reduction after the retrofitting with load factor of 0.8 is 496.2MWh. After retrofitting, levelized reduction in energy for lights appears to be 60 %, in Fans 40% and in ACs ranging from 20 to 30 % as compared to appliances used previously. Comparison shows 38% reduction of energy consumption for a random selected functional day of GCU before and after retrofits. The reductions has been estimated in the terms of bill reduction and is presented in the paper. Water conservation via rain water harvesting has been calculated and estimated for the use conservation and translated in terms of energy conservation. This research work is a step forward towards achieving sustainable development goal 6 and 7.

Key words: *Energy Conservation, Water Conservation, SDGs*

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SYNTHESIS OF PIEZOCERAMIC THICK FILMS ON FLEXIBLE SUBSTRATE FOR ENERGY STORAGE APPLICATIONS

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ABSTRACT

For practical applications like structural health monitoring sensors and biological microelectromechanical systems, functional ceramics play a pivotal role in providing real-time signals. In this work, the electrophoretic deposition (EPD) technique was used to deposit functional ceramic thick films on flexible, low cost, electrically integrateable Ni substrate. EPD process is a commonly used, eco-friendly process for the coatings of ceramic on a conductive substrate.

Keywords: Functional coatings; Flexible substrate; Impedance spectroscopy; Electrophoretic Deposition

Introduction
The fundamental components of numerous devices like sensors, actuators, ultrasonic imaging, transducers and energy harvesting instruments, etc., are piezoelectric and ferroelectric based materials [1-2]. Thick film based dielectric materials are promising candidates for multi-chip modules (MCM) and printed wiring boards (PWB) structures, extensively used in telecommunication, computing, military, space and automotive applications, and capacitors for energy storage applications.
Methodology
A simple process was used to stabilize the suspension of particles salary made by solid-state reaction method, and high energy ball milling process was used to disperse the particles without utilizing the complex dispersants and costly noble metal electrode. Piezoceramic films with thickness ranging from ~55-165 µm were successfully obtained by exploring EPD parameters, i.e. voltage from 100-125 V and coating time from 30-240 sec.
Results and Analysis
Comparative better adhesive thick coatings were achieved at 100 and 125 V with coating time up to 90 sec. Finally, thick, dense films obtained by sintering samples at 1150 °C for 30 min. Phase analysis was conducted by using X-Ray and infrared radiation in combination with Raman analysis of sintered films. Further, X-ray diffraction analysis revealed the formation of pure perovskite structure of BNT thick film. Scanning electron microscope studies indicated that dense and uniform microstructure was obtained by EPD coating. Impedance spectroscopy was used to investigate. Impedance spectroscopy was used to investigate the electric involvement of grain and grain boundaries.

Conclusions
The work will open the corridor for replacing lead-based thick films for applications like sensors, actuators and especially capacitors for energy storage applications.

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EFFECT OF pH AND MOLAR RATIO (Mg:P) ON THE RECOVERY OF STRUVITE

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ABSTRACT

Struvite ($Mg:NH_4:PO_4.6H_2O$) precipitation is a technique, potentially used to remove and recover phosphorus and nitrogen from wastewater streams. The potential advantage of struvite lies in its usage as an alternative slow-release fertilizer. Struvite precipitation highly depends on pH, and molar ratio of (Mg:P). The main objective of this study was to optimize the effect of pH and molar ratio on struvite precipitation. The pH was selected in the range of 8.0-10.0 and molar ratios of Mg:P in range of 1.1:1 - 1.5:1. The results indicated that at pH 9 NH_4^+-N removal was 50.00% whereas, PO_4^3-P removal was 85.60% and crystals yield was 390 mg which was maximum among all the pH levels. Although the maximum removal efficiencies of NH_4^+-N and, PO_4^3-P were obtained at Mg:P 1.5:1, but considering the cost of chemicals, Mg:P 1.2:1 was selected optimal at which removal of NH_4^+-N and, PO_4^3-P was 58.40% and 98.33%, respectively.

Key words: Struvite, Phosphorus recovery, Mg/P Molar Ratio

Introduction:

Phosphorus is the key element of fertilizers, but due to its limited deposits and high usage the resources would be exhausted by next century [1]. Therefore, current research is focused on better management of this non-renewable resource, with the most cost-efficient, environmentally friendly and energy efficient means. Struvite crystallization is a technique potentially used to recover phosphorus with the most cost efficient, environmentally friendly and by energy efficient means [2]. Struvite is a white crystalline substance with an orthorhombic pattern, having equimolar concentration of magnesium, ammonium, and phosphate ($Mg:NH_4:PO_4{\cdot}6H_2O$) (MAP) [3]. Struvite precipitation depends on various physiochemical factors: including pH, molar ratio, mixing rate, temperature and the presence of different foreign ions in solution [4]. The main objective of this study was to find the effect of pH, and molar ratio of (Mg^{+2}: NH_4-N: PO_4^{3-}-P) on struvite recovery.

METHODOLOGY:

Preparation of Synthetic Wastewater:

Magnesium chloride hexahydrate ($MgCl_2.6H_2O$), Potassium dihydrogen phosphate (KH_2PO_4) and ammonium chloride (NH_4CL) were selected as sources of Magnesium (Mg), Phosphorus (P) and Nitrogen (N) for struvite precipitation. For pH adjustment NaOH and H_2SO_4 were used. All the chemicals were ACS certified grade with purity > 97%, obtained from Fischer Scientific Store, USA.

Struvite/MAP (Magnesium Ammonium Phosphate) Precipitation:

For MAP precipitation already prepared stock solutions of monopotassium phosphate (KH_2PO_4) as source of PO_4^{3-}-P and Ammonium Chloride (NH_4Cl) as source for NH_4^+-N were used. Initial concentrations of NH_4^+-N and PO_4^{3-}-P were determined and with respect to PO_4^{3-}-P concentration, ($MgCl_2$) as source of magnesium was dosed. Five pH ranges (8, 8.5, 9, 9.5, 10) were selected and five molar ratios of Mg:P (1.1:1, 1.2:1, 1.3:1, 1.4:1, 1.5:1) were selected to find the effect of pH and molar ratio on struvite precipitation. The experiments were conducted at room temperature (25-35 °C), and samples were agitated at 120 rpm for 1-h. The pH of the solution was maintained using 5N NaOH and 5N H_2SO_4 solutions. After achieving the desired pH value and mixing, the samples were allowed to settle down and final NH_4^+-N and PO_4^{3-}-P were calculated to see the percentage recovery as indicated in Fig (1).

RESULTS AND DISCUSSION

3 Effect of pH on Struvite Precipitation:

For the present study, the pH was selected in the range of 8.0-10.0 (with 0.5 increment) to see the optimum conditions for struvite removal. The results indicated that NH_4^+-N removal at pH 8 was 43.25%, showing a slight increment up to 44.50% at pH 8.5, increasing further up to 50% at pH 9.0

whereas showing a decline of 47.90% and 43.25% at pH (9.5 and 10.0). The removal of PO_4^3-P was 82.60% at pH 8.0, showing an increment up to 84.70% at pH 8.5, increasing further at 85.60%, whereas showing a decline of 85.17% and 84.40% at pH 9.5 and 10.0. The crystal yield is strongly dependent on pH, a significant increase in crystals weight was observed up to pH 9 which declined above it Fig1(a). The mass of crystals obtained at pH 8.0 was 322.95 mg, which increased further up to 370.00 mg and 390.00 mg at pH 8.5 and 9.0. The yield of crystal declined slightly up to 372.50 mg and 375.00 mg at pH 9.5 and 10.0 as indicated in Fig.1(a). The pH 9.0 was most suitable for recovering NH_4^+-N and PO_4^3-P as struvite.

3.2 Effect of Molar Ratio on phosphorus Recovery:

Molar ratios of Mg:P for this experiment were selected as 1.1:1, 1.2:1, 1.3:1, 1.4:1 and 1.5:1. The removal of NH_4^+-N at Mg:P (1.1:1) was 50.33%, it increases up to 58.40% at Mg:P (1.2:1), showing a decline at Mg:P (1.3:1) 49.05%, and then increasing up to 55.03% and 61.43 % at Mg:P (1.4:1, and 1.5:1). The PO_4^{3-}-P removal was 93.38% at Mg:P (1.1:1) showing an incline at Mg:P (1.2:1) up to 98.33%, whereas increasing consequently up to 98.70%, 98.80% and 99.06% at Mg:P (1.3:1, 1.4:1 and 1.5:1) as shown in Fig 1(b). The mass of crystals formed also increased with increasing molar ratio of Mg:P, at Mg:P (1.1:1) the mass of crystals obtained was 322.95 mg which increased consequently up to 343.50, 364.20, 372.50 and 390.00 mg at Mg:P 1.2:1, 1.3:1, 1.4:1 and 1.5:1.

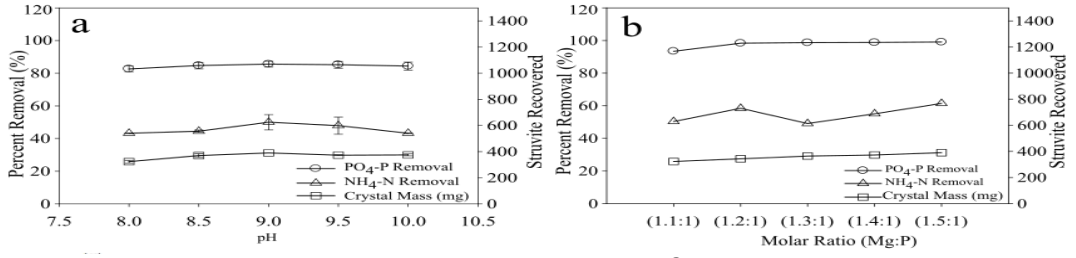

Fig 1. Effect of (a) pH, (b) Mg:P; on removal of PO_4^{3-}-P, NH_4^+-N and Crystal Mass

Conclusions:

In this study, the effect of pH and molar ratio on struvite precipitation was analyzed and it was concluded that: The pH and molar ratio had great effect on removal of phosphorus and nitrogen. The pH 9.0 was most suitable for recovering NH_4^+-N and PO_4^3-P as struvite. The molar ratio of Mg:P of 1.2:1 was efficient for recovering NH_4^+-N and PO_4^3-P as struvite whereas crystal purity was also maximum at this level. Considering the cost of chemical and to make the product cost effective Mg:P 1.2:1 is most suitable for struvite recovery. The combination of pH 9 and molar ratio Mg:P 1.2:1 is optimal for recovering struvite.

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SYNTHESIS OF N-MODIFIED TiO_2 NANO-POWDERS FOR EFFICIENT PHOTOCATALYSIS OF RHODAMINE B DYE UNDER NATURAL SUN IRRADIATION

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ABSTRACT

In this work, Nitrogen modified TiO_2 Nano-powders were successfully synthesized via fast acid catalyzed sol-gel method with ammonium hydroxide (NH_4OH) as a primary nitrogen source. The amount of nitrogen was increased by incorporating secondary nitrogen in prepared sample using urea precursor by wet impregnation method. For comparison, Pure TiO_2 Nano-powders were also synthesized. Prepared photo-catalysts were characterized by FTIR, XRD and DRS Spectroscopic analysis. Indoor photocatalytic decomposition experiments on Rhodamine B (RhB) dye under artificial lamp (20W White LED) revealed the highest activity of photo-catalyst doubly doped with ammonium hydroxide and urea (T5N2), whereas pure TiO_2 powders showed poor photoactivity. The effect of operational parameters such as photo-catalyst dose, solution pH and substrate concentration on photocatalytic efficiency was also evaluated to obtain optimal conditions. Under natural sunlight, T5N2 photocatalyst showed remarkable performance of 99.9% dye decolorization after 1 hour illumination.

Key words: Solar Photocatalysis, TiO_2 Nano-powders, Nitrogen Dopant, Fast Sol-Gel Synthesis, Urea Precursor

Introduction

Synthetic Dyes are organic compounds extensively used in textile industry to impart vibrant colors to the commodities, however, during dyeing stage, significant quantity of these coloring compounds does not bind to the fabric thus released as waste in the effluent, posing serious environmental concern [1] Semiconductor-based heterogeneous photocatalysis has gained importance since few decades as a promising technology for water detox application. In this regard Titanium Dioxide (TiO_2) is considered as "golden" photocatalyst due to its chemical, biological and photo-stability, non-toxicity and low cost. However, the main barrier in the applicability of pure TiO_2 under natural sunlight is the wide optical bandgap. Development of an efficient sunlight responsive TiO_2 photocatalyst is therefore a challenge. Nitrogen (N) is considered as an efficient and low cost dopant in terms of lowering bandgap and enhancement of photoactivity [2]. The present study deals with the preparation of nitrogen modified TiO_2 Nano-powders by adopting alcohol free Sol-Gel process with NH_4OH as a primary source of nitrogen. The adopted procedure follows hydrolysis of Titanium Isopropoxide precursor at room temperature, facilitated by Acetic Acid, allowing the completion of Sol-Gel reactions within short time. The amount of nitrogen dopant was enhanced further by wet impregnation with urea. For comparative study, pure TiO_2 Nano-powders were also synthesized. The activity of prepared Nano-powders was evaluated by photocatalytic decolorization of Rhodamine B dye under artificial 20W white LED and natural sunlight irradiation.

Methodology

For Photocatalyst preparation, a simple Sol Gel method as reported in reference [3] has been adopted with some modifications. 40ml of Titanium isopropoxide (TTIP) was added directly into distilled water and the suspension was immediately stirred on magnetic stirrer. Anhydrous acetic acid was added after 30 min such that the molar ratio of TTIP: Distilled H_2O: Acetic Acid was maintained as 1:172:12. The colloidal suspension was continuously stirred for 3hr after which NH_4OH (33%) solution was added to raise the solution pH to 11.0. Precipitates formed were washed and dried in oven at 100°C until dried powders were obtained which were calcined at 400°C for 1 hour. The sample was labeled as T5N1. To check the effect of increase in the amount of dopant on activity of

photocatalyst, secondary nitrogen dopant (urea) was incorporated into as-prepared catalyst (T5N1) via wet impregnation route. For this, 2g of T5N1 was added in distilled water forming colloidal suspension to which Urea solution (keeping TiO_2 to urea molar ratio 1:1) was added and the mixture was stirred for 1 hour. The temperature was then raised to 68°C while keeping the mixture under stirring for further 30 min, followed by solvent evaporation in open beaker at 100°C. The obtained photocatalyst material was dried in oven and baked at 350°C for 1h. The sample was named as T5N2. For comparative study, pure TiO_2 was also synthesized via similar sol gel method as adopted for T5N1 sample except NaOH was used instead of NH_4OH for precipitation.
All fabricated Nano-powders were subjected to FTIR spectroscopy with Cary-630 spectrophotometer. X-Ray diffraction (XRD) has been conducted with D2 Phaser diffractometer and diffuse reflectance spectroscopy (DRS) was performed for determination of band gap energies by Jasco-V770 spectrophotometer.
Indoor photocatalytic experiments were performed in a batch reactor (Pyrex glass beaker) under artificial 20W portable LED white lamp. The suspension of RhB dye (10ppm) and photocatalyst powders was fed to the photo-reactor setup. After regular intervals, samples were withdrawn from the suspension and decolorization of dye was monitored by measuring solution absorbance with UV-Vis Spectrophotometer (Perkin Elmer Lambda 25) at λ_{max} value of 554nm. For experiments under natural sunlight, photocatalytic assembly was placed directly under the sun with optimum load of photocatalyst powders at the Institute of Chemical Engineering and Technology, University of the Punjab Lahore, Pakistan.
Results and Analysis
The FTIR peaks obtained at 3225 cm^{-1} and 1630 cm^{-1} revealed the presence of adsorbed water/OH functional groups on all prepared photocatalysts. The small peaks at 1449 cm^{-1} and 3334 cm^{-1} were obtained on T5N2 sample showing the presence of nitrogen. XRD analysis confirmed the formation of pure anatase phase in all samples with crystal size in 5-7nm range. Bandgap energies obtained by DRS were 3.35, 3.08 and 2.99eV for pure TiO_2, T5N1 and T5N2 respectively.
Pure TiO_2 showed very low activity under artificial light with 17.45% decolorization of RhB dye whereas 83.12% and 96.93% photo-degradation was achieved with T5N1 and T5N2 photocatalysts respectively. The best degradation efficiency was observed at pH=3 and catalyst load of 1.5g/l. Under natural sunlight T5N2 showed 99.9% degradation efficiency whereas the activity was only 19% with pure TiO_2. However for both pure and doped photocatalysts, slightly higher activity was achieved under sunlight illumination as compared to white LED lamp.

Conclusions

Nitrogen modified TiO_2 Nano-powders were synthesized by acetic acid assisted Sol-Gel method with ammonium hydroxide as primary nitrogen precursor (T5N1). The amount of nitrogen was increased by wet-impregnation with urea as secondary nitrogen dopant (T5N2). Significant bandgap reduction of Nano-powders with nitrogen insertion was confirmed by DRS spectroscopy. Under 20W Artificial White LED with T5N2 Nano-powders, degradation of RhB dye was 96.93% after 1 hour whereas experiments under Sunlight demonstrated higher photo-decomposition efficiency as compared to white LED light with 99.9% decolorization of dye within same time duration. The adopted method of optical bandgap tuning with nitrogen modification has effectively enhanced the activity of TiO_2 under natural sun illumination, making it a potential candidate for practical photocatalysis application.

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ENHANCED PHOTODEGRADATION OF METHYL ORANGE IN AQUEOUS MEDIUM

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ABSTRACT

This study reports the visible light and Co-ZnO assisted enhanced photodegradation of methyl orange as model pollutant. The composites including 5% Co-ZnO, 10% Co-ZnO and 15% Co-ZnO were prepared and characterized by advanced techniques. The prepared composites were tested as catalysts for degradation of dyes pollutants using methyl orange as model pollutant. It was found that Co-ZnO loaded with 10% Co can remove the 100 mg/L methyl orange from water with 93% photocatalytic efficiency.

Key words: ZnO, Co-ZnO-graphene, Methyl orange, Photodegradation

Introduction

Photocatalytic treatment of organic compounds containing wastewater has gained significant attention in recent years. Generally, metal oxides have been reported as catalyst under ultraviolet light for treatment of organic compounds containing wastewater. It is important to develop an effective visible-light-driven catalyst for the eradication of aqueous phase organic pollutants. ZnO has been widely used as catalyst for removal of dyes under UV irradiation. Irradiation of ZnO results in formation of positive hole and electron with in the ZnO. Through a series of reaction, this pair of hole and electron result in formation of OH radicals. These OH radicals are responsible for degradation of pollutants. However, due to wide band gap, ZnO can not be employed as catalyst under visible light. The implantation of ZnO with transition metals causes the narrowing of the band gap of ZnO [1-4]. In this study, Co is implanted on ZnO for synthesis of Co-ZnO visible light active catalyst for photodegradation methyl orange.

Methodology

The Co-ZnO catalysts loaded with different percentage of Co e.g. 5%, 10% and 15% Co were fabricated by chemical precipitation method. The prepared catalysts were characterized by advanced techniques including XRD, DR-UV-Vis, PL, TPD and PEC. The photocatalytic activity was evaluated by performing degradation of methyl orange using a 50 mL solution of specified concentrations e.g. 100, 200 and 300 mg/L in the presence of catalyst and visible light.

Results and Analysis

Figure 1 depicts the XRD ZnO and Co-ZnO loaded with different percentages of Co. The XRD confirmed the formation of ZnO.

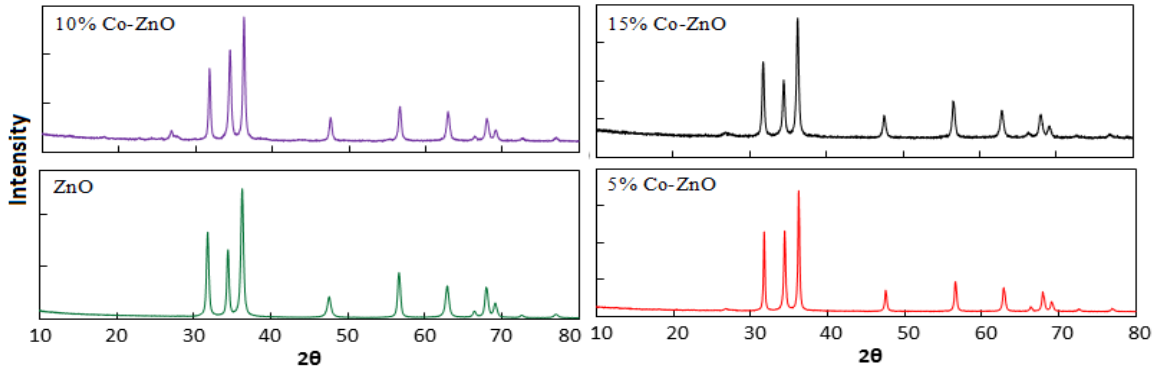

Figure 1. XRD pattern of catalysts

The photocatalytic efficiency of ZnO and Co-ZnO loaded with 5%, 10% and 14% Co towards photodegradation of methyl orange is Figure 2. The data shows that Co-ZnO loaded with 10% Co is

more active catalyst as compared to other catalysts. This study confirmed that incorporation of Co (II) in crystal structure of ZnO caused a significant improvement in catalytic efficiency of ZnO towards photodegradation of organic pollutants.

The catalytic efficiency of Co-ZnO loaded with 10% Co was further explored in terms of various parameters including the concentration of dye, temperature, pH of solution, catalyst dosage and catalyst recycling [5, 6].

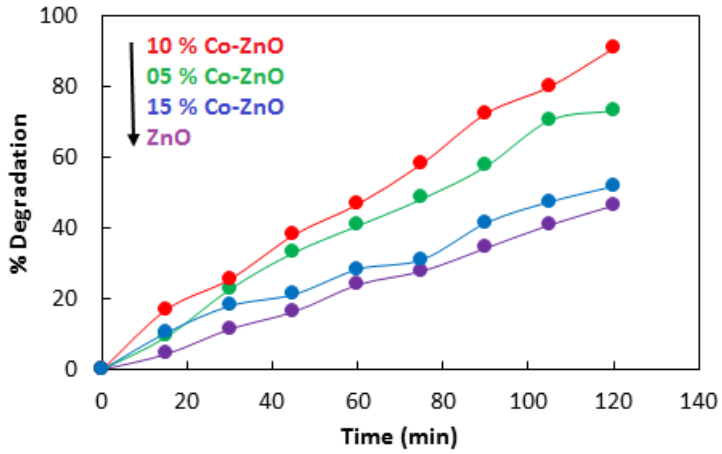

Figure 2. Comparison of catalytic efficiency of different catalysts

Conclusions

The addition of Co in the crystal structure of ZnO caused an improvement in the catalytic efficiency of ZnO by dispersing and suppressing the rate of recombination of photogenerated electron-hole pairs. The degradation data was analyzed according to 1st order and 2nd order kinetics model.

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RECLAMATION OF COOLING TOWER BLOWDOWN WATER USING RECYCLED END OF LIFE RO MEMBRANES

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ABSTRACT

Recycling end-of-Life RO membranes for ultrafiltration applications is an attractive proposition for developing countries where both RO and ultrafiltration membranes are exclusively imported. Even as the membrane recycling process is well covered in literature, a research gap exists in terms of development of pilot data that can be used for performance prediction of the recycled end-of-life RO membranes for commercial applications. In this work, recycled end-of-life RO membranes were used to treat cooling tower blowdown water stream to evaluate membrane performance. The membrane was able to achieve a 95.5% reduction in turbidity while removing all particulates above 0.1 μm in size. Filtrate SDI and MFI values were also consistently reduced to less than 1.0. The results demonstrate that the recycled membranes have good particulate rejection properties, and may be considered for use in ultrafiltration applications.

Key words: Recycling, Cooling Tower Blowdown, Ultrafiltration, End-of-Life RO Membranes

Introduction

Application of desalination has been growing over the years as one of the means of addressing water security the world over, with reverse osmosis (RO) accounting for the major share of the world's total installed capacity. After use in desalination plants, over 840,000 end-of-life RO membranes are discarded each year [1]. It has been proposed to use these end-of-life RO membranes in ultrafiltration (UF) applications after the removal of the polyamide layer and subsequent exposure of the underlying polysulfone layer, which in commercial RO membranes is already in the ultrafiltration range in terms of membrane porosity [2]. This idea is most attractive for developing countries who have to rely on import for both RO and UF membranes.

The process in which the RO membranes are converted into UF membranes has been covered in published literature, and focus of current research is moving into application of these membranes for the prediction of their performance and fouling behavior [3]. In this work, recycled end-of-life RO membranes were used to treat cooling tower blowdown (CTBD) water to gauge the particulate retention behavior, with emphasis on filtrate water treatability for downstream RO membranes.

CTBD feed water is a wastewater stream generated in the industry from open recirculating cooling water that is conventionally discharged to control the water chemistry to prevent scaling and corrosion in the cooling system. Accordingly, the stream has higher salinity than the feed water, residuals of treatment chemicals and suspended solids taken from the atmosphere that need to be addressed for any water reclamation activity [4].

Methodology

A discarded 4"x40" brackish water RO membrane from Lanxess Lewabrane was used in this study. The membrane was subjected to a hypochlorite exposure of 300,000 ppm.h, followed by characterization experiments. The membrane was subsequently used to treat grey water, and results of the conversion, characterization and filtration experiments have previously been reported [5].

In this study, the membrane was subjected to CTBD feed water from an open recirculating cooling water system in Islamabad. Membrane particulate rejection was studied in terms of reduction in turbidity, silt density index (SDI) and particle size, and filtrate modified fouling index (MFI).

Results and Analysis

Feed and filtrate water turbidities are shown in Figure 1. Table 1 summarizes the turbidity reduction across the membrane. The results show a turbidity reduction of over 95%, showing appreciable removal of particulates from the feed stream.

Table 1: Feed and filtrate water turbidity

	Feed (NTU)	Permeate (NTU)
Ave. Turbidity	37.62	1.69
Ave. Removal		95.5%

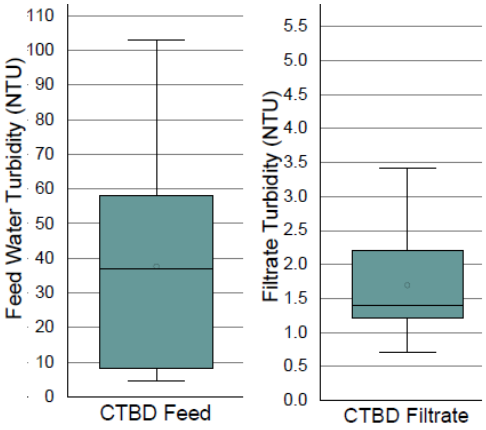

Fig 1. Feed & Filtrate Turbidity

Table 2 further summarizes the particle size distribution for the feed and filtrate. The 100% laser transmittance of the particle size analyzer across the filtrate water shows that no particles above the minimum detection limit of the analyzer (0.1 µm) were present in the filtrate water. The results show membrane absolute porosity to be below 0.1 µm, which confirm its operation as a UF membrane.

A comparison of the SDI filter paper after exposure to feed and filtrate water showed a value of over 5.0 in the feed reduced to that below 1.0 in the filtrate, which compares favorably with a benchmark value of 3.0 below which fouling in downstream RO membranes is appreciably reduced. Figure 2 finally shows a plot of t/V against V for the volume of filtrate water passing through the SDI filter paper, the slope of the resulting straight line showing the value of MFI, which at 0.109, was again, well below the benchmark value of 1.0 below which fouling in downstream RO membranes is appreciably reduced. These results show excellent reduction in feed water particulate and colloidal load for the recycled end-of-life membrane use as a UF membrane upstream of RO.

Table 2: Laser transmittance & particle size

	Feed	Filtrate
Laser Transmittance	95.5%	100.0%
Min. Particle Size (µm)	4.5	N/A
Median Particle Size (µm)	276.5	N/A
Max. Particle Size (µm)	600.0	< 0.1

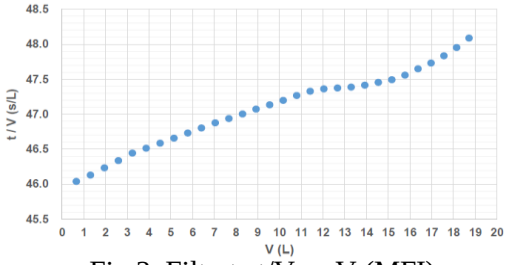

Fig 2. Filtrate t/V vs V (MFI)

Conclusions

After conversion to UF membranes, recycled end-of-life RO membranes have been tested for the first time on CTBD feed water, and have been demonstrated to show good particle rejection characteristics by achieving a > 95% reduction in turbidity to a filtrate turbidity of consistently less than 2.0 NTU. Filtrate SDI and MFI values have also been found to be < 1.0 in both cases, demonstrating positive potential for use in recycling CTBD water through ultrafiltration followed by RO. Long terms testing may further be carried out to substantiate performance in the long run supported by experiments on membrane fouling and mitigation.

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SYNTHESIS AND CHARACTERIZATION OF HIGH SURFACE ALUMINA FOR THE EFFICIENT REMOVAL OF HEAVY METAL IONS

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ABSTRACT

Ammonium Aluminum Carbonate Hydroxide (AACH) whiskers were synthesized via hydrothermal method using aluminum nitrate and urea as raw materials. AACH, the precursor for alumina, was calcined at three different temperatures i.e. 700,900 and 1100℃ to get the desired adsorbent. AACH and alumina powders were characterized by X-ray diffraction(XRD), Density meter, Fourier transform infrared spectrometer(FTIR), Thermogravimetery-differential thermal analysis(TG-DTA) and scanning electron microscopy(SEM) to get the thermal and structural/morphological information. Application of the acquired alumina as an adsorbent for the removal of lead ions was investigated in this work. It was found that removal efficiency (R.E.) was highest i.e. 26.4 % for the alumina calcined at 700℃ and at pH 4. Effect of contact time was also studied and highest R.E. was found for 60 minutes' contact time.

Key words: Ammonium Aluminum Carbonate Hydroxide (AACH), Removal Efficiency (R.E.), adsorbent

Introduction

Amongst the inorganic water pollutants, lead was chosen due to its toxicity. Lead reaches human body mainly through drinking water and causes various diseases [1]. Various ion removal techniques have been reported for the removal of heavy metal ions. The reason for choosing adsorption process over others was the high surface area of nano-adsorbents providing more sites for adsorption. Further the control of surface area through alteration in calcination temperature or surface morphology is also possible [2].

Alumina synthesized through sol gel [3] and combustion method [4] has been used for the adsorption of lead but no study has been reported for adsorption by alumina synthesized through hydrothermal method.

Methodology

An autoclave containing the aqueous solution of aluminum nitrate and urea was kept in an oven at 120℃ for 24 hours. The resulting solution was washed with distilled water followed by filtration and drying. The obtained AACH powder was put into a carbolite furnace for three different temperatures i.e. 700,900 and 1100℃ to get the alumina powder. XRD, Density measurement, FTIR, TGA and SEM were used for the characterization of alumina particles.

Lead ion solution was prepared from lead nitrate in distilled water. Atomic Absorption Spectroscopy (AAS) was used to calculate the lead ion concentration before and after the absorption process. Pseudo-1st order and pseudo-2nd order models were used for the kinetic study of lead adsorption on alumina.

Results and Analysis

XRD confirmed the formation of AACH. The XRD of alumina obtained from lower temperature calcination showed broad peaks as compared to alumina calcined at higher temperature. The denser structure at higher temperature due to crystalline nature was further confirmed by density meter. FTIR of alumina showed the Al-O bond peaks. Thermal behavior for AACH was studied through TGA, mass loss at lower temperature showed the desorption of water and evolution of gases and phase

change at higher temperature. SEM showed the whisker like morphology for both AACH and alumina. Lower temperature calcination favored the high R.E. at an optimum pH of 4. An increase in contact time of adsorbent and adsorbate resulted in higher R.E. The adsorption isotherms were well fitted by Langmuir equation.

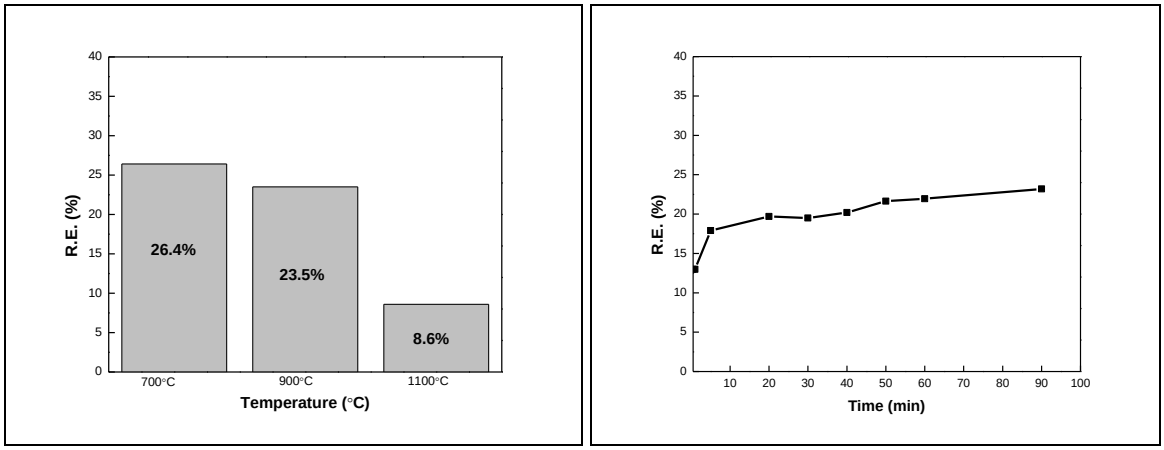

Fig. 1: Effect of temperature and time on removal efficiency

Conclusions

Alumina obtained through hydrothermal process by using low cost precursor and lower calcinations temperature renders it a very promising plat-form for lead removal. The highest removal efficiency was observed at the lowest calcination temperature due to its amorphous nature and higher surface area.

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A POSSIBLE REMEDIAL SOLUTION AGAINST ERYTHROMYCIN-RESISTANT BACTERIA ISOLATED FROM SALT LAKE CITY, UTAH

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ABSTRACT

At present, medications accessible in clinics are not productive in contradiction of the resistance of certain bacterial strains to antibiotics. In both emerging and industrialized countries, demand for plant-based antibiotics is growing; they are ordinary remedies that easily eco-friendly, generate minimal environmental risks, having no side effects, and are relatively reasonable in price. Four erythromycin-resistant bacteria (*E. coli*, *Enterobacter*, *Enterococcus*, and *E. Faecalis*) were isolated. Zone of inhibition of *Coriandrum Sativum L*., (coriander), *Zingiber officinale* (ginger), and *Spinacia oleracea* (spinach) were measured by Disk diffusion method and agar well diffusion method. The bacterial activity was checked by UV- Visible Spectrophotometry at 600nm, PCR and Electrophoresis was used for gene isolation and identification. Among all Coriander showed best remediation against Erythromycin-resistant bacteria. ErmB gene was almost present in all isolates.

Keywords: Coriandrum Sativum L., Zingiber officinale, Spinacia oleracea, Remedy, and Erythromycin

Introduction

Environmental contamination with antibiotics and resistance genes has now become a growing challenge to human health. Antibiotics and antimicrobial agents against superbugs cannot work effectively, bypass and return to the water treatment facilities. They then return to the ecosystem and our bodies. Antibiotic consumption was assessed, based on sales, in 76 countries, between 2000 and 2015 [1]. Antibiotic consumption data is scarce and often not available [2]. Natural products have mind-blowing achievement following guidelines for new antibacterial drug disclosure. Also, antibiotics got according to the guidelines are natural. As it is noticeable that the bioactive plant extracts are promising sources of the main part of medications [3]. This study was aimed to evaluate some plants source having antibacterial properties that could be used in drugs against Erythromycin-resistant bacteria (ERB).

Methodology

This study was carried out in the Department of Civil and Environmental Engineering Laboratory, University of Utah, Salt Lake City (SLC), Utah. Erythromycin-resistant bacteria (*E. coli*, *Enterobacter*, and *Enterococcus*) were isolated from returned activated sludge of SLC. Resistant colonies were isolated by using Mueller Hinton (MH) Agar. Crude aqueous extracts of coriander, ginger, and spinach were prepared in miliQ water. The crude extracts were loaded on 6 mm filter paper discs. Minimum inhibitory concentration (MIC) was observed using UV-spectrophotometer at optical density of 600nm. DNA extraction and quantification were proceeded by a polymerase chain (PCR) and gel electrophoresis to identify the genes present in ERB.

Results and Analysis

The two-fold serial dilution of ERB were subjected to observe growth pattern and to evaluate the MIC and they were cultured on MH agar. A maximum number of colonies were obtained at 64 mg/L of concentration. All plant activities were checked by following disk diffusion method, ginger showed

the best activity against *E. coli* (11±0.6 mm), and lowest against *Enterobacter* (7.6±0.8 mm) in terms of zone of inhibitions. While, coriander and spinach showed excellent activity against *Enterococcus* showing zone of inhibition 12.6±0.6 and 11±0.6 mm, respectively. Intermediate activity of coriander and spinach was found against *Enterobacter* 8±0.6 and 7±0.6 mm, respectively.

Following Agar well diffusion method, ginger showed the best activity against *Enterococcus* (10±1.2 mm), and no activity was observed against *Enterobacter.* Coriander showed excellent activity against *E. coli* (13.3±0.3) and lowest for *Enterococcus* (8±1.2), spinach showed good activity against *E. Faecalis* (10.3±0.8) while moderate for *E. coli* (9.3±0.6). The plant suppressed the bacterial growth after time interval. The DNA was quantified having *E. Faecalis* (0.230g), *Enterococcus* (0.314g), *Enterobacter* (0.071g) and *E. coli* (0.04g). ErmB gene was identified by using the PCR and electrophoresis. The band of ErmB gene was most prominent in *E. Faecalis* Strains as compared to *E. coli. Enterococcus, Enterobacter*.

Conclusion

The suppressing activities of natural products over the ERB were observed. The potential suppressing bacterial activity was shown by coriander while intermediate activity was observed for spinach than ginger. All selected bacterial cells were possessing ErmB gene. Though, additional investigation on the role of bacteria in antibiotic resistance progression is obligatory to attain occupied applications of such plant based remedies.

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SYNERGISTIC EFFECT OF *EPIPREMNUM AUREUM* AS A DISINFECTANT AGAINST SURFACE MICROBES

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ABSTRACT

This study was carried out to investigate the disinfectant properties of *Epipremnum Aureum* (Money plant) leaves aqueous extract mixed with tannic acid against *E. coli* and *S. aureus*. The analysis was done using disk diffusion method. Minimum inhibitory concentration (MIC) was done to observe the bacterial strain by measuring the optical density at 600 nm through spectrophotometer. Time kill analysis was done to check the growth of microbes with time duration. The results revealed that aqueous extract of money plant leaves with TA shows promising activity with different concentration having zone of (15.33±0.66) for E. coli and for S. aureus with a zone of 17.33±0.66.

Key words: Concentration, Aqueous, Disinfectant

Introduction

Microbes thriving on surface such as floor and bench tops are one of the main sources of contamination, which is a serious health and sanitation issues. The natural disinfectant obtained from natural plants would not only be effective in preventing microbial growth, it would also be environmentally friendly. Several plants have been focused to use against microbes but not studied yet to clean surface. In this study, we focused on disinfectant property of plant and its synergistic effect mixed with tannic acid.

Epipremnum Aureum is a member of the *Araceae* family and is commonly referred to as the money plant. *Araceae* is a wide family that includes several medicinal plants that are therapeutically active [1,2]. Tannic acid is the biomaterial which contain wide range of biological and chemical properties [3]. The present study was attempted to evaluate aqueous extracts of the leaves of *E. aureum* suspended with tannic against the selected gram +ve and gram –ve bacteria. Further, evaluation of minimum inhibitory concentration (MIC) and Time kill analysis was carried out for target microorganisms to evaluate the disinfectant effect.

Methodology

The study was conducted at MUET Jamshoro. The fresh leaves of money plant were collected from the garden area of USPCASW. The bacterial samples were isolated from kitchen via cotton swab, and put in broth, and kept in incubator for 24 hours. After incubation, presence of growth was observed in the form of turbidity. *S. aureus* and *E. coli* were selected for further study. The method of disk diffusion had been used to determine antimicrobial activity. The sterile filter paper disks (6 mm) were filled with various concentrations of plant extracts. Disks were mounted on MH agar in the petri dishes and inoculated with screened microbes. The plates were incubated for 24 h at 37 °C. The results were measured and reported in terms of the diameter of the inhibition zone around the individual disks.

MIC was also determined using serial dilution technique of broth. MIC was evaluated with plant extract by optical density measurement with a UV-vis spectrophotometer at 600 nm. Time-killing analysis was performed in the culture medium of broth with different tubes containing 1 ml of the bacterial strain with 8 ml of Muller-Hinton broth and 1 ml of plant filtrate with tannic acid. The optical density was recorded at different time intervals of 0, 15, 30, 45, 60, 75 and 90 min. A growth inhibition curve was plotted between optical density and time. Data was analyzed using Microsoft Excel.

Results and Analysis
The results revealed that the disinfectant screened for antimicrobial activity had considerable antibacterial effects on microbes. Maximum effect was achieved when 2000 mg/ml of leaves extract were used against *E. coli* with a zone of (15.33±0.66 mm) and for *S. aureus* with a zone of 17.33±0.66 mm. For MIC at 800 mg/ml concentration was showing an increase and a decrease in growth for *E. coli* and *S. aureus*. In time kill analysis, the growth rate was decrease at 0 minute then after 15 minute the growth rate was in static condition. Hence, as the time increased the growth rate decreased.

Conclusions
It has been concluded that *Epipremnum Aureum* has different effect on different concentration of microbes. Synergistic effect of *Epipremnum Aureum* were also observed. The potency of disinfectant was observed to enhance the antimicrobial activity towards inhibition of microbial growth. Synergistic effect between plant and TA showed promising effect against microbes.

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EFFECT OF MAGNESIUM SOURCES ON THE RECOVERY OF STRUVITE FROM SYNTHETIC URINE

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ABSTRACT

Phosphorus is a vital element of life and one of the main nutrients for agriculture and a limiting resource. Urine is rich in phosphorus and ammonia content, so it could be a sustainable source for nutrients recovery. One of the sustainable methods to recover both nutrients is by struvite precipitation. Struvite ($MgNH_4PO_4.6H_2O$) is a slow-releasing fertilizer, which precipitates only when $Mg:NH_4:PO_4$ reaches the molar ratio 1:1:1, so for the struvite precipitation magnesium needs to be added to the urine. In the present study, four magnesium sources $MgSO_4$, $MgCl_2$, $Mg(OH)_2$, MgO, were compared for struvite precipitation using four Mg:P ratios i.e., 1:1, 1.2:1, 1.5:1, 2:1 with each magnesium source. For the struvite recovery, the optimum Mg:P ratio is 1.2:1, at which ammonium-nitrogen recovery was (49.8-69.2)% and phosphate-phosphorus recovery (92.3-98.9)% for $MgCl_2$, $MgSO_4$, MgO respectively. Whereas, $Mg(OH)_2$ has shown approximately half of ammonia and phosphorus recovery as compared to other magnesium sources.

Keywords: Struvite, Magnesium sources, Synthetic urine

Introduction

Urine contributes a total of 1% of raw domestic wastewater, which contains nitrogen and phosphorus total of 85% and 50% respectively [1]. Urine separation not only reduces a load of nutrients in the municipal wastewater but also facilitates nutrient recovery. There are many technologies like precipitation, volume reduction, adsorption, and stripping developed to recover nutrients from urine [2], but struvite precipitation is one of the simplest, easily implemented, and operated technology [3]. Struvite due to its low solubility decreases the leaching of nutrients in runoff, which contains $Mg:NH_4:PO_4$ with a molar ratio of 1:1:1. However, there are many limitations by which struvite precipitation can be affected, that are pH, concentrations of ions like Mg^{2+}, NH_4^+, PO_4^{3-}, Ca^{2+}, Cu^{2+}, Zn^{2+}, and Al^{3+} can also affect the precipitation of struvite [4]. In this study, Mg:P ratios were studied using different magnesium sources ($Mg(OH)_2$, MgO, $MgSO_4$, $MgCl_2$).

Methodology

The synthetic urine composition was prepared according to Harada [5], which contained Na^+ (1600.8 mg/L), NH_4-N (282.52 mg/L), PO_4-P (416.52 mg/L), Mg^{2+} (44.4 mg/L), K^+ (832.83 mg/L), Ca^{2+} (48.49 mg/L), and Cl^- (3201.4 mg/L). The composition was achieved using KCl, $CaCl_2.2H_2O$, $MgCl_2.6H_2O$, NH_4Cl, NaCl, $Na_2HPO_4.12H_2O$. In the synthetic urine the Mg:P ratio was 0.14:1. The concentration of magnesium in the synthetic urine is lower than the required concentration ($Mg:NH_4:PO_4$ 1:1:1). The required concentration was achieved using four different magnesium sources (MgO, $MgCl_2$, $Mg(OH)_2$, $MgSO_4$). For the precipitation of struvite, stoichiometric calculations were based on the Mg:P ratios (1:1, 1.2:1, 1.5:1, 2:1). According to those calculations, magnesium sources were used. The magnesium sources $Mg(OH)_2$ and MgO are insoluble in water, so they were used in suspension form. The pH was adjusted using 1N NaOH, and 1N HCl solution for $MgCl_2$ and $MgSO_4$ which was kept in the range 9.5-9.7. The pH for the remaining two sources had no use of the alkali solution because these compounds are alkali themselves. After 20 mins of mixing the struvite crystals were separated by centrifugation, and final ammonium-nitrogen and phosphate-phosphorus concentrations were determined to calculate the percent removal of these compounds. The crystals then were dried at 105 ºC for 24-hour.

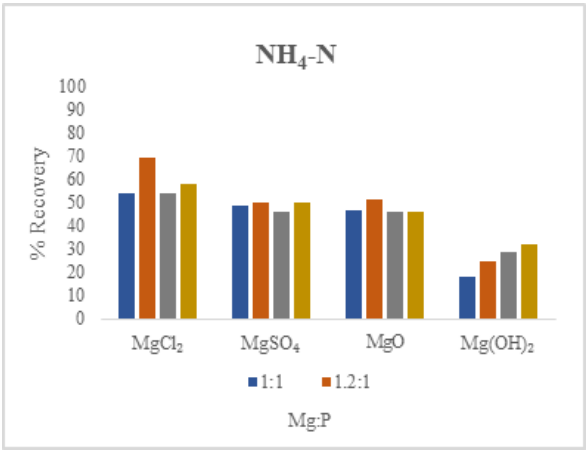

Figure 21. Ammonium-nitrogen recovery at different Mg:P ratios using different Magnesium sources

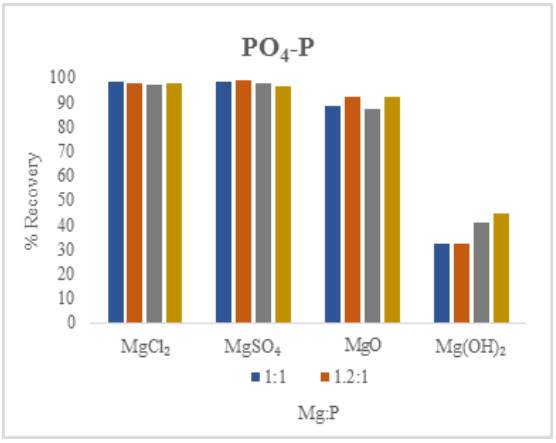

Figure 22. Phosphate-phosphorus recovery at different Mg:P ratios using different Magnesium sources

Results and Discussion

Magnesium sources were compared for ammonium-nitrogen and phosphate-phosphorus recovery. The maximum ammonium-nitrogen recovery as shown in figure 1, was achieved by using $MgCl_2$ which was 69.2% at a 1.2:1 Mg:P ratio. The ammonium-nitrogen recovery using $MgSO_4$ in comparison with $MgCl_2$ was less i.e., 49.8% same at two Mg:P ratios 1.2:1 and 2:1. As in the case of MgO, which was used in suspension form, has the maximum ammonium-nitrogen recovery approximately equal to $MgSO_4$ which was 51.1% at an Mg:P ratio of 1.2:1. The optimum Mg:P ratio for the ammonium-nitrogen recovery was 1.2:1 for $MgCl_2$, $MgSO_4$, and MgO. In comparison with these three magnesium sources, $Mg(OH)_2$ suspension had the minimum ammonium-nitrogen recovery which was 32.1% at 2:1. The phosphate-phosphorus recovery from synthetic urine was 98.1% and 98.9% for $MgCl_2$ and $MgSO_4$ respectively at Mg:P ratio 1.2:1 as shown in figure 2 which is considered as optimum Mg:P ratio. While observing MgO, the maximum phosphate-phosphorus recovery was 92.3% at 1.2:1, which was an optimum Mg:P ratio. However, the $Mg(OH)_2$ had the least recovery as compared to other magnesium sources which was 44.6% maximum

Conclusion

In the present work, struvite was recovered from synthetic urine using different magnesium sources with four Mg:P ratios. It was observed that MgO suspension can be used for struvite recovery from urine, but $Mg(OH)_2$ suspension did not show good results, which had a maximum recovery of only 32.1% for ammonium-nitrogen and 44.6% for phosphate-phosphorus. The best magnesium source for the recovery of ammonium-nitrogen and phosphate-phosphorus was $MgCl_2$, which has the ammonium-nitrogen recovery highest of all other magnesium sources 69.2%, and phosphate-phosphorus recovery was 98.8%.

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BISMUTH OXIDE THIN FILM COATED ON INDIGENOUSLY MADE CLAY FILTER AND ITS PHOTOCATALYTIC PROPERTIES IN VISIBLE LIGHT

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ABSTRACT

Advanced oxidation process needs further to be explored in treating organic pollutants present in wastewater. Therefore, the surface of indigenously made clay filter was coated with bismuth oxide (BO) thin film by dip-coating. BO sol gel is used in the dip-coating method. The photocatalytic properties of the BO film coated on the clay filter were investigated under visible light. Resultantly, the BO film absorbed UV and visible spectrum of up to 610nm. The bandgap of bismuth oxide was estimated about 2.33 eV. Furthermore, Indigo carmine (IC) was decolorized by photocatalysis under visible LED light on the BO coated clay filter. Overall, the obtained results suggested the efficacy of BO thin film, coated on filter made of indigenous clay, towards visible light decolorization of IC. This highlights the great potential of the advanced photocatalytic process for the treatment of organic pollutants.

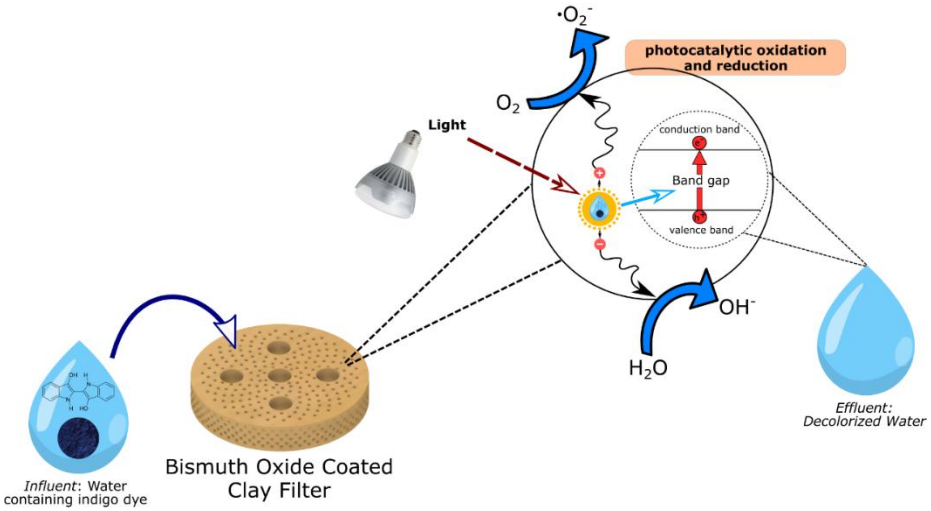


Figure 23 Photocatalytic activity of bismuth oxide thin film coated on clay filter in visible light.

Key words: clay filter, bismuth oxide, photocatalyst, visible light, sol gel

Introduction

The scientific community has produced the research on various semiconductor photocatalysts since titanium dioxide (TiO_2) was found photoelectrochemical reactive in decomposing water (H_2O) into hydrogen and oxygen [1]. Among numerous semiconductor photocatalysts, titanium dioxide is chemically stable and found harmless to human body, therefore it is being commonly used in several photocatalytic reactions. However, due to large band gap (3.22 eV) of TiO_2, it is restrictive to the application under visible light, therefore the need arose to develop a visible light active photocatalyst. In order to use sunlight in photocatalytic reactions, it is essential to develop a photocatalyst that is sensitive to visible light [2, 3]. Bismuth oxide (BO) is found to have band gap much lesser than TiO_2 which make it promising to be used under visible light in hydrogen producing and environmental purification technologies.

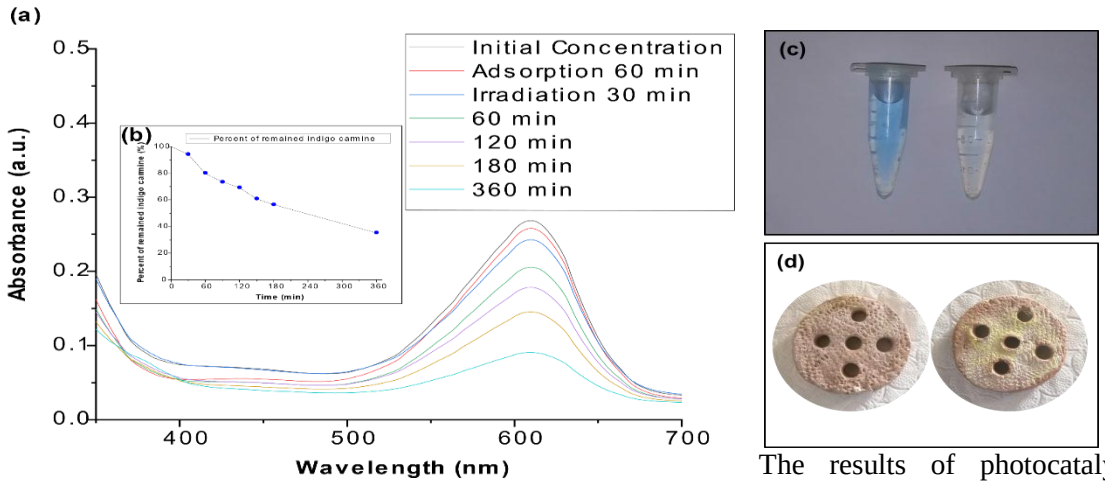
In this study, a clay filter is coated with a thin film of bismuth oxide (BO). The photocatalytic properties of BO coated on clay filter were analyzed. Subsequently, the decomposition properties of

indigo carmine (IC) were also evaluated under visible light using the clay filter coated with BO thin film.

Methodology

Bismuth oxide was synthesized through sol-gel reaction. Where Bi(NO3)3 ·5H2O (Sigma-Aldrich, 98%) 0.5 M was introduced in 100mL of HNO_3 (RCI Labscan Limited, 70%) 1.0 M. The mixture was stirred and homogenized for 2h to obtain BO sol-gel. The layer of BO photocatalyst was coated by dip-coating method in which a clay filter (10mm thick and 60mm in dia.) was soaked in a BO sol-gel. The filter was dried and calcinated in muffle furnace at 150℃ for 45 min, 300℃ for 30 min and then 500℃ for 90 min. The photocatalytic decomposition of 5ppm indigo carmine (Acros Organics, 100%) was performed using BO thin film as photocatalyst coated on the clay filter under visible light. Power output of the LED lamp used in this study is 36 W.

Results and Analysis



The results of photocatalytic degradation of Indigo carmine (IC) on BO film under visible light are shown in Fig 2. Fig. 2(a) shows an absorbance spectrum of IC under visible light in presence of BO thin film. The concentration of IC decreased as the reaction time passed, as shown in Fig. 2(b). IC was removed by about 65% after 360 minutes. According to the spectrum, it was found that BO absorbs UV and visible light up to 610nm. Using Kübelka-Münk theory, the bandgap of the BO was estimated as 2.33eV. The small bandgap of BO indicates that it can exhibit photocatalytic activity in the visible region.

Figure 24 (a) UV-Vis spectra of IC Photodegradation under visible light on BO thin film (b) Percentage of IC degradation on BO film (c) Initial and final concentration of IC (d) Bare and BO coated clay filter

Conclusion

Dip-coating method was used in coating BO thin film on the clay filter surface using BO sol-gel. The clay filter coated with BO thin film was able to absorb the UV and visible light up to 610nm. The bandgap of coated BO thin film was measured to be 2.33eV. The small bandgap of BO makes photocatalytic activity possible under the visible light. This results into the successful photodegradation of indigo carmine on the clay filter coated with BO thin film under LED visible light.

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REDUCTION OF NITRATE THROUGH PHOTOCATALYSIS USING IRON-DOPED TITANIUM DIOXIDE COATED CERAMIC FILTER

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ABSTRACT

Fe-TiO_2 particles were synthesized and immobilized on surface of selected ceramic filter. Synthetic wastewater of 25, 30, 40 and 50 nitrate concentrations were produced, and its reduction was analyzed under visible light of 12W, at 30, 60, 90 and 120 intervals of time in minutes. Maximum reduction was achieved 50mg/l to 4.35mg/l in 120 minutes.

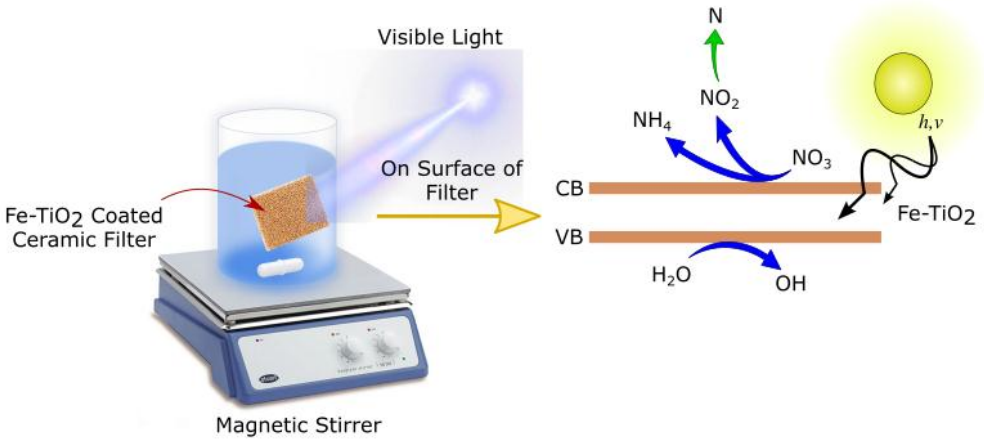

Figure 25 Photocatalytic reduction of nitrate by using coated filter

Key words: Reduction of nitrate, Iron-dopped titanium, coating, ceramic filter, photocatalytic

Introduction

Water quality deterioration is a serious threat to environment. Wastewater is particular concern which contains nitrogen components such as nitrate, nitrite, ammonium, etc. There are various methods used to remove and reduce such compounds, among them photocatalysis is one of the effective techniques. Nitrate is oxidized form of nitrogen and its sources are accumulation of waste, over use of animal and chemical fertilizers, agricultural and foodstuff processing, and industrial effluents [1]. The reduction of nitrate is of special interest because nitrogen plays big role in eutrophication of receiving waters, this has harmful impacts on aquatic species, and human health problems when exceed limit of nitrate in water [2]. For reduction of NO^-_3 various methods are being used such as physicochemical, biological nitrification and denitrification process, and photocatalytic reduction [3]. Objective of study is to reduce the nitrate concentration of synthetic wastewaters by using Iron-dopped Titanium dioxide (Fe-TiO_2) coated on surface of ceramic filter.

Methodology

According to [4], sol-gel technique was applied to synthesize the Iron-dopped Titanium Dioxide (Fe-TiO_2 1:10) particles. Stoichiometric amount of Titanium Trichloride ($TiCl_3$) was dissolved in 0.5M of HCl named sol (A) and Iron nitrate nonahydrate (Fe-$NO_3.9H_2O$) was dissolved in 0.1M of HNO_3 named sol (B). Both solutions were dissolved homogeneously and added drop by drop, and formed gel solution named sol C. Ceramic filter of 40x40x11 size and 80-90% porosity was washed with DI and ethanol, and was dried at 105C for 15mints. Filter was soaked in gel solution properly and was heated at 125℃, 260℃ and 475℃ for 45, 30 and 60 minutes, respectively. Uniform growth of particles was achieved on surface of filter. Synthetic wastewater of different nitrate concentration was

produced, and its reduction rate was analyzed using coated and uncoated filters under visible light. UV-Vis-Spectrophotometer technique was used to analyze nitrate reduction, and nitrite and ammonia formation. All the experiments were performed at normal atmospheric 28-31C. Filters were further characterized to analyze its morphology and optical properties.

Results

Fig 2(a) shows the standardized preparation of Fe-TiO_2 particles. While the fig 2(b) indicates the coating steps of produced solgel solution on filter. Uniform thin layer of catalyst on surface of filter was achieved at 475℃ final calcination. The results of nitrate reduction obtained by using Iron-dopped Titanium Dioxide (Fe-TiO_2) coated on ceramic filter are shown in fig 2(c). while the results of uncoated filter are shown in fig 2(d). the nitrate was reducing into nitrite (NO_2) and ammonium (NH_4). The coated and uncoated filters were analyzed simultaneously. Maximum nitrate reduction was obtained at 50 mg/L using coated filter.

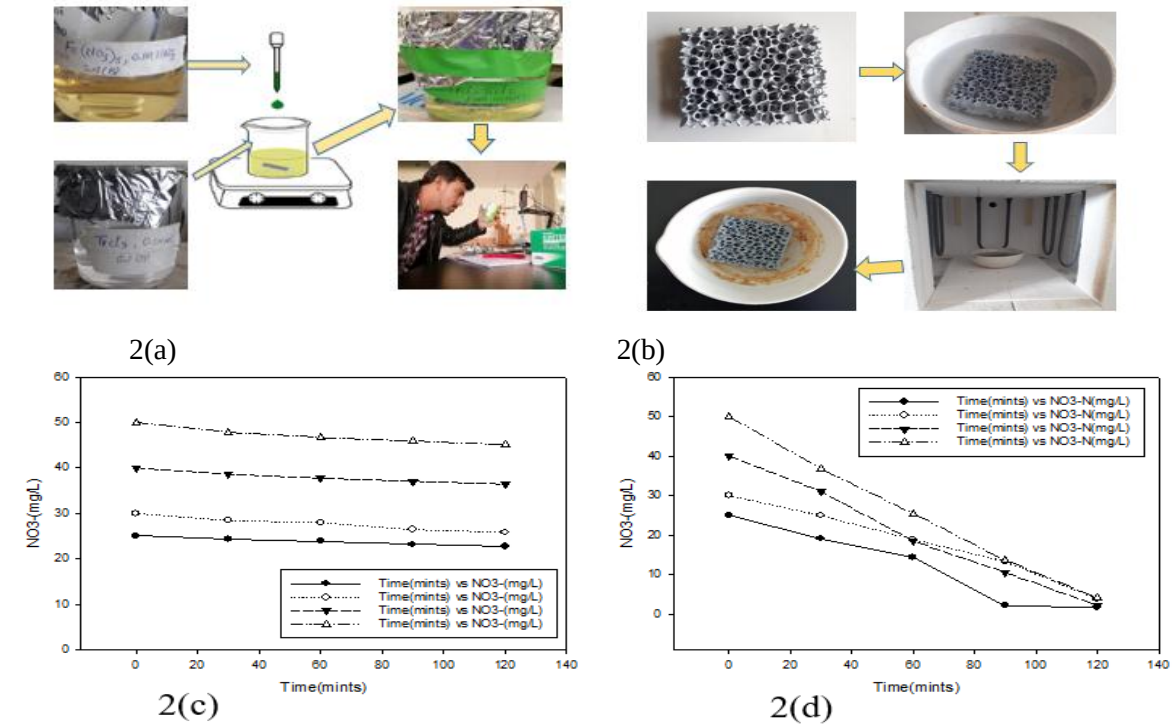

Figure 26 (a) Solgel preparation (b) coating of produced solgel solution on ceramic filter (c) Nitrate reduction using uncoated filter (d) Nitrate reduction using coated filter

Conclusion

Iron-dopped titanium dioxide (Fe-TiO_2) coated ceramic filter was able to reduce the nitrate under visible light. Obtained results using coated filter were Efficient as compared to bare (uncoated) filter.

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WASTEWATER TREATMENT THROUGH CFA BASED HETEROGENEOUS FENTON LIKE OXIDATION PROCESS: MATERIAL CHARACTERIZATION AND PARAMETRIC ANALYSIS OF POLLUTANT REMOVAL

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ABSTRACT

The rapid surge in ongoing industrialization have raised many concerns over various organic contaminants that is a great challenge for environmental remediation. In this work, Copper (CuSO4) catalyst was developed on acid wash coal fly ash via impregnation method and its degradation performance was studied on removal of P-Nitrophenol which was selected as model organic pollutant. The physio-chemical properties of CFA/Cu were characterized using XRD, FTIR, SEM with EDX analysis. Various parameters involving initial pH of the solution, Catalyst dosage, amount of H_2O_2, initial PNP concentration, reaction time and temperature were investigated along with the reusability of as prepared Cu/CFA catalyst. It is observed that up to 90.5% of p-Nitrophenol was reduced under optimum values of pH 6.0, 4 ml of H_2O_2, 5 mg Catalyst at 50 ppm p- Nitrophenol concentration and 60°C in 20 mins reaction time. To understand the degradation mechanism, adsorption isotherm and Kinetic Study were also performed where Langmuir model fits the reaction more efficiently than other applied isothermal models. Kinetic analysis showed that pseudo 2nd order model exhibited good fit with experimental data. The reusability of Cu/CFA catalyst was also examined at optimum values of parameters and it has been confirmed that Fenton like catalyst was stable for up to 3 cycles and showed significant decrease afterwards.

Key words: Fenton Like Processes, Isothermal analysis, Kinetic models, p-Nitrophenol

Introduction

Advanced oxidation processes (AOP) are unique and best inspiring technologies that has been verified to be effective and robust in the degradation of complex and noxious pollutants that have carcinogenic effects in human and aquatic lives. Among the different AOP techniques, Fenton and Fenton Like process has gained much recent attention [1]. Fenton Like Oxidation is an efficient advanced oxidation process, also recognized as a green technology (i.e., this process uses environment friendly reagents), use low capital cost with various advantages. The process has high performance and simplicity for the oxidation of organics and its non-toxicity (H_2O_2 can break down into safe species like H_2O & O_2). Based on these advantages, the Fenton process has been applied to treat many kinds of wastewater such as olive oil wastewater, textile wastewater, pesticide wastewater, pulp mill effluent. However, Copper based Fenton like heterogeneous catalyst with Coal Fly Ash has not been developed to the best of our knowledge. Therefore, this study is aimed at development of CFA based Fenton like catalyst and its degradation performance on p-Nitrophenol whereas, its reusability and stability was also scrutinized along with parametric analysis.

Methodology

The chemicals used in this study were Hydrochloric acid (37% w/w), Acid treated Carbon fly Ash (CFA), Ferrous sulfate ($FeSO_4 \cdot 7H_2O$), Copper Sulfate ($CuSO_4$) anhydrous, Ethanol 98%, Sodium hydroxide (NaOH), Sulfuric acid (96% w/w), p-nitrophenol 99% and Hydrogen peroxide 35%. All chemicals were of analytical grade and were used as received.

At first the catalyst was prepared through wet impregnation method. Coal fly ash (CFA) is dried, calcined, and then chemically treated with acid. Acid treated CFA is doped with different composition of $CuSO_4$ & $FeSO_4.7H_2O$ & sonicated for a while to get optimum dopant composition for Fenton-Like process. The metal doped CFA is then calcined & later utilized it in experiment. The physio-chemical analysis and elemental analysis was performed through XRD, EDX, FTIR and SEM analysis.

Stock solution of p-nitrophenol (PNP) diluted to 50 ppm (50 mg/L) solution by adding distilled water. The as prepared catalyst (CFA + Cu-Fe) with variable composition is added to solution and placed for

ultrasonication in sonicator across each experimental run. Once the reaction time is being achieved, amount of H_2O_2 & 1 ml NaOH was added into treated solution to cease the reaction. Then, solution was filtered and subsequently analyzed to observe the degradation of PNP. Effect of key parameters i.e., catalyst dosage, concentration of H_2O_2, pollutant concentration, time, pH range is investigated by varying the key parameters to find the optimum results.

Results and Analysis

SEM images shows that raw CFA surface contain spherical ball like particles structure of different sizes which is due to the presence of aluminosilicates. After modification, CFA surface has become smooth and there is no significant difference can be observed in shape and size of the coal fly ash particles. Later behavior may attribute to high thermal stability of CFA [2].

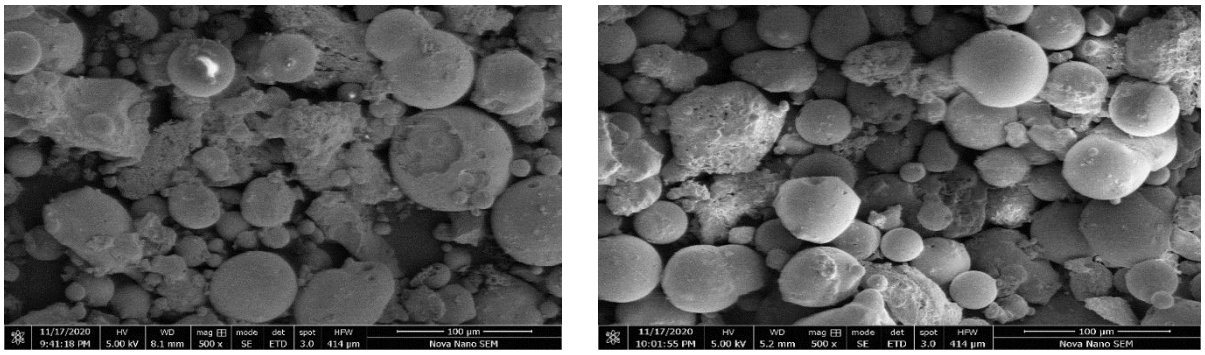

Fig. 1 SEM images of (a) Raw CFA (b) Cu-CFA

The performance of catalyst with different concentration of dopant was evaluated. For this purpose, the concentration of dopant between Fe and Cu on CFA was varied between 0-10 percent. Results shows that CFA with 10% Cu stacking gives higher degradation efficiency. The impact of the initial pH on PNP evacuation was examined by changing the pH in the scope of 3.0–7.0 and optimal pH of solution is found to be 6.0. The influence of H_2O_2 concentration on PNP removal is investigated by differing the dosage from 2 ml to 10 ml per each batch process. The mechanism of adsorption process is investigated through the fit of experimental data to different adsorption isotherm, based on Langmuir, Freundlich and Temkin isothermal models. Isotherm analysis shows that Langmuir isotherm gives better fitting than the Freundlich and Temkin isotherm model. The kinetic analysis was performed using pseudo 1st order model and pseudo 2nd order model. Results suggest that pseudo 2nd order model fits the experimental data more efficiently than pseudo 1st order. Reusability of CFA-Cu is evaluated through three consecutive cycles under optimized condition. After three cycle, the reusability of catalyst in 4th & 5th cycle shows decrease in degradation [3].

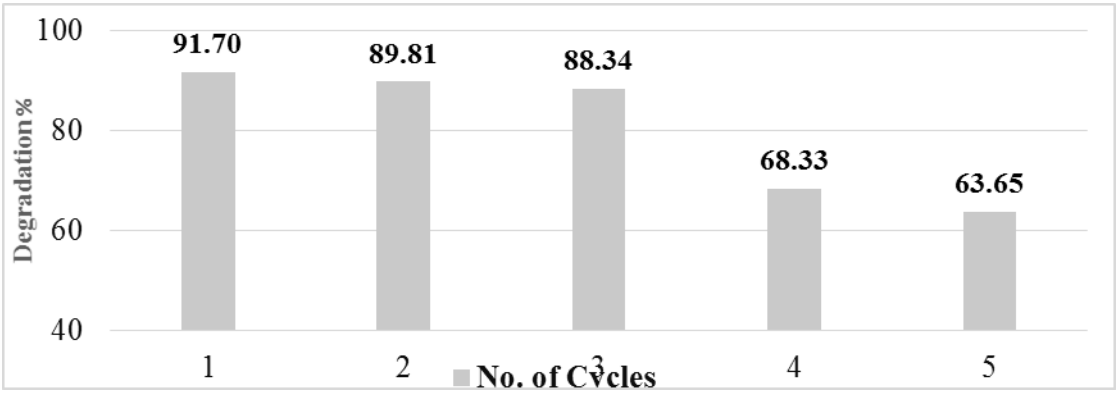

Fig.2 Reusability of Cu-CFA catalyst for p-Nitrophenol degradation

Conclusion

Synthesis of Fenton like catalyst was performed by taking different composition of Copper and Iron on CFA. Results showed that Copper metal showed favorable results out of all combinations 90.5% of PNP reduction was achieved at optimum values of pH, H_2O_2 concentration, [PNP], time and temperature. Various qualitative and quantitative techniques was performed on as prepared catalyst. Langmuir model showed optimum fitting whereas pseudo-2nd order model was selected as efficient kinetic model.

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PERFORMANCE AND ECONOMIC EVALUATION OF SOLAR BASED HYBRID CV-CC CAPACITIVE DEIONIZATION DESALINATION SYSTEM: A CASE STUDY

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ABSTRACT

CDI (Capacitive deionization) is a recently developed electrochemical technique used for the desalination of saline-water in which porous carbon is applied as an electrode substance for the ion adsorption process. In this work, a comparison is presented for operating system of CDI (constant voltage (CV), constant current (CC), and hybrid CV-CC) in terms of effluent concentration, water quality, water recovery and energy consumption. A mathematical model of hybrid CV-CC was derived to desalinate the ground water for selected cities of Pakistan like Lahore, Sheikhupura, and Faisalabad. The selected sample of water was tested for TDS values from Pakistan Council of Scientific and Industrial research, Lahore. The design frame work for this mathematical mode was to produce pure water with high water recovery, low energy consumption, and renewable power generation using the PV modules selected as power source. The selected samples of Lahore, Sheikhupura, and Faisalabad were desalinated through CDI system from 745 ppm to 158 ppm, 622 ppm to 126 ppm, and 3120 ppm to 367 ppm according to WHO standard. Furthermore, the power calculations for PV system were designed as 176, 135 and 1125 watts for Lahore, Sheikhupura, and Faisalabad, respectively. The power and effluent concentration has been calculated through Mathcad software by using operational parameters like flow rate, capacitance, dead volume, spacer volume, series resistance, applied voltage, and cell voltage. The PV modules designed on PVsyst software on the basis of input power required and provided a brief description about performance ratio, orientation optimization, loss factors, normalized production, monthly analysis report, PV module, and battery specifications. The results of PVsyst showed that the PV panels will provide sufficient energy in all seasons for 8 hours working with batteries, but in summer season the panels will provide more energy than the load. This PV integrated CDI system optimized energy consumption as well as reduce environmental impact.

Introduction

The world population is increasing day by day and about 7 billion of people living on earth [1]. By the report of United Nations 2004, the world population is believed to be going to 10 billion [2]. The necessary factor of human life is pure water and it is utilizing in every aspects of human needs like 10% for industrial utilization, 20% for domestic use and 30% for environment [3]. The water consumption and increase in population has direct relationship; as the increase in the population at a tremendous rate also increases the pure water demand and availability. According to World Health Organization, the value to be accepted for the total dissolved solids (TDS) in pure water for human utilization is less than 500 ppm [4]. Therefore, the new methods for obtaining the pure water from different sources (i.e., groundwater, brackish water, and sea water) is very necessary. There are various systems like membrane distillation, thermal distillation and electrical desalination that are utilizing frequently depends on its applications and energy utilization. The electro dialysis (ED) and capacitive deionization (CDI) are used as an alternative for the low salinity water distillation. Both of these systems uses the direct current (DC) to remove ions from the feed solution but the principle of operation is different. ED removes ions through ion-exchange membranes from one solution to another but CDI uses one solution to remove ions. The energy consumption of ED is more than CDI for the given amount of feed water [5]. So, the main concern is capacitive ionization.

Methodology

The substantial steps that need to be followed starts with the location selection and input parameters, design, simulation, analysis, power calculations, design of PV panels and cost analysis.

The quality of water is different for different location. Three location of Punjab cities (Faisalabad, Sheikhupura, Lahore) of Pakistan were selected for determination of the total dissolved salts in the ground water. The water sample from the selected locations are collected and tested to determine the salts and impurities in it. The CDI system design was performed in the MATHCAD software. On the basis of the input parameters, the results of simulation were analyzed and the permeate TDS was compared with the WHO standards. The PV system is designed for power purpose. The PV system has been designed in PVsyst software. After designing and analyzing PV CDI system, the cost analysis has been performed.

Conclusions

The results obtained after desalination process by using CDI system has excellent efficiency and capacity for the purification of ground water samples of selected cities of Pakistan. The selected samples of Lahore, Sheikhupura and Faisalabad were desalinated through CDI system from 745 ppm to 158 ppm, 622 ppm to 126 ppm and 3120 ppm to 367 ppm according to WHO standard. Furthermore, the power calculations for PV system were designed as 176, 135 and 1125 watts for Lahore, Sheikhupura, and Faisalabad, respectively. The results of PVsyst showed that the PV panels will provide sufficient energy in all seasons for the working for 8 hours with batteries, but in summer season the panels will provide more energy than the load. This PV integrated CDI system optimized energy consumption as well as reduce environmental impact.

Future Work

The water quality data of most of cities of Pakistan are not available in the literature. The different cities can be selected for study of PV CDI feasibility. Experimental analysis of the system's performance and water productivity may be considered. The long-term analysis may be done to collect the system performance data. The feasibility report can be presented for same geographical regions. The study of sea water CDI desalination may be considered for the different cities of Pakistan.

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OPTIMIZATION, KINETIC AND THERMODYNAMIC STUDIES FOR REMOVAL OF BISPHENOL A USING PEANUT HUSK AND ITS COMPOSITES

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ABSTRACT

The recent work is about the use of Peanut husk (PH) and its different polymeric composites as an adsorbent for the removal of Bisphenol A (BPA) from wastewater in batch mode. Effect of different parameters like pH, temperature, contact time and adsorbent dose, initial concentration of BPA has been studied. The results showed that the maximum adsorption capacity of peanut husk and its composites were at pH 6 and pH 7, respectively. At 75 mg L−1 initial concentration of BPA, peanut husk exhibited the maximum adsorption capacity of 14.148 mg g−1 at 30°C and pH 6.0. At 100 mg L−1 initial concentration of BPA, peanut husks polymeric composites (PAN/PH, PPY/PH) exhibited the maximum adsorption capacity 19.428 and 17.104 mg/g at 30°C and pH 7.0. Different equilibrium models like Temkin, Freundlich, Langmuir, Harkins Jura, and Dubinin-Radushkevich were applied to experimental equilibrium data of BPA. It was observed that Freundlich and Temkin's models were best fitted for the equilibrium data. While in the case of dynamic models pseudo-second-order was best fitted to experimental data. The thermodynamic study was also carried out to find (ΔS, ΔH, ΔG) which proved that adsorption is exothermic and spontaneous.

Keywords: Bisphenol A; Peanut husk; Thermodynamics; Kinetics;

Introduction

Bisphenol A (BPA) is used as an insecticide. It is a carcinogenic, mutagenic, and endocrine-disrupting compound that causes health effects in humans (Zhao *et al*., 2021) and in other aquatic animals like fishes, amphibians, etc. It is the major, very often present insecticide in the atmosphere, ground, and surface water through seepage from agricultural lands. The effect of the persistent BPA on marine life is mostly due to movability, much aqueous solubility, and tenacity. It is an organic persistent, so its elimination from the environment is much difficult. So there is a great need to design such techniques which can be helpful to fight such necessary evils. The traditional techniques for the removal of BPA like coagulation, filtration, sedimentation, and disinfection, were found to be least efficient. In the past few years, the eradication of BPA from polluted water has elevated the issues.

Among several removal techniques, adsorption is considered the leading one due to the simplicity of design, cost-effectiveness, efficiency, and reusability of adsorbents. Adsorption efficiency could be enhanced by recently synthesized composite materials. Current research work was designed for the synthesis of novel biocomposites for the efficient removal of BPA from aqueous media.

Methodology

PH was treated with formaldehyde and sulphuric acid at 60^0C in an orbital shaker for 36h leading to washing and drying. To enhance the efficacy of PH, two different biocomposites were synthesized with polyaniline (PAN/PH) and polypyrrole (PPY/PH)(Ishtiaq *et al*., 2020). For PAN/PH synthesis, polyaniline was treated with HCl and ammonium persulfate at freezing temperature to get polyaniline. After that, 5g polyaniline was dissolved in 100mL of 0.5M sodium hydroxide to get Polyaniline Emeraldine-base (EB-PANI). At last, 0.5g of EB-PANI was stirred with 50 mL of formic acid and left it overnight for reaction completion. For PPY/PH synthesis, 3g of PH was soaked in 100 mL of pyrrole and left it overnight. On the next day, 0.5 M $FeCl_3$ was prepared and added drop-wise into the above mixture. Left the system overnight. Filtered the above mixture and washed it with methanol for the monomer removal. After filtration, the composite was dried at 60^0C. Native and prepared biocomposites were used as an adsorbent for batch study to optimize various process parameters by varying one parameter and keeping all other constant (Bhatti *et al*., 2020).

Results and Discussion

Characterization:

Morphological properties like porosity and particle shape were analyzed through SEM. Porosity and adsorption capacity has direct relation. Results demonstrated that PPY/PH is more porous and the native is the least. FT-IR spectra confirm the presence of hydroxyl and carboxylic functional groups on the adsorbent surface.

Batch study:

Native and prepared biocomposites were used as an adsorbent for batch study to optimize various process parameters like adsorbent dose, contact time, BPA concentration, temperature, and pH. The maximum adsorption capacity was achieved at pH 6 for native and 7 for biocomposites, adsorbent dose 0.05g, contact time 60 min and 30^0C temperature. Different kinetic, equilibrium and thermodynamic models were applied on experimental data. It was observed that Freundlich and Temkin's models were best fitted for the equilibrium data while in kinetic models pseudo-second-order was best fitted.

Conclusion

The present study was carried out the adsorption of BPA on the surface of PH and its biocomposites (PAN/PH and PPY/PH). It was found that both composites are more efficient as compare to native in the adsorption process. Results revealed that the PH-based biocomposites could be used for BPA removal from aqueous media.

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"PERFORMANCE EVALUATION OF 3D PRINTED Ti6A4V ALLOY NANOTUBES REACTOR AS EFFICIENT POINT-OF-USE DISINFECTION DEVICE FOR MULTI-DRUG RESISTANT (MDR) E. COLI."

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ABSTRACT

Conventional disinfection methods cannot be called as effective methods, when it comes to hazardous disinfection by products (DBPs) and application of these technologies for point-of-use water treatment system. Applications of nanomaterials holds great potential and can revolutionize the conventional disinfection system, as well as water and wastewater treatment system. In this study disinfection efficiency of 3D printed Ti6A4V alloy nano-tubes reactor was performed on MDR *E. coli*. Results showed 99.999 % removal efficiency of MDR *E. coli* at 6 volts and 20ml/sec of flow rate. Point-of-use potential of the device was analyzed by 10 minutes' disinfection cycles on tap water and drinking (mineral) water.

Key words: Multi-Drug Resistant E. Coli, Disinfection, Nano-Materials

Introduction

In today's world water pollution is the major concern. Globally, annual water pollution causes death of more than 700 million people, while more than 2.1 billion people are forced to drink contaminated water (WHO, 2012). Water borne disease are the major contributor to the total deaths. About 600 and more disinfection by products (DBPs) has been reported till date by researchers, many of which are carcinogenic. Some major DBPs are; chlorite, chlorate, bromate, biodegradable organic carbon, cyanogen halides, trihalomethanes (THMs), halo-acetic acids (HAAs), nitrosodimethylamines (NDMAs) [1]. DBPs can are very hazardous to human health and can cause a wide range of diseases, ranging from headache to coma and death. Apart from human health these DBPs possess threat to animal's health and degrade eco-system. These hurdles regarding disinfection can be tackled by applications of nanotechnology in water disinfection [2]. Photo-catalytic oxidation and electro-catalysis are advanced process which can be used for water disinfection. During these processes UV-radiations or electric current is applied to create OH radicals which further form reactive oxygen species (ROS) and disinfection by mean of oxidation of microorganisms [23]. Various nanomaterials either natural or synthetic are used in photo-catalysis and electro-catalysis. Large specific surface area and their greater reactivity at nanoscale are the properties making them excellent adsorbents, catalysts, sensors and disinfectants [4].

This study focuses on performance evolution of TiO2 Nano-Tubes Arrays (TNAs) Electro-Catalyst Reactor as an efficient disinfection against Multi-Drug Resistant (MDR) *E. Coli*. This process is cost effective, easy to operate, has lower foot prints, and is highly efficient.

Methodology

Multi-Drug Resistant *E. Coli* was isolated from river water. Multi-Drug Resistant sensitivity of the *E. Coli* was analyzed by Disk Diffusion Method. For performance evaluation of the device following operating parameters were optimized; applied voltage (volts), flow rate (ml/sec), HRT (sec), initial bacterial dosage (CFU/ml) and retention time (sec).

Various concentrations of NaCl solution (20ppm, 50ppm, 100ppm, 250ppm and 500ppm) were analyzed at optimum parameters to acquire optimum NaCl concentration for the disinfection. After

obtaining optimum efficiency at disinfection parameters, 10 minutes' disinfection cycles were conducted on tap water and mineral water in order to analyze point-of-use suitability of the device. Energy consumption, disinfection mechanism of the device and other research parameters of the study were studied by using theoretical approach and extensive literature review.

Results

Isolated E. Coli was totally resistant against 5 antibiotic disks and intermediate resistant against 2 disks. Total resistant was obtained against Ceftriaxone (CRO 30□g), Meropenem (MEM 10□g), Clarithromycin (CLR 15□g), Amoxicillin (AMP 25□g) and Carbenicillin (CAR 100□g).

In this study maximum disinfection efficiency of 99.999% (Log 5 reduction) was achieved at 6.5 volts, 20ml/sec flow rate, 3.5 seconds (HRT) and retention time of 75 seconds.

Among 20, 50, 100, 250 and 500ppm NaCl solutions, almost all the ppm concentrations resulted in same disinfection efficiency ranging from 99.99% to 99.999% (Log 5 Reduction). Disinfection cycles of 10 minutes was performed on tap water and drinking water (mineral water) in order to assess point-of-use disinfection performance of the reactor. The maximum disinfection efficiency for tap water and mineral water was 99.999% (Log 5 Reduction).

Conclusion

Current study shows that this device is one of the most innovative, state-of-art, and efficient disinfection device against MDR *E. Coli*. Device has the potential to replace conventional disinfection systems for *Total Coliform* and *E. Coli* and revolutionize the point-of-use disinfection technologies. Reactor is able to disinfect 70 million CFU/ml of MRD *E. Coli*. Device can mitigate *E. Coli* contamination with 99.999% removal efficiency (Log 5 Reduction) at 6 volt and 20ml/sec of flow rate.

For tap water and drinking water cycles 99.999% disinfection efficiency (Log 5 Reduction) has been achieved at optimum parameters (6 volts and 20ml/sec flow rate).

From different NaCl solution the device was able to reduce 99.999% *E. coli* (Log 5 Reduction) in 20ppm and 50ppm NaCl solutions.

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IDENTIFICATION AND CHARACTERIZATION OF MICROBIAL RESISTANCE IN HOUSEHOLD WASTEWATER DRAINAGE OF HYDERABAD, SINDH

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ABSTRACT:

Antimicrobial resistance is one of the major threat to human life in 21st century. Many bacterial infections and can be cured by antibiotics .Pakistan is a country where people used antibiotics without doctor's prescription and this misuse leads to antibiotic drug resistance in human body. The route of transmission of these resistance genes is mainly human faecal excreta, which ultimately through waste water drainage mixes with our fresh water sources and transmit resistance genes to the community. In this study we identified antimicrobial susceptibility of four commonly prescribed antibiotics with *Ecoli* .Results shows that 50-59% of samples are resistance to azithromycin and ciprofloxacin.

Keywords: wastewater, antibiotic resistance, bacteria

Introduction:

Antibiotic resistance (ABR) is becoming a threat to human life as many bacterial infections and waterborne diseases can effectively be cured with antibiotics. Many resistant antibiotics are now considered as emerging contaminants in water as owing to large amount of misuse worldwide (Picó et al., 2015).The World Health Organization has reported that antibiotic resistant bacteria (ARBs)in water have become a serious global health issue and it is now considered as one of the utmost global threat of 21st century. (Li et al., 2015).Unfortunately its overuse or misuse is making these vital drugs resistant in human beings and many antibiotics are now not curable for many diseases (Conly et al., 2005). In Enterobacteriaceae e.g. *Escherichia coli* are the main cause of many water borne infectious diseases, but very limited drugs options are available for its cure and many of them are resistant antibiotics (Livermore, 2009).

Latrine wastewater is considered as one of the contributor in transmission of antimicrobial resistance genes specifically in underdeveloped countries(Zhang et al., 2016). So there is a need to check antibiotic resistance frequency in the wastewater of community latrine.

Methodology:

Study design: The data is collected through random sampling from the households' latrine wastewater of Hyderabad Sindh and its resistant susceptibility is test by using Kirby Bauer disk diffusion method.

Kirby Bauer disk diffusion test:

Collection of waste water through swab in tryptic soy broth tube and incubate for 18-24 hours.

Next Streak broth for isolation on KPC CHROMagar. For isolation of colonies streak on CHROMagar and Mueller Hinton agar for 18-24 hours. Purple or red colonies isolated on full CHROMagar orientation plate and incubate for 18-24 hours.If CHROMagar orientation shows a single colony type, use associated colonies on Mueller Hinton agar for suspension.Use suspension for standard disk diffusion test with Ciprofloxacin, Azithromycin, Cefixime, and Meropenem antibiotic disks. Determine the level of resistance based on zones of inhibition.

Results:

Table: 1 Antibiotic susceptibility ratio from the latrine wastewater samples

Antibiotics	***Ecoli* resistant N (%)**	***Ecoli* intermediate N (%)**	***Ecoli* susceptible N (%)**
Meropenum	9 (28)	19(59)	4(12)
Azithromycin	19(59)	1(3)	8(25)
Ciprofloxacin	19(59)	1(3)	12(37)
Cefixime	28(87)	2(6)	2(6)

Conclusion:

The overall results shows that azithromycin and ciprofloxacin is the most resistant antibiotic. Ciprofloxacin is also found to have the highest susceptible ratio in samples taken from the waste water of community drainage of Hyderabad Sindh, Pakistan.

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GREEN SYNTHESIS OF CU & NI FUNCTIONALIZED HYDROXYAPATITE BIOCOMPOSITES FROM LABEO ROHITA SCALES: SUSTAINABLE APPROACH TOWARDS ENVIRONMENTAL REMEDIATION

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ABSTRACT

Advancement in technologies has revolutionized the industrial production globally and the waste (heavy metals, azo dyes, toxic organic pollutants etc.) generated from different industrial units has caused the pollution of different Environmental Compartments. [1]. Fish and aquaculture industry by being a food processing industry is also a major contributor of bio waste on land as well as water bodies and management of this waste has become a major challenge towards the road to sustainability [2, 3, 4]. The current research was conducted with the aim to articulate some greener approaches to convert waste into wealth, which ultimately results in environmental remediation and green recovery. In this regard, refused fish scales of *Labeo Rohita* were collected and used to extract hydroxyapatite (HAp) by acid-alkali treatment [4]. At first step scales were deproteinized by washing with 0.1M HCl solution and then treated with 5% (w/v) NaOH solution under continuous stirring for 7 hours to get white precipitates. 50% (w/v) NaOH solution was used to treat the dried precipitates at 100 ºC for 1 hour to get HAp powder, followed by washing with deionized water and drying. HAp was further functionalized with Cu and Ni metals via calcination method in order to synthesize the metal-HAp biocomposites. FTIR, XRD and XRF techniques were used to characterize the samples, which confirmed the synthesis of desired products i.e. HAp (LR), Cu-HAp (3 wt. %-LR), and Ni-HAp (3 wt. %-LR) biocomposites. Figures 1 and 2 below shows the FTIR spectrum and XRD of HAp (LR) respectively. Furthermore, the synthesized biocomposites were used as adsorbents of Cadmium ions (Cd^{2+}) and Malachite Green (MG) from wastewater. For this purpose, close batch of 60min were conducted to evaluate the removal efficiency of the employed adsorbents and samples were analyzed by UV-Visible Spectrophotometer *(Shimadzu, Japan, Model: UV-1601)* and Flame Atomic Absorption Spectrophotometer (FAAS) *(Shimadzu, Japan, Model: A7000F)*. According to findings, Ni-HAp 1:3 (1% metal) and Cu-HAp 1:3 (1% metal) acted as good adsorbents towards Cd^{2+} with the removal efficiency of 93% and 76% respectively while in case of MG, both the adsorbents showed the removal efficiency of 60% (fig. 3) and 64% respectively. Antibacterial assessment was carried out by disk diffusion method to evaluate the antibacterial nature of these biocomposites and Ni-HAp 3:1 (3 wt. % metal) has proved as best antibacterial agent with the inhibition zone of 42mm against *S. aureus* as shown in fig. 4. Results supported the multilayer adsorption pattern in case of MG and Cd^{2+} while Pseudo second order showed the best fit, for both adsorbents, among kinetic modals.

Keywords: Hydroxyapatite (HAp); Biocomposites; Adsorption; Wastewater treatment; Antibacterial assessment.

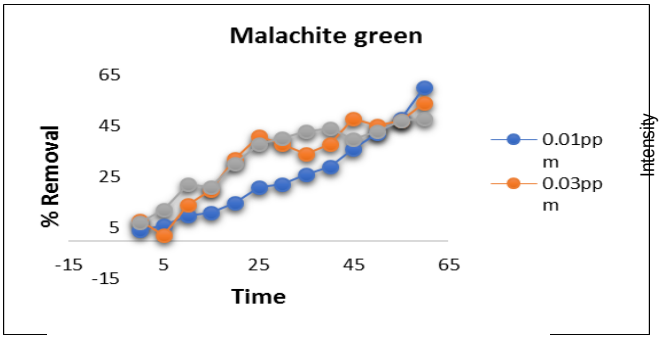

Fig.1. FTIR Spectrum of HAp (LR)

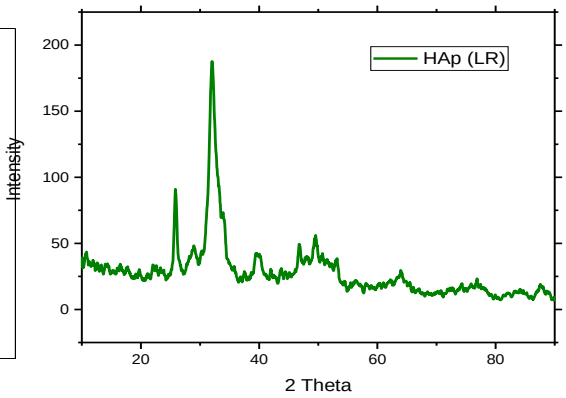

Fig. 27. XRD spectrum of HAp (LR)

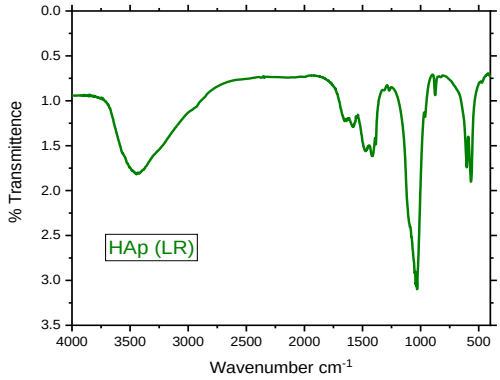

Fig.3. Malachite green with NiHAp 1:3 (LR)

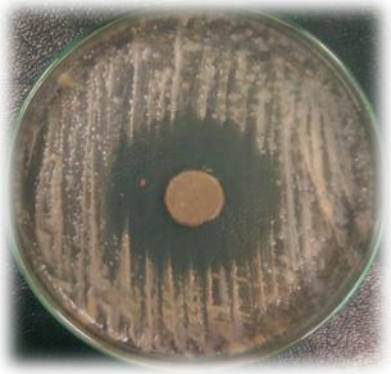

Fig. 4. Inhibition zone of NiHAp 3 wt. % (LR)

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CONSIDERATION OF METAL-ORGANIC FRAMEWORKS FOR ATMOSPHERIC WATER HARVESTING

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ABSTRACT

Atmospheric water harvesting using adsorbent materials holds great potential to deliver drinking water. This review outlines the significance of metal-organic frameworks (MOFs) which have emerged as a unique class of adsorbents capable of extracting atmospheric water even at low relative humidity levels and perform with fast water uptake and release kinetics. The number of porous MOF materials have been developed and tested at various conditions. The results showed that the MOFs could harvest water from dry areas and deliver enough amount of water per day.

Key words: metal-organic framework, adsorption, atmospheric water harvesting, energy

Introduction

Water scarcity has been experiencing by many countries and this projection is increasing day by day due to climate change, water pollution, and global population [1]. In this situation, humidity in the earth's atmosphere can be considered as an alternative resource to access fresh drinking water. In this regard, efforts have been made to harvest water from atmospheric air and metal-organic framework (MOF) based water harvesting systems have been proposed as the most efficient ones [2]. In this concept, MOF materials adsorb and desorb the water vapors and showed a high potential for water harvesting even from dry air. This study highlights the recent progress in atmospheric water harvesting using MOFs.

Atmospheric water harvesting principles

The atmospheric water harvesting system can be powered by low grade renewable energy sources and requires materials with large working capacities [3]. The principle comprises of three steps (i) adsorption of water at high relative humidity and low temperature (ii) desorption of water (iii) condensation of vapors into liquid form. Figure 1(a) shows the working of water harvesting device which comprises of an adsorbent material and a condenser. The ultrahigh porosity of MOFs renders them the prime candidates for water harvesting from air.

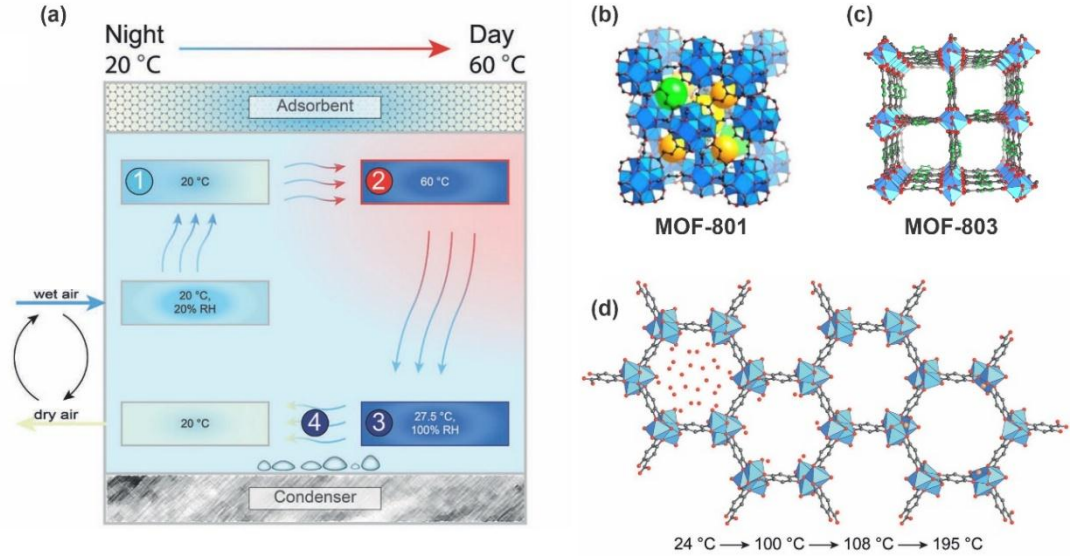

Figure 28. Adsorption based atmospheric water harvesting. (a) Schematic of water harvesting device comprises of an adsorbent layer and a condenser. (b-c) Illustrations of water-stable MOFs (801,303). (d) chemisorption behavior on open metal sites of MOF [1,2].

MOFs as next-generation adsorbents

MOF materials have evolved as one of the prime candidates for atmospheric water harvesting due to their flexible nature, and tailorable architectures [2]. Figure 1(b-c) shows the water-stable and most efficient MOFs employed in water harvesting systems. As the metal ions constitute the MOF materials so they show the hydrolysis process in the presence of water. From the thermodynamic perspectives, the metal linkers and the positioning of the water molecules play a significant role in the hydrolytic stability of the MOF structure [2]. In MOF, the water adsorption mechanism comprises (i) chemisorption on open metal sites, (ii) physisorption in the form of layers or clusters, and (iii) capillary condensation. Figure 1(d) shows the dehydration steps in the structure of (Zn)MOF-74 in which loosely bound water is removed under mild conditions (24-100^{o}C), strongly adsorbed water is removed at 108^{o}C and chemisorbed water is removed at the highest temperature (195^{o}C) [1].

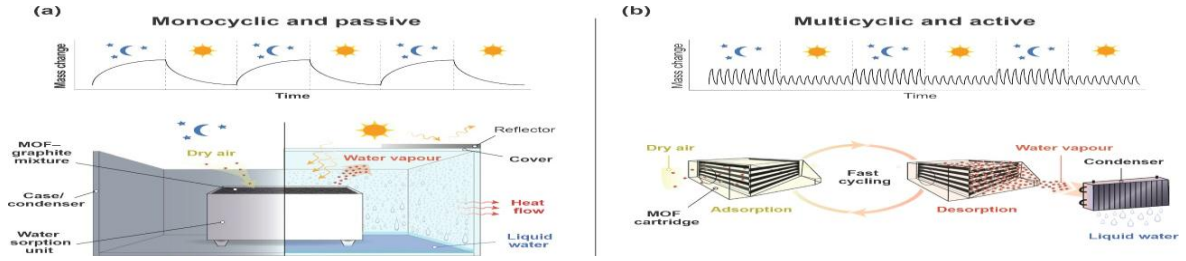

Figure 29. MOF water harvesters. (a) monocyclic and passive MOF water harvester [4]. (b) multicyclic and active MOF water harvester along with the illustrations of mass change and water uptake against time [5].

Figure 2 shows the illustrations of monocyclic (once a day process) and multicyclic (several times a day process) MOF water harvesters. The monocyclic water harvesters rely on water adsorption at night and desorption during the day when exposing to sunlight. But these water harvesters possess a fundamental drawback of the adsorbent capacity. To overcome this drawback, a multicyclic water harvester has been developed which performed multiple adsorption-desorption cycles and produced a high amount of water [5].

Conclusions

In this review, the progress and development of metal-organic frameworks (MOFs) as the adsorbents have been discussed from the atmospheric water harvesting standpoint. Recently developed MOFs are promising due to their structural diversity and hydrophilicity. MOFs based water harvesting systems are discussed in this study. It is concluded that if carefully designed and synthesized the MOFs materials then these could well be the answer to address the water scarcity conditions in future.

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INVESTIGATING DESALINATION SYSTEMS WORKING ON DEW-POINT EVAPORATION, STANDALONE ADSORPTION AND ADSORPTION-EJECTOR METHODS

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ABSTRACT

Mitigation of energy and water poverty confers the researchers to disclose alternate option to obtain freshwater. Desalination is an artificial mean of removing salts from water, for the sake of acquiring freshwater in abundance. Although, thermal and membrane-based desalination systems are actively involved for desalination. However, massive energy consumption and sophisticated controlling conditions make it inappropriate, particularly for developing countries having unstable economic status like Pakistan. On the other hand, advance adsorption and evaporation concept breaks the former barrier for developing countries. Therefore, the present study discusses the fundamentals and performances of standalone adsorption desalination system (ADS), integrated ejector adsorption desalination system (EJ-ADS) and dew point evaporative (DPE) desalination system. In addition, feasibility of these emerging desalination systems is explored considering Köppen climatic conditions of Pakistan. The results reveal that, these systems have potential to employ in developing countries due to its low energy consumption (0.92 kW-hr/m^3), low carbon footprint and most importantly, simultaneous production cooling which intended need.

Keywords: adsorption desalination, ejector, dew point evaporative, comparison.

Introduction

Desalination is getting more attention from the last few decades due to the ungoverned population growth, which directly impacting freshwater devouring patterns [1]. Matured thermal and membrane-based desalination systems are authenticated and commercialized to meet the water demands [2]. However, its contradictory flaws such as high carbon footprint [3], high energy consumption, and above all environmental degradation; discloses the researchers to identify alternative options that desalinate the brackish seawater effectively. The present study describes the fundamentals of AD system, its integration with the ejector and DPE desalination system using schematics. In addition, the performance parameters and operating conditions are evaluated. A fair comparison table has been made between the emerging desalination systems (AD, EJ-AD, DPE). Moreover, the study concluded with future directions related to emerging desalination technologies.

Fundamental of emerging desalination systems

Fundamental of AD is based on the adsorption and desorption phenomenon. The whole system comprises of three major components; (i) saline water evaporator (for evaporation <25 ^{o}C), (ii) pair of adsorption bed/reactors (for continuous water production), and (iii) condenser to consolidate the water vapors. The working of ADS has been presented in Fig. 1. Ejector is integrated with AD system to increases the overall system productivity. Therefore, additional two loops are taken from the evaporator and condenser/desorption bed and connect with low pressure and high-pressure ejector inlets, respectively. EJ-ADS working is presented in Fig. 1. DPE desalination system is based on standalone evaporation and condensation processes, excluding the adsorption/ desorption process compared to the AD system. As the fundamentals are concerned, DPE desalination scavenges the psychrometric renewable energy carried by the surrounding air. The working of DPE desalination system is presented in Fig.1.

$$DWP_{AD} = \frac{Q_{con}}{h_{fg}(T_{con})m_{sg}} \quad (1)$$

$$COP_{AD} = \frac{Q_{evap}}{Q_{reg}} \quad (2)$$

$$DWP_{DPE} = \frac{86400\ \Delta HR_{2-4} m_{4,a}}{\rho_w V_1} \quad (4)$$

$$COP_{DPE} = \frac{Q_4}{Q_1} \quad (5)$$

$$PR_{AD} = \frac{m_{con,w} h_{fg}(T_{con})}{Q_{reg}} \quad (3) \qquad PR_{DPE} = \frac{\Delta HR_{2-4}\, m_{4,a}}{\Delta HR_{2-1} m_{2,a}} \quad (6)$$

(a) ADS (b) EJ-DPE (c) DPE desalination system

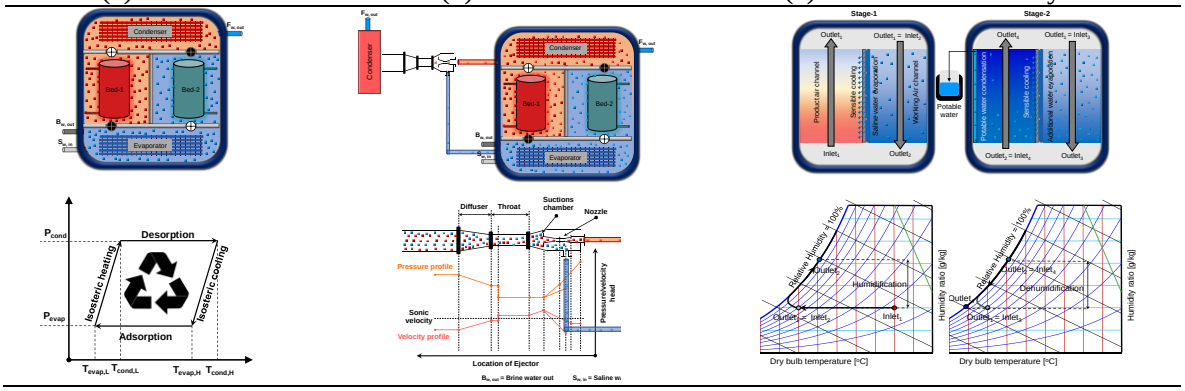
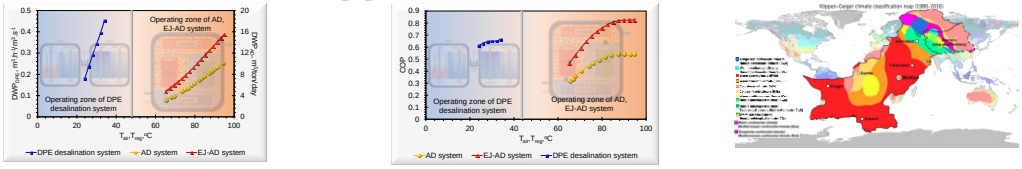


Fig. 4. Working of emerging desalination system along with cyclic representation

Operating condition, performance evaluation and feasibility in Pakistan

Operating conditions/parameters are super sensitive to performance indicators. In Pakistan water and energy scarcity has been continuously increasing. Fig. 5 shows the performance comparison of emerging desalination system. Moreover, their applicability is explored considering Köppen climate classification map. According some estimates, reported by United States of Peace (USP), the energy shortfall has been growing 2% of annual GDP [4]. Similarly, the freshwater availability has been observed below the United Nations water availability standards. In 2019, membrane-based desalination system has been planned by the Hub Power Company (Hubco) for meeting the clean water demand for DHA Karachi [5].



(a) DWP (b) COP (c) Feasibility in Pakistan

Fig. 5. Performance comparison of emerging desalination systems and their feasibility in Pakistan

Comparison study

Desalination option	Advantages	Disadvantages
Multistage effect desalination (MED)	• High production rate • Commercialized seawater treatment facility • Utilized for evaporation	•High dependency on primary energy resources (thermal energy) •Corrosion and blockage of desalination facility •Drastic impact on environment •Concentrated brine solution
Reverse osmosis (RO)	• Most active desalination approach • Massive production rate	• 4.00 kWhr/m^3 electrical energy requirement • Membrane fouling and clogging • Expensive membranes having low cycle and thermal stability

ADS		EJ-ADS		DPE desalination	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**	**Advantages**	**Disadvantages**
•Option to recover waste heat •Dependency on renewable energy sources •1.38 kWh/m^3 EC	•Production rate is low •Low COP value •Quite difficult to generate true vacuum in	•High production rate compares to ADS •0.92	•Low production rate compares to active desalination approaches	•Scavenges ambient psychrometric renewable energy	•Low production rate compares to active desalination approaches

	evaporator	kWhr/m^3 EC • Zero liquid discharge			• Efforts required commerciali ze the technology

Conclusions

The study concluded that, emerging desalination systems are effectively employed in Pakistan due to its positive attributes. Regarding performance, EJ-ADS outperforms as compared to ADS and DPE desalination system. However, of emerging adsorption desalination system is so far less as compared to active desalination system. But a great a protentional is still available to improve the performance efficiency.

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SIMULATION AND PARAMETRIC ANALYSIS OF ZIRCONIUM POLYACRYLAMIDE (ZRPACM-43) HYBRID COLUMN FOR THE REMOVAL OF ARSENIC FROM DRINKING WATER

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ABSTRACT

This study deals with the simulation and parametric analysis of Zirconium Polyacrylamide (ZrPACM-43) hybrid column employed for the removal of Arsenic from drinking water. Aspen Adsorption V11 was used to simulate ZRPACM-43 hybrid material. The concentration range of Arsenic in water from literature was the average range of concentration found at various locations of Pakistan. Bed specification used in the development of Adsorption column was taken from literature review. Various parameters such as Flow rate of feed diameter of the bed and height of the bed were varied to check the removal efficiency of the bed. The effect of all three parameters i.e. Flow rate of feed, diameter of the bed and height of the bed on removal efficiency of bed was observed on three different values of each parameter. For flow rate the values were taken 100 L/hr, 200 L/hr, and 300 L/hr, for diameter of bed the values were 8cm, 10cm and 12cm and for height of bed values were 80cm, 100cm and 120cm. It was concluded that increase in the flow rate of feed causes the reduction in removal efficiency of bed and vice versa and increase in the height and diameter of bed increases the removal efficiency of bed and vice versa. The results revealed that increasing the diameter of bed increases the removal efficiency of bed up to some range, more ever an increase in the diameter of bed could not affect the removal efficiency any further. In the same way, increasing the flow rate of feed decreases the removal efficiency of bed up to some extent. In addition to that, an increase in flow rate of feed could not affect the removal efficiency of bed to any significant extent.

Key words: Adsorption, Arsenic, Zirconium Polyacrylamide, Simulation, Removal efficiency

Introduction

Arsenic, commonly available substance in nature, is considerably toxic and one that causes cancer. Keeping the hazards associated with the arsenic that is found in shallow water zones, it is considered as a predicament worldwide. Quite unsurprisingly, the water obtained from shallower subsurface structures in many Asian countries, is full of Arsenic and is widely used for Industrial, commercial, domestic as well as drinking purposes. The common concentrations of Arsenic in various parts of the Asian continent, particularly India, Pakistan, China, Bangladesh, Egypt, Nepal, Philippines & Indonesia, is more than 50 ppb [1,2]. The use of water with such a high level of contamination happens to be responsible for diseases like cancer in the bladder, kidney, skin and even lungs [3]. To cope up with this issue related to this excessively high concentration of Arsenic in water, the World Health Organization (WHO) and United States Environmental Protection Agency (USEPA), have set forth the maximum standards values of 10 ppb for drinking water purposes [4].

There have been scores of several methods employed for the purification of water and removal of Arsenic, adsorption, coagulation, co-precipitation, ion-exchange and oxidation-reduction process, but the specialties associated with adsorption process when it comes to removal of arsenic have made this process the most viable one [5].

This research focuses on simulation of analysis based on different parameters of Zirconium Polyacrylamide (ZrPACM-43) hybrid column for the sake of separating Arsenic from water available

for drinking purposes. The substance used for simulating the hybrid material under study i-e (ZrPACM-43) was Aspen Adsorption V11. The concentration levels of Arsenic in Pakistan matched those in water samples used in literature review.

The configurations of bed used for this purpose were obtained from literature review. The parameters such as diameter of the bed, height / elevation of the bed and flow rate were changed to observe its effect on the efficiency of Arsenic removal from water. The subsequent analysis was performed by closely monitoring the effect the said three parameters – diameter of the bed and height of the bed, Flow rate of the feed, on the efficacy of the process in terms of three different values of each parameter and their impact on Arsenic Removal efficiency of the entire process.

Methodology

The extent to which Arsenic can be removed depends upon use of zirconium Aspen Adsorption (V11) by using Zirconium Polyacrylamide hybrid material (ZrPACM-43), mathematically modeled by Partial Differential Equations (PDEs), Ordinary Differential Equations (ODEs) and algebraic equations, coupled with the proper preliminary and terminal settings. The data for this research from literature review as well from samples of known concentrations from various locations of Pakistan. Figure 01 shows the adsorption column model selected for simulation. The mass transfer coefficient provided in the model was taken default and the forces responsible for flow of arsenic molecules were merely convective forces. The flow was maintained for 900 minutes and Big upward difference scheme (BUDS) with 50 numbers of nodes was assumed as difference method to calculate the model equations.

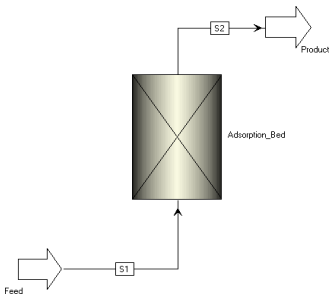


Fig.1. The model of Fixed Bed Adsorption Column developed in Aspen AdsorptionV11.

Assumptions

The assumptions that were taken into consideration in the study are.

i. The fluid flow behavior was Plug flow.
ii. The drop in liquid phase pressure is taken as contestant, whereas the molar volumes are considered for molar concentrations.
iii. The resistance is linear, quadratic while the mass transfer coefficients are taken to be constant.
iv. Aspen Adsorption is used for both isothermal as well as Non-isothermal conditions but in case of non- isothermal, conditions need to be checked carefully.

The correlations used in the model were:

Model Assumptions (Liquid)

Linear Lumped Resistance was selected which assumes mass transfer driving force for component as a linear function of the liquid phase concentration or solid phase loading and expressed in terms of following correlations:

$$\square s \, \square_i wi / \square t = MTC_S (ci - c^*) \quad (1)$$

Material Balance
Equations used in the model is presented as

$$-\varepsilon_i E_i \, \partial^2 c_i / \partial z^2 + \partial / \partial z (v_i c_i) + \varepsilon_i \, \partial c_i / \partial t \, \partial_s \, \partial w_i / \partial t = 0 \qquad (2)$$

The first term in the equation shows while second term shows the convective force 3rd term shows accumulation and last term shows Mass transfer from the liquid to the solid phase.

$$\partial w_k / \partial t = MTC_{sk} \, (w_k^* - w_k) \qquad (3)$$

Convention with constant dispersions
Convention with constant dispersions option was incorporated in this study whereas a constant value for dispersion coefficient was interleaved to solve the expression.
Isotherm Selection
The major force responsible for all adsorptive liquid separation mechanisms is the deviation from adsorption equilibrium. For once, the component's adsorption isotherms are considered, suitable bed conditions can be formed.

$$w_i = IP_{1i} \, IP_{2i} \, c_i / 1 + IP_{2i} \, c_i \qquad (4)$$

Results and Discussion

The results of the study obtained through Aspen Adsorption software are described as follows.
Effect of Flow Rate on Bed

If the diameter and height of the bed are kept unchanged, the rise in rate of flow of Arsenic reduces the segregation / removal efficiency of the bed. The Effect of flow rate of Arsenic on Bed was observed on three different values i.e. 100 L/hr, 200 L/hr and 300 L/hr.

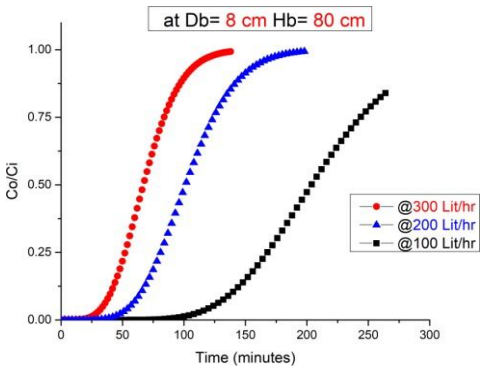


Fig2. Variation in flow rate at Db=8cm and Hb=80cm

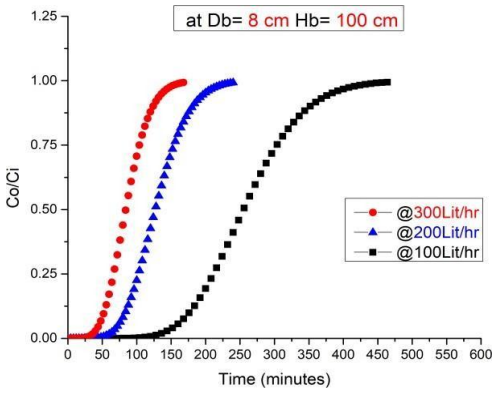


Fig. 3. Variation in flow rate at Db=8cm and Hb=100cm

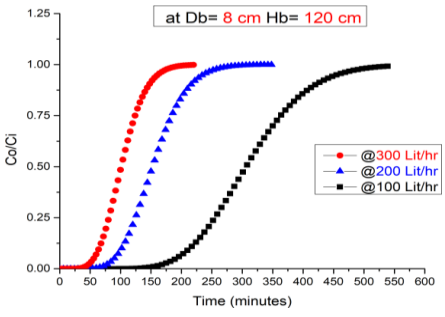


Fig.4. Variation in flow rate at Db=8cm and Hb=120cm

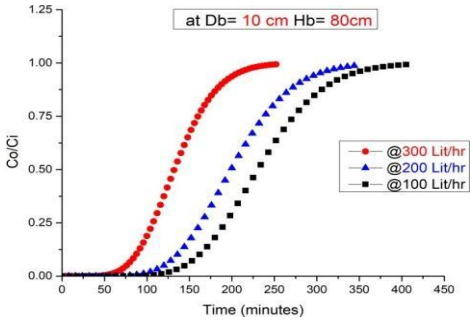


Fig.5. Variation in flow rate at Db=10cm and Hb=80cm

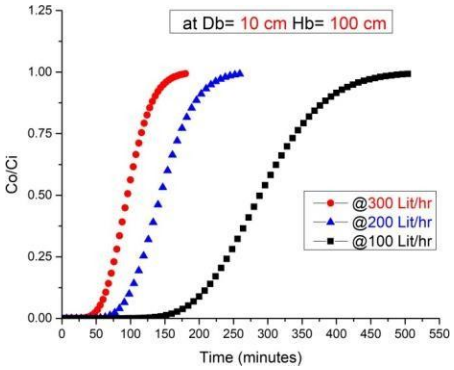


Fig.6. Variation in flow rate at Db=10cm and Hb=100cm

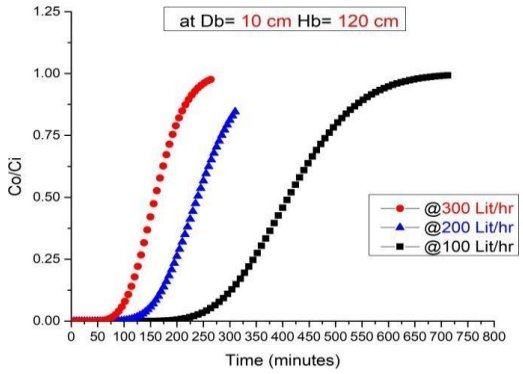


Fig. 7. Variation in flow rate at Db=10cm and Hb=120cm

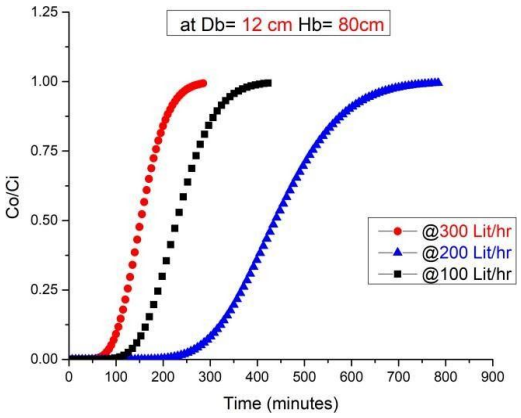


Fig.8. Variation in flow rate at Db=12cm and Hb=80cm

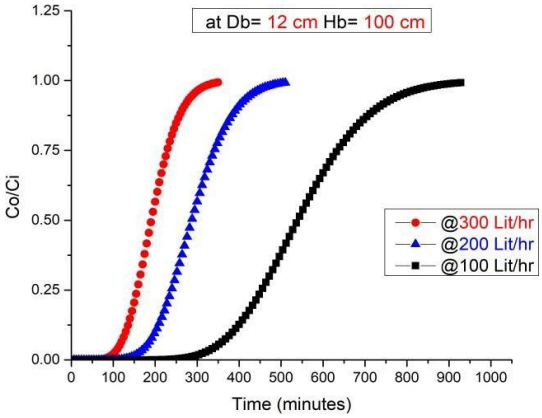


Fig.9. Variation in flow rate at Db=12cm and Hb=100cm

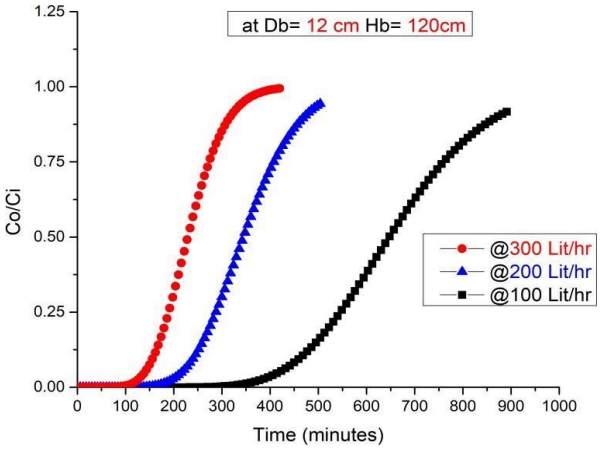
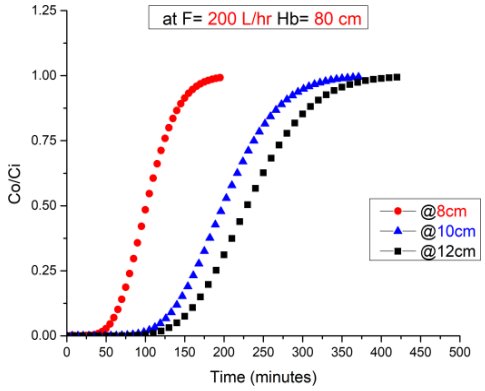


Fig.10. Variation in flow rate at Db=12cm and Hb=120cm

Effect of Diameter of Bed

It was observed that if the feed flow rate is not changed along with a constant height of bed, the bed diameter enhances the efficiency of removing the Arsenic.



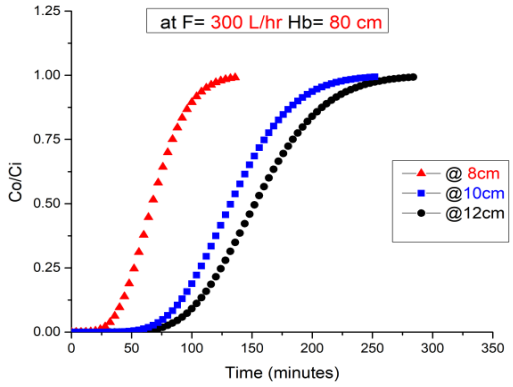
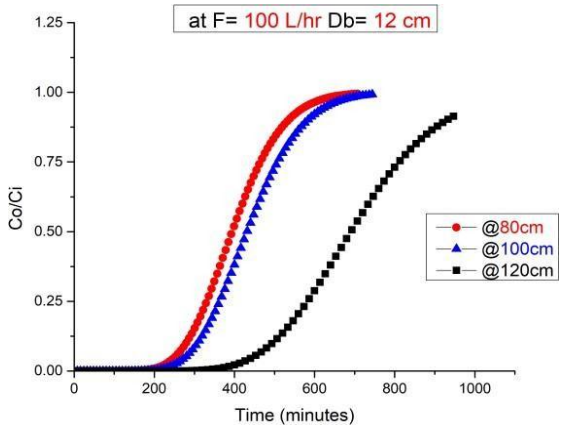


Fig.11. Variation in Diameter of bed at F=200 L/hr and Hb=80cm **Fig.12: Variation in Diameter of bed at F=300 L/hr and Hb=80cm**

Effect of Bed Height

If the diameter of the bed and rate of fluid is kept constant, rise in height of the bed enhances the efficiency of bed in removing the Arsenic as illustrated below



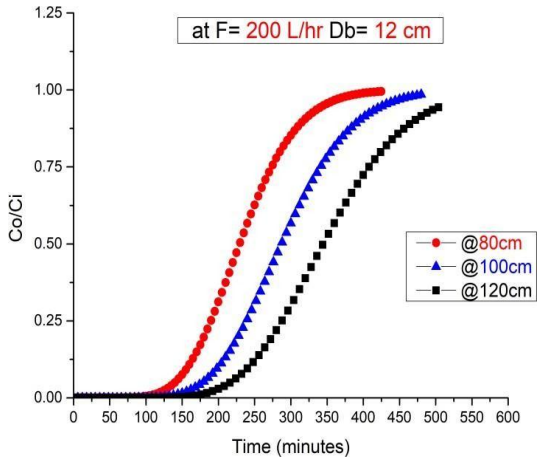


Fig.12: Variation in Height of bed at F=100 L/hr and Db=12cm **Fig.13: Variation in Height of bed at F=200 L/hr and Db=12cm**

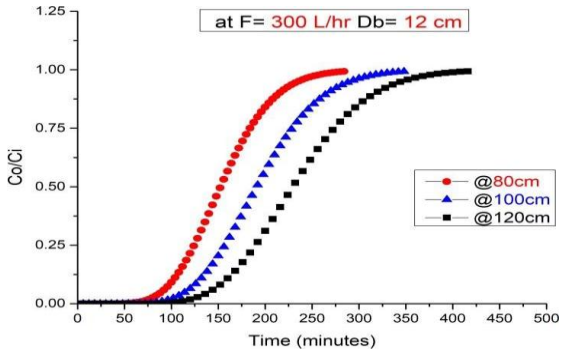


Fig.14: Variation in Height of bed at F=300 L/hr and Db=12cm

Conclusion

The impact of bringing variations in all the parameters discussed were observed on three different values 100 L/hr, 200 L/hr and 300 L/hr for diameter of bed the values were 8cm, 10cm and 12cm and for height of bed values were 80 cm, 100 cm and 120 cm. As a result, it was observed that rise in rate of feed flow happens to be responsible for decrease in overall efficiency and vice versa. Furthermore, an increase in bed diameter enhances the removal efficiency up to 97% whereas any further increase in bed did not impact the process. Similarly, a rise in rate of flow of feed reduces the overall efficiency of the system. Moreover, the rise in feed flow rate did not have any considerable impact on bed's removal efficiency any further.

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INVESTIGATION OF METAL ORGANIC FRAMEWORKS BASED WATER DESALINATION AND COOLING SYSTEMS

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ABSTRACT

The escalating scarcity of potable water and unbridled contamination with ever-increasing population density has hampered the potential of local furnishes to attain demands for water quantities at sufficient water quality levels. Furthermore, wastewater treatment systems are in operation to satisfy strict standards for water quality, and so their re-use can also be thoroughly pursued to resolve the problem of water scarcity. Therefore, it is of utmost importance to research and improve membranes with the highest separation and efficiency for use. The common methods employed for water desalination include humidification - dehumidification desalination (HDH), multiple-effect distillation (MED), solar distillation (SD), multi-stage flash distillation (MSF), and vapor compression distillation (MVC) including technologies such as nanofiltration (NF), electro-dialysis (ED), reverse osmosis (RO) and forward osmosis (FO). Some of the advantages of desalination systems include the ability to utilize waste heat, reduced maintenance cost reduced electricity consumption, and cogeneration ability with cooling and freshwater production. The drwbacks are low cooling capacity and coefficient of performance. Metal-organic frameworks are of great importance as investigated recently owing to their unique chemistry and possible applications. Recent researches have thoroughly evaluated the employment of MOFs for water treatment and gas separation. The present study, therefore, addresses the potential for the use of improved MOF materials in cooling and water desalination. With the decrease in the temperature of the condenser and increase in the temperature of the evaporator, the output of the cycle significantly increases. The purpose of the study was to investigate the employment and development of MOFs in water desalination membranes.

Keywords: Adsorption desalination system, Adsorbent materials, MOF adsorbents, Desalination

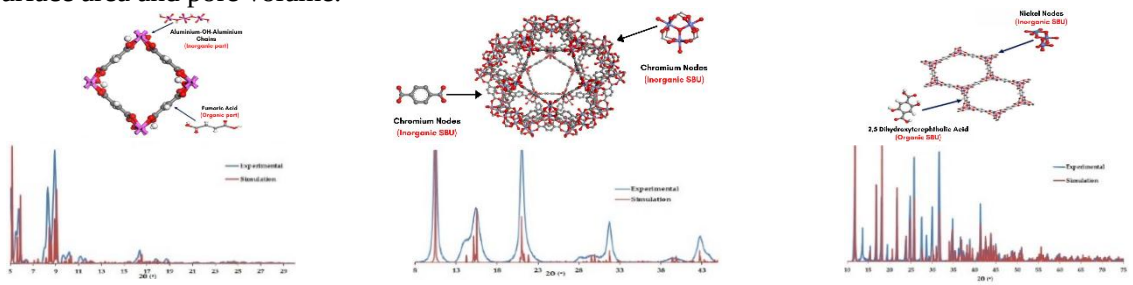
Introduction

The demand for freshwater has skyrocketed in recent years making its unavailability one of the most serious environmental problems. Adsorption desalination technology offers a structured approach to appease the surging need for potable water as it can generate desalinated water and cooling, utilizing a waste heat (low-temperature) driven adsorption cycle. A conventional AD system consists of three main components, such as the condenser, evaporator, and single or multiple adsorption beds [1]. At the same time, high-quality desalination and cooling are obtained from the ADS employing a single heat source [1]. There are various studies conducted by researchers for the investigation of different adsorbent materials including silica gel, zeolite, metal-organic framework, activated alumina, and ferroaluminophosphate. The porous metal-organic frameworks are a new class of water adsorbents due to the exhibition of the distinct inability of their hydrophilic and structural properties [2]. The current study provides insights into the MOF materials-based two beds AD system, their suitability, and thermodynamic cycle performance under various conditions. Furthermore, the potentials of aluminium fumarate, MIL-101(Cr), and CPO-27(Ni) materials are compared to other adsorbents, concluded with their application and suitability for water desalination systems.

MOF Adsorbent Materials

Adsorption desalination systems are used in conjunction with various MOFs in the present time. Some commonly employed solid adsorbents including zeolites have been researched extensively and major advances have been made over the past years. Conversely, it is inevitable to overlook their limitations. For example, considering their distinct advantages and operations to capture carbon, increased operating costs are a significant drawback to the industrial use of zeolites, as bicarbonate formation allows them the structural recreation at elevated temperatures. The integration of organic compounds

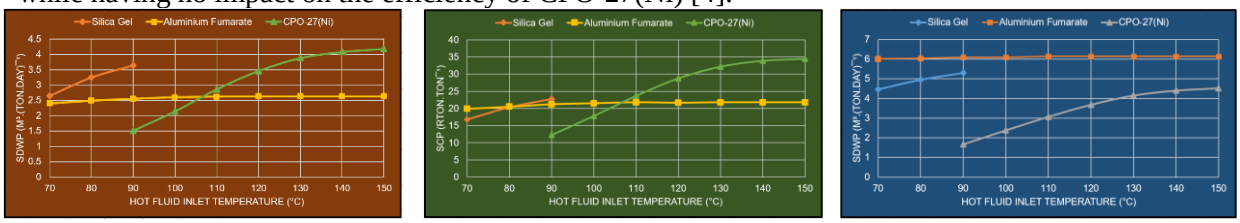
and transition metal ions have the potential to prevent the limited amount of functional building units plus operating difficulties that have arisen in the zeolite method, prompting researchers to develop realistic and strong adsorbing substances such as MOFs [3]. The system in the study consists of the investigation for some commercially available MOFs and performance evaluation for various water adsorption applications. The crystalline structure along with simulation and experimental PXRD structure of Aluminium fumarate, MIL-101(Cr), and CPO-27(Ni) are demonstrated in Fig. *6*. The structure shows the metal nodes and the organic ligand which are used for the determination of the surface area and pore volume.



(a) (b) (c)

Fig. 6 Crystal structure, PXRD, experimental and simulation variations of a. Aluminium fumarate, b. MIL-101(Cr), and c. CPO-27(Ni) [4].

The impact of chilled water and hot fluid temperatures on the performance of the AD cycle with the employment of MOF adsorbents has been investigated. The temperature of the hot inlet fluid and cooled water was between 70 °C - 150 °C, and 5 °C - 20 °C respectively. The temperature of the adsorption bed and the condenser remained unchanged at 25 °C having switching and cycle time of 70 and 700 s respectively. Fig. 7(a) represents how hot inlet fluid temperature impacts the MOF material's specific daily water production in contrast to silica gel. The temperature increment causes an increase in the SDWP and the increment in the temperature of the hot fluid having productivity of 4.3 and 2.66 m^3.(ton. day)$^{-1}$ from the aluminium fumarate method. Fig. 7(b) indicates the effect on the SCP of the two systems by the inlet temperature of the hot fluid relative to the silica gel adsorbent. Analysis indicates that an increase in the temperature of the hot fluid causes an increment in the SCP provided by both of the systems, which are 35.3 Rton.ton^{-1}, and the aluminium fumarate system's productivity is found to be 22 Rton.ton^{-1} [4]. Fig. 7(c) indicates the impact of hot fluid inlet temperature in both systems relative to the silica gel-based cycle on the SDWP. There is an improvement in SDWP as there is an increase in hot fluid temperature, with an output of 6.3 m^3.(ton. day)$^{-1}$, whereas the desalination system of CPO-27(Ni) has a productivity of 4.6 m^3.(ton. day)$^{-1}$. When the temperature of hot fluid is 90 °C, the silica gel method has the production of 5.3 m^3.(ton. day)$^{-1}$. A contrast of Fig. 7 (a) and (c) demonstrate the impact of increasing evaporation temperatures, which will have a substantial impact on the output of water for the silica gel and aluminium fumarate while having no impact on the efficiency of CPO-27(Ni) [4].



(e) SDWP, when $T_{chilled}$= 5 °C (f) SCP, $T_{chilled}$= 5 °C (g) SDWP, $T_{chilled}$= 20 °C

Fig. 7 Inlet temperature's impact on the water production from the ADS, reproduced from [4].

Conclusions

All three materials namely, aluminium fumarate, MIL-101(Cr), and CPO-27(Ni) showed great potential for adsorption desalination. It has been observed that studied materials are suitable for employment in thermally driven ADS. The study highlighted the potential of MOF adsorbents in

water desalination having applications that are at this time dominated by typical porous adsorbent materials including zeolites and silica gel.

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AEROBIC BIODEGRADATION MONOETHANOLAMINE USING BACTERIAL CONSORTIUM

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ABSTRACT

Monoethanolamine (MEA) is extensively used in many industries where carbon capturing through absorption is very common. Treatment of wastewater containing the amine solution is important to protect the environment. In this study, aerobic fed batch reactor was used to biodegrade the MEA based synthetic wastewater having COD of 13100 mg/L through bacterial consortium. Maximum removal of COD was 95%, achieved after 9 days of cycle while maximum NH_3 was 56% and the nitrate removal was 39% after 9 days of cycle.

Key words: Monoethanolamine, COD, bacterial consortium

Introduction

Amine based solvents are widely used for CO_2 capturing process (CC) to mitigate the greenhouse gas (GHG) emissions[1]. Most of the solution is recycled however 5-10% monoethanolamine is released due to equipment corrosion, volatile degradation of compound and reboiler condensate, etc. [2, 3]. This amine wastewater is very toxic and can cause severe effect on human health and ecosystem [4]. There are different technologies available to treat this amine wastewater like membrane filtration, adsorption but biological degradation is an economical and environmentally friendly solution. In this study, MEA wastewater was aerobically biodegraded.

Methodology

The synthetic wastewater having conc. of 10 g/L of MEA was prepared and for bacterial growth $MgSO_4$ (50 mg/L), $FeCL_3.6H_2O$ (50 mg/L), KCL (50 mg/L), $CaCl_2.H2O$ (100 mg/L), $NaHPO_4$ (200 mg/L) and KH_2PO_4 (200 mg/L) were added to wastewater. An aerobic fed batch reactor as shown in figure (1) was designed and fabricated for lab scale experiment. The municipal sludge having 3.5% of total solids and 72% of volatile solids was used as bacterial consortium source. While the pH of the reactor was maintained at 7.5 ±0.1 using the stock solution of 0.1N of HCL and NaOH solutions. The sCOD, NH_3 and NO_3 of the reactor were monitored by using the standard method of APHA [5].

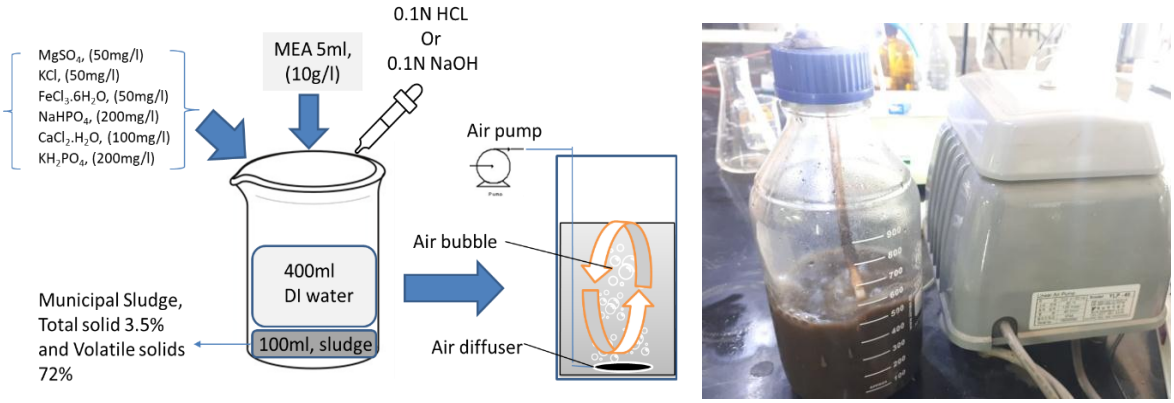

Figure 30: Designing and operation of aerobic fed batch reactor.

Results and Discussion:

MEA was successfully biodegraded by bacterial consortium while the byproduct of MEA was NH_3 which was also nitrified by nitrifying bacteria into NO_3. The initial sCOD was 13,100 mg/L and after 9 days the sCOD was reduced to 730 mg/L as shown in figure (2). NH_3 was formed as the MEA was

degraded into CO_2 and NH_3 in the initial 5 days, but after that NH_3 was also biodegraded by bacteria into NO_3. The calculated conc. of NH_3 in the form of MEA was 2950 mg/L while after the completion of cycle it was just 1300 mg/L. Total NO_3 conc. calculated was 10,030 mg/L while the residual NO_3 was 1700 mg/L and some in the form of residual NH_3. Dry cell weight and Optical density of the reactor was also monitored as shown in figure (3). The pH of the reactor was daily monitored and maintained at 7.5.

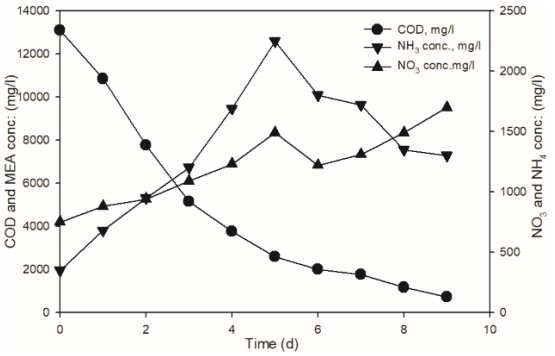

Figure 2: COD, NH_3 and NO_3 conc. with respect to time

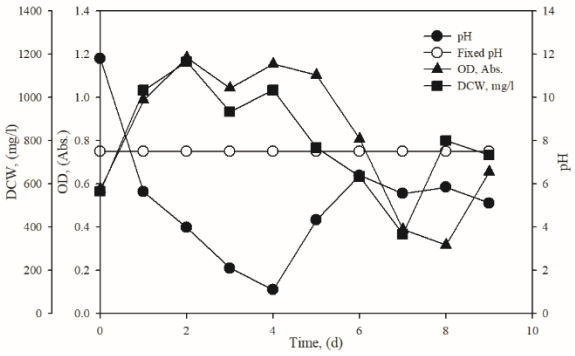

Figure 3: DCW, OD and pH with respect to time

Conclusions

Monoethanolamine was biodegraded by bacterial consortium into CO_2 and NH_3.While the nitrifying bacteria oxidized this NH_3 into NO_3 which was consumed by bacteria as a nitrogen source. In this research, COD was efficiently biodegraded by bacterial consortium and maximum COD removal was achieved 95% but the NH_3 and NO_3 removal was low.

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PRODUCTION OF BIO-METHANE FROM TEXTILE SLUDGE WITH BUFFALO DUNG THROUGH ANAEROBIC CO-DIGESTION USING SAMPTS (SEMI AUTOMATED METHANE POTENTIAL TEST SYSTEM)

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ABSTRACT

In Asia, Pakistan is the 8th largest exporter of textile products. Textile sludge contains heavy metals like Cu, Ni, Hg, and Zn these elements have severe effects on humans and environment. Anaerobic digestion is multi stage process that comprises of Hydrolysis, acidogenesis, acetogenesis and methanogenesis steps. Different ratios were run on BMP (bio methane potential), from textile sludge that is mixed with buffalo dung 100/0, 80/20, 60/40, 40/60, 20/80, 0/100. The ratio of blank sludge has 45.7 ml/ g VS, 80/20 has 49.2 ml/g VS, 60/40 has 58.7 ml/g VS, 40/60 has 25.4 ml/g VS, 20/80 has 82.5 ml/g VS and blank dung has 76.6 NM/L. The optimum ratio of textile sludge and cow dung that has maximum methane yield is 60/40.

Key words: Textile sludge, anaerobic digestion, Methane Generation

Introduction

Globally, due to urbanization and economic growth the demand for textile product is increasing continuously. There are so many problems which is being faced by textile industry [1]. Textile waste water has severe effects in increasing the water pollution. With this waste water ample quantity of textile sludge is discharged, which affect the Eco life system and creates environmental pollution but also causing soil and ground water contamination[2]. Anaerobic digestion is an effective method for obtaining bioenergy in the form of methane from organic wastes [3]. Conventional method of raw biogas comprises of 60% CH_4 and 40% CO_2, water vapor and produces certain amount of hydrogen sulfide [4]

Methodology

Sample of sludge was collected from textile industry Nooriabad. While the buffalo dung was collected from buffalo yard located in Qasimabad, Hyderabad. . The samples textile sludge and cow dung were characterized into elemental and proximate analysis. In pilot scale lab of USPCAS-W cow dung and textile sludge were mixed at different ratios and run on lab instrument known as SAMPTS as shown in figure 1 to see the maximum methane yield. The nitrogen was purged in these ratios to create anaerobic conditions. The readings were recorded on a daily basis.

Figure 1 Semi-Automatic Methane Potential Test System (SAMPTS)

Results and Analysis:

The elemental analysis of textile sludge and cow dung were done by SGS Pakistan private limited Karachi as shown below in table 1. Whereas the Moisture content, total solids, volatile solids and ash content of textile sludge and cow dung were analyzed in Micro wave oven located in water lab USPCAS-W MUET Jamshoro. *Table 1 Ultimate analysis*

Parameters	**Textile sludge**	Cow dung
Carbon	24.52%	36.83%
Nitrogen	1.85 %	2.02%
Oxygen	26.79%	39.95%
Sulphur	1.09%	0.91%
Hydrogen	4.96%	3.99%

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Table 2 Proximate analysis[2]

Parameter	Textile sludge	Cow dung
Moisture content	96.33%	82.21 %
Total solids	3.66%	17.78 %
Volatile solids	73.33%	83.35%
Ash content	26.66%	16.64%

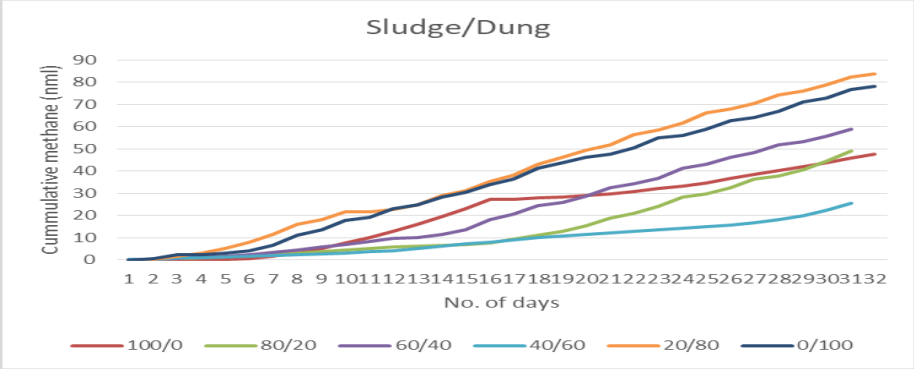

Figure 2 Graphs of Cumulative methane

The figure 2 shows the different ratios cumulative methane generation including blanks of textile sludge and buffalo dung.

Conclusions

Treatment of textile sludge and cow dung by anaerobic co-digestion not only yield maximum methane but also their by product that is bio fertilizer would be used as a compost. Six ratios were made that includes blank dung and sludge. Whereas ratio of 60/40 textile sludge and dung have optimum methane yield.

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EFFECTIVE TREATMENT OF ETHANOL DISTILLERY BIO-METHANATED SPENT WASH /WASTEWATER USING COMBINED PHYSICO-CHEMICAL PROCESS

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ABSTRACT

In this research work, advanced and novel composite materials have been prepared for the treatment of biomethanated wastewater. The characterization of prepared materials was conducted and compared with COD and BOD removal efficiency. Solid waste materials were transformed into porous nature coagulant-adsorbent (hybrid properties). The effects of process parameters such as reaction time, dosage and pH variations were studied and compared with treatment performance. The surface and functional properties of composite materials were characterized. SEM analysis showed that prepared material is porous in nature. Chitosan coagulant could reduce 35% of COD concentration, whereas, activated bagasse fly ash could reduce 52% COD concentration. The composite material exhibited an excellent treatment efficiency and reduced 86% COD at 374 mg/g adsorption capacity. The COD removal efficiency and adsorption capacity improved with increase in material dosage, treatment time and pH at some extent level. Composite material possess good adsorption capacity and removal efficiency.

Keywords: Biomethanated wastewater; Chemical Oxygen Demand; Composite Material.

Introduction

Among chemical process industries, Ethanol Distillery industries/units are the main water consumer in the production of steam, ethanol and biogas. During chemical process, very toxic and non-biodegradable chemicals have been utilized in production of ethanol, biogas and carbon dioxide [1]. Recently, the billion gallons of ethanol is produced from sugarcane and other cellulose materials, which is being utilized in bioethanol production, medicines, and chemical products and so on. These industries use large amounts of water for treatment and cleaning operations, and discharge highly toxic and polluted wastewater into rivers and oceans [2]. For these industries, discarding bio methane wastewater without treatment is a major problem. According to reports, these wastewaters contain high concentrations of chemical oxygen demand, biological oxygen demand, total suspended solids, color, heavy metals and some toxic chemicals, making it typical wastewater [3]. The characteristics of distillery wastewater vary according to molasses quality. Discharge of such highly polluted and organically enriched wastewater in rivers causes environmental pollution and produces allergic diseases. High rate of COD and BOD decrease oxygen demand of aquatic animals and destroy their growth. Normally very serious efforts have been to control the level of COD and BOD as per EPA standard but which is uncontrollable for distillery industries. The main objective of work was to analyze wastewater characteristics of distillery plant and find-out effective treatment methodology (preparation of composite material and hybrid treatment process) under optimization study for the reduction of COD and BOD level as per EPA standards.

Methodology

For the effective treatment of distillery wastewater, following stepwise methodology was implemented such as: Literature Review and distillery plant study (b) analysis of distillery plant wastewater parameters (c) Preparation of composite material from sugarcane bagasse fly ash and chitosan (d) Characterization study of prepared materials (e) Treatment of distillery wastewater with composite materials (f) Effects of process parameters on COD and BOD removal efficiency.

Results

All prepared materials were tested in distillery wastewater treatment. Individual materials (e.g. bagasse fly ash and chitosan) showed poor COD/BOD removal efficiency. When composite material (combination of both materials) was applied in biomethanated wastewater, it gave an excellent removal efficiency for COD and BOD. The process parameters such as reaction time, dosage adsorbent and pH variation were studied and their parametric effects on COD and BOD removal

efficiency were studied in detailed and compared. With increase in reaction time at optimum level, treatment efficiency was recorded. Similarly, with increase of material dosage, COD and BOD removal rate was high whereas, mass transfer limitations were observed at higher dosage. Furthermore, pH variations showed major variations in COD and BOD removal. The treatment efficiency was lower in acidic medium, whereas, higher removal efficiency was recorded at neutral pH value. The composite materials was found more suitable and effective for the reduction of COD and BOD pollutants.

Conclusion

For the effective treatment of wastewater, novel composite materials have been prepared from industries wastes. Chitosan (bio-coagulant) was prepared from fisheries waste using chemical treatment (acid and alkali treatment). Similarly, activated sugarcane bagasse fly ash was prepared through acid-treatment. The composite materials were characterized through SEM and FTIR techniques. SEM analysis showed that prepared material is porous in nature. BET analysis showed that bagasse fly ash contain high surface area and pore volume, which decreased with doping of chitosan. The effects of composite material dosage, treatment time and pH variations on COD removal efficiency have been studied in detail. Chitosan coagulant could reduce 35% of COD concentration, whereas, activated bagasse fly ash could reduce 52% COD concentration. The composite material exhibited an excellent treatment efficiency and reduced 86% COD at 374 mg/g adsorption capacity. The COD removal efficiency and adsorption capacity improved with increase in material dosage, treatment time and pH at some extent level. Optimum process conditions were 15g dosage, 5h treatment time and pH=7. Lower COD reduction rate was observed at lower pH values (3-6). Composite material possess good adsorption capacity and removal efficiency.

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TREATMENT OF FISHERY WASTE THROUGH CHITINASE PRODUCED BY *GLUTAMICIBACTER URATOXYDANS* KIBGE-IB41

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ABSTRACT

The waste generated by marine industry as fishery waste is mainly composed of shells and scales from crustaceans and fishes, respectively. The shells are composed of calcium carbonate, protein and chitin. Chitin is the biopolymer which generate after the processing of sea food. The improper practices of sea food shells processing generates tones of waste which increases the water pollution as the waste rich in protein. Utilization of this crustacean waste is essential as it can produce adverse effects on coastal and marine environment. Chitinases are the enzymes which hydrolyze chitin and are mostly produced by number of bacteria, fungi, plants and animals. Chitinase is utilized in several industries and has wide applications in various biotechnological processes. In the current study, Chitinase was produced by *Glutamicibacter uratoxydans* KIBGE-IB41 after 72 hours of incubation time at 25°C. This was further partially purified using ammonium sulfate 60% and was purified through Sepharose CL-6B column. The further characterization of enzyme revealed that enzyme degrade chitin at low temperature and could be used as potential source for waste water treatment in sea food processing plants.

Key words: *Chitinase, Chitin, Waste water treatment, fishery waste, Characterization of Enzyme*

Introduction

The pollution which is caused by Marine sector is a major problem in recent era. As the number of industries and requirement increases the consumption and generation of sea food products exponentially increases which ultimately damages the environment and ecosystem. The sea food processing plants generates tons of shell waste generated with active compounds including calcium carbonate, protein and chitin. The Chitin is the most abundant biopolymer which believed to be exist on earth crust in second most abundant category. This biopolymer is insoluble and highly resistant to degradation from normal processing. The degradation require consumption of harmful chemicals and enzymes. The chemical treatment of such waste ultimately lead to environmental pollution. In order to reduce the effect of chemical burden on earth crust, enzymatic treatment is the most potential alternative solution. The enzymatic cleavage also generates a lot of important components which could be utilized for increasing the fish immune system, drug delivery system, drug delivery agent, water treatment and also as a fertilizer for the better production of plants [1, 2]. The microorganisms that has potential to synthesize chitin-degrading enzymes are useful for bioremediation and waste management along with the maintenance of biogeochemical cycles by maintaining the carbon, nitrogen cycles in the environment [3]. Many marine microbial strains have chitinase producing ability. In the current study, chitinase producing strain was explored for its ability to hydrolyzed chitin. The enzyme was also explored for its ability to resistant against different environmental stresses in order to determine its potential application in industry.

Methodology

In the current study, the chitinase producing strain was isolated from soil and identified through polyphasic approach which was further used for the production of chitinase through one factor at a time approach. The enzyme was further purified and characterized for determining the potential application of chitinase in waste water treatment (summary of methodology shown in Figure 1).

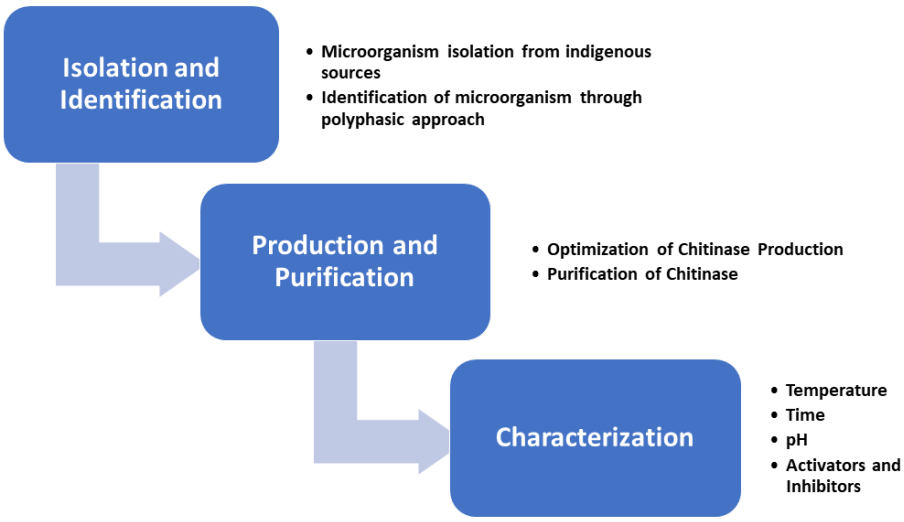

Figure 1: Summary of Methodology

Results and Analysis

In the current study, chitinase producing novel strain was isolated from soil and identified as *Glutamicibacter uratoxydans* KIBGE-IB41. The production of chitinase was optimized and enzyme was purified. The purified enzyme was further used for the characterization purpose. The major application which were determine after enzyme characterization is in waste water treatment as the enzyme functional at low temperature and alkaline pH which support its survival in sea water with different metal ions.

Conclusions

Chitinase producing novel bacterial isolate was identified as *Glutamicibacter uratoxydans* KIBGE-IB41. This bacterium was further used for the production of chitinase. The chitinase was further purified through gel permeation chromatography and was characterized for their potential application in waste water treatment plants.

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MORPHOLOGICAL CHANGES OF INDUS RIVER SECTION FROM SUKKUR TO DADU USING GEOSPATIAL TECHNIQUES

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ABSTRACT

Present study is aimed to analyze various morphological changes of Indus River section form Sukkur to Dadu during 1989 to 2019. The main channel paths are digitized from georeferenced satellite images using a semi-automated GIS analysis which are used for quantification and analysis of fluvial channel parameters such as channel depth, channel width, sinuosity and their derivatives. Under the impact of floods in Indus River, the main channel migration is a paramount characteristic of the Indus River in Sindh. This study illustrates the evidence of active bank erosion, channel migration, degradation of adjacent land and widening of flood plains. The rate of channel migration has been assessed, variation of sinuosity index and radius of curvature have also been calculated from 1989 to 2019. We have summarized these morphological changes per decades, i.e. 1989-1999, 1999-2009, 2009 -2019 which may be helpful to reckon the anthropogenic or natural causes. The assessments of this study highlight a significant message of immense vulnerability of Indus River affecting the agricultural activites and socio-economic growth of the region.

Key words: Spatial Analysis, Indus River, Morphological Changes, GIS, Landsat

Introduction

A river is the natural water channel which develops surface landforms through channel/fluvial processes such as erosion, transportation and sedimentation. River course changes are significant landform changes on the earth surface. Rivers are continually changing its course from its evolutions governed by atmospheric, morphological and anthropological agents. River morphology is explained by channel patterns such as bifurcation or juncture of river and channel forms which controlled by inter dependent factors (river discharge, gravitational gradient, water volume, water velocity, depth and width of channel course, cross section, and river bed materials etc.) due to sedimentation and erosion. The channel migration directly affects the land use and land cover change specifically in the flood plain of the study area.

The Indus river is one of the largest and oldest river of Asia. It originates from higher Himalayas and fall in Arabian Sea, forming modern Indus delta in and around Badin. The total length of the Indus river is about 3,233 Km [1]. Downstream to Kalabagh, the Indus river flows for about 1600 Km, through the plains of Punjab and Sindh. The five major rivers of Punjab i.e. Chenab, Jhelum, Ravi, Beas, and Sutlej carry the sediments flux along with the natural river load drained in Indus river channel at Panjnad. Flowing through the agricultural and densely populated Punjab, these rivers are of great importance to the agricultural productivity of the region [2].

Indus river continues to be braided in its upper course in the plains until it reaches the southern Sindh region where it becomes a meandering stream. Downstream of Mithankot, a number of abandoned courses of the Indus can be recognized. Major avulsions of the river took place well above the deltaic region, preferentially around Kashmore and Sehwan and old courses can be traced toward the Indus delta in the lower Sindh [3,4].

Methodology

The utilization of recent satellite images and GIS-mapping techniques facilitated in mapping and computation of different morphological features. The methodological work flow of this study includes the vector data mapping on satellite images and estimation of river characteristics. We have identified the features in the understudy river section.

Results and Analysis

The results of this study are presented in the form of interpreted satellite images as figures. The quantitative analysis of various features are presented in the Tables and respective graphs. One of the result shows the instabilities, morphological changes of Indus river observed during recent years (Fig. 2).

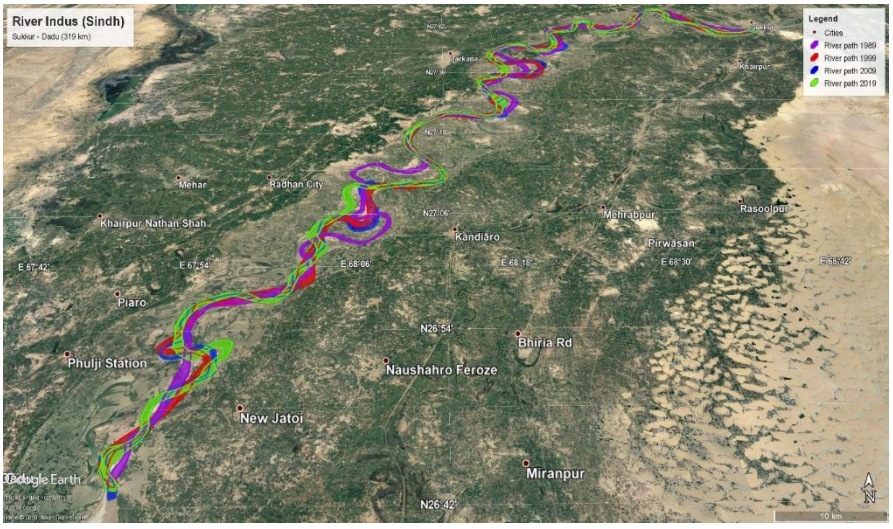

Figure 2: Surface map shows the spatial changes of river paths over 30 years (1989-2019)

Conclusions

Time series analysis suggest that the main river channel (about 255 Km) has undergone migration or shifting its path at different rate during different periods. Lateral shift of the western and eastern margin over 30 years, sand bars depositions, variation of sinuosity of meanders, oxbow lakes formation by channel shifting in the study area are mapped. Down the stream from Sukkur, the presence of loose bank material in the meandering channel cause lateral erosion and the river erodes deposits and migrates for a long distance in east-west direction. However, at some places unchanged / unaltered parts remain during this migration period, which cannot be eroded due to the presence of hard rock and/or natural vegetation cover.

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CHARACTERIZATION OF INDIGENOUS ALGAE FOR MULTIPRODUCT BIOREFINERY; WATER-ENVIRONMENT-ENERGY NEXUS

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ABSTRACT

Cultivation of microalgae/cyanobacteria in city wastewater and the subsequent utilization of the biomass to produce biofuels and other high-value products have remarkable potential to address the problems related to Water-Environment-Energy nexus. The present study was aimed on bioprospecting of the indigenous microalgae and cyanobacteria for multiproduct algal biorefinery using city wastewater as low-cost growth media. Four algal strains *Acaryochloris sp.* BERC03, *Pleurocapsa sp.* BERC04, *Oscillatoria sp*. BERC06, and *Chlamydomonas reinhardtii* BERC07, were characterized for their potential for wastewater cultivation, atmospheric carbon mitigation, and production of biofuels and high-value industrial products. All strains exhibited excellent wastewater cultivation potential and respectively produced 1.9 gL^{-1}, 2.2 gL^{-1}, 1 gL^{-1}, 2.23 gL^{-1}, 1.1 gL^{-1} of biomass (dry basis) with 3.54-4.2 gL^{-1} of CO_2 fixation ability. Moreover, wastewater cultivation improved biomass and lipid production in all strain without having any negative impact on the biodiesel composition. Furthermore, 62.9-95.3 mgg^{-1} of phycobilins were produced by these strains. The results indicated the suitability of wastewater for enhanced biomass production with improved environmental and biotechnological potentials.

Keywords: *microalgae, wastewater, sustainability, biodiesel, high-value bioproducts*

Introduction

Cyanobacteria and microalgae are considered as promising cell factories because of their short cultivation period, valuable metabolite composition (biofuels, pigments, pharmaceuticals, biofertilizers), stress-tolerance mechanism, and environmental mitigation abilities [1]. Despite their tremendous potential they have not been completely explored commercially due to difficult cultivation and economic unfeasibility. Many unicellular and filamentous strains have been cultivated on wastewater to improve their biomass production and the metabolite content. *Pseudanabaena mucicola* produce 0.55 gL^{-1} of biomass along with 237 mgg^{-1} of phycobilin production in aquaculture wastewater [2]. *Oscillatoria* sp. produced two-times higher biomass with significantly improved methane production on diluted nitrate-rich wastewater as compared to the standard cultivation media [3]. These studies indicate the viability of the wastewater as low-cost cultivation media for the high biomass production with desired properties.

Methodology

Algal samples were collected from freshwater and wastewater sites across the Punjab province, identified through morphological and molecular methods. Strains were cultivated in city wastewater, and impact of wastewater cultivation was studied on the biomass productivity, metabolite composition, and biodiesel properties using standard procedures as described previously [4].

Results and Analysis

Impact of wastewater as low-cost media on biomass production

All the strains exhibited excellent potential to utilize wastewater as low-cost media for biomass production. Wastewater-based cultivation of under study cyanobacteria improves the biomass production by

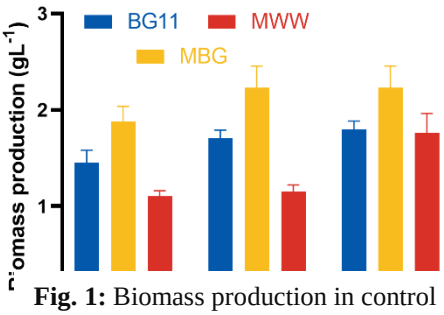

Fig. 1: Biomass production in control (BG11), synthetic wastewater (MBG) and city wastewater (MWW).

1.30-fold, 1.31-fold, and 1.24-fold which respectively corresponds to the final biomass production of 1.88 gL^{-1} for BERC03, and 2.23 gL^{-1} for BEERC04, and BERC06 (Fig. 1). The biomass production also subsequently corresponds to the 3.54 gL^{-1}, and 4.2 gL^{-1} of CO_2 utilization ability of BERC03, BERC04, and BERC06 in wastewater. The results indicate the suitability of the wastewater as low-cost cultivation for cyanobacterial production with the additional environmental benefits. Wastewater cultivation showed an increasing trend in the lipid biosynthesis whereas, carbohydrate and lipids content almost remained same in control and wastewater-cultivated samples (Fig. 2). All the strains produced 26-29% of the carbohydrate with 23-28% of the protein content. The highest protein and carbohydrate production of 0.62 gL^{-1} and 0.63 gL^{-1} was reported in wastewater cultivated BERC06. Maximum lipid content of 43% was produced by BERC04 followed by 41% by BERC06, and 39% by BERC03 in response to wastewater as compared to 35%, 37%, and 35% of respective lipid content of control samples. BERC03, BERC04, and BERC06 respectively produced 0.73 gL^{-1}, 0.96 gL^{-1}, and 0.91 gL^{-1} of lipids. It is demonstrated that wastewater cultivation is feasible approach to improve lipid content without effecting biodiesel quality.

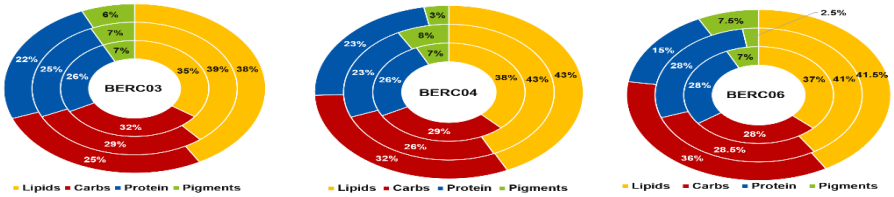

Fig. 2: Impact of cultivation on metabolite production in control (inner ring), synthetic wastewater (middle ring), and city wastewater (the outermost ring)

Impact of wastewater on pigment content

Wastewater cultivation improved the PBP yield of BERC03 from 65 mgg^{-1} to 90 mgg^{-1} and BERC04 from 65.5 mgg^{-1} to 89 mgg^{-1}. While, declining trend was observed for BERC06 where PBP yield was reduced from 95.3 mgg^{-1} to 62.9 mgg^{-1} (Fig. 3).

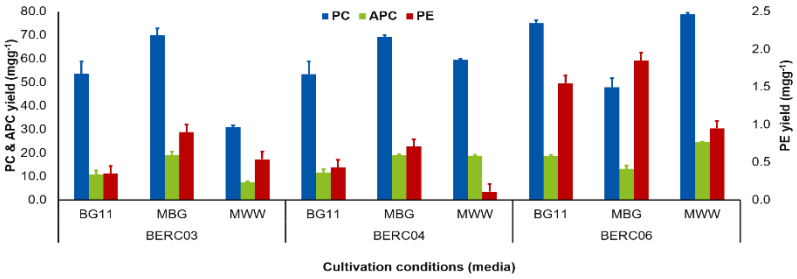

Fig. 3: Impact of wastewater cultivation on pigment production

Conclusions

Our data demonstrated the promising potential of wastewater-cultivated algae to be used as feedstock for multiproduct biorefinery with concomitant pollutant removal, and mitigation of atmospheric carbon.

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CALOTROPIS GIGENTEA MEDIATED GREEN SYNTHESIS OF CR_2O_3 NANOPARTICLES, CHARACTERIZATION AND APPLICATION IN WATER TREATMENT FOR REMOVAL OF MICROBIAL AND ENDOCRINE DISRUPTING CHEMICALS

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ABSTRACT:

Plant mediated Cr_2O_3 (GCO) nanoparticles (85.72nm) were synthesized using room temperature synthesis using ethanolic leaves' extract of Calotropis gigentea. The nanoparticles obtained were characterized using FTIR, SEM/ EDX, AFM and powder XRD. The synthesized GCO were checked for their efficacy towards the removal of Endocrine Disrupting Chemicals and pathogenic bacteria. The results showed high adsorption capacities (296.11, 87.92 and 231.3 mg g^{-1}) for the three contaminants i.e. Direct Yellow 24, Bifenthrin and Dioctyl phthalate, respectively in just 15-20min at room temperature. GCO also showed good bacteriostatic activity and is able to remove 80.9% of the microbes in simulated water samples. Hence, it can be safely concluded that the prepared GCO is a good material for effective treatment of multi-natured organic contaminants as well as microbes without requiring any stringent experimental conditions.

Keywords: Plant mediated synthesis, endocrine disrupting chemicals, microbes, water treatment, adsorption models, kinetic models

Introduction

Provision of clean and quality water is posing major challenges to water treatment technologies. Recent advances hence focus on exploitation of nanomaterials [1,2] to use these materials to for treatment of contaminated water [1]. Metal oxide NPs owing to their better reduction efficacy are used for water treatment. Chromium oxides, exists in various forms and among these Cr_2O_3 is stable one [3] which shows superior properties due to large band gap (~3.4 eV) and p-type semiconducting character [4]. Because of these, Cr_2O_3 showed good activity towards removal of organic pollutants and antimicrobial activities [5]. Hence, the current research is aimed towards synthesis of Cr_2O_3 NPs through plant mediated synthesis using Calotropis gigentea leaves and utilizing these prepared NPs for the effective treatment of multiple contaminants i.e. microbial and endocrine disrupting chemicals.

Methodology

C. gigentea plant leaves were collected, washed with distilled water and shade dried. Ethanolic extract (1L) was prepared by dipping 300g crushed leaves. To the resulting extract, 0.5M ethanolic solution of $CrCl_3.6H_2O$ was added and contents were sonicated at RT for 24h. UV/Vis spectrum (200 to 800nm) was acquired at different time intervals (0-24h) to confirm NPs formation. After that extract was rotary evaporated and thick viscous material hence obtained was sintered at 600^{o}C to result in light green powder.

Results and Analysis

Ethanolic extract of plant leaves of C. Gigentea was employed in essence to exploit its prospective as potential bio-factory for the synthesis of GCO nanoparticles. C. gigentea leaves extract have rich source of active organic compounds which have effect NPs synthesis by acting as good reducing as well as capping /chelating agents. During the course of reaction, reduction of Cr (III) ions to Cr (0) ions takes place as evidenced via UV-vis spectra of the plant extract which clearly shows the decrease

in $CrCl_3$ peak recorded at 664 cm^{-1}. SEM image (Fig. 4a) illustrates the porous nature of material. EDX analysis (Fig. 4b) confirms formation of Cr_2O_3 NPs having experimental percentage (theoretical %) by weight of chromium and oxygen i.e. 65.96 (68.42%) and 25.08 (31.58%), respectively.

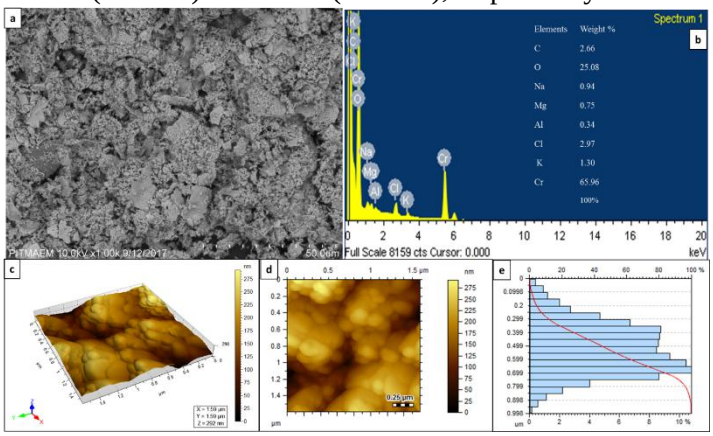

Fig.4. a) SEM image, b) EDX spectra, c) AFM 3D image d) AFM 2D image and e) histogram of Cr_2O_3 NPs

AFM images (Fig. 4) clearly evidence the agglomeration/ cluster formation of the particles resulting in increase in average particle size i.e. 292 µm and broad particle size range. XRD spectrum obtained is in close match with standard reference pattern of Cr_2O_3 (96-901-6610) having Eskolaite phase confirming formation of single phased materials. The particle size as calculated by Debye Scherer Equation comes out to be 85.72nm.

Catalytic activity of NPs towards multiple contaminants i.e. dye (DY), pesticide (BF) and phthalate (DOP) was checked by carrying out adsorption by varying experimental parameters like contact time (t, min), temperature (T, K) and initial dye concentration (C_i, mg L^{-1}) to determine the maximum adsorption conditions. RT studies were carried out to study the effect of contact time between adsorbent (0.1g) and adsorbates (DY, BF and DOP) on adsorption by varying time. The incremental increase in adsorption capacity is observed in all the three cases with time with maxima lying at 20min (43.0mg g^{-1}) for DY, 15min (4.94 mg L^{-1}) for BF and 15min (80.53 mg L^{-1}) for DOP. The decrease in adsorption of the dye by nano-adsorbent (2g/L) from 25°C to 70°C points to the exothermic nature of the process. Adsorption capacity was checked out with various concentrations of DY (100 to 700mg L^{-1}), BF (10-200mg L^{-1}) and DOP (100-400mg L^{-1}) at 25°C and neutral pH with 0.1g nano-adsorbent. For all the three cases, incremental increase in q_t (mg g^{-1}) with escalating concentration was observed till it achieves the equilibrium at 600, 150 and 300 mg L^{-1} for DY, BF and DOP, respectively. The antimicrobial potential of GCO NPs was checked using S. aureus as test contaminant. Appreciable % reduction of cell i.e. 80.9%. was observed at 110min.

Conclusions

Simple and RT synthesis of single phased Cr_2O_3 nanoparticles was achieved by using Calotropis gigentea ethanolic leaves extract. The prepared NPs were found effective for water treatment applications to remove multiple natured contaminants i.e. direct yellow 24 dye, BF, DOP and S. aureus microbes.

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A LOW COST AND EFFECTIVE BIOSORBENT FOR REMOVAL OF METHYLENE BLUE FROM AQUOUS SOLUTIONS

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ABSTRACT

The presence of toxic chemicals for example dyes, in industrial waste water pose alarming threats to human beings and other aquatic species. Hence, the search of low cost materials for exclusion of toxic chemicals from water is highly desirable. In the present study, Viburnum grandiflorum (VG) leaves powder has been applied for effective removal of Methylene Blue (MB) from aqueous solutions. Effect of different parameters including contact time (10-100 minutes), temperature (293-323 K), pH (4-13), initial concentration (5-25 mgL^{-1}) and biosorbent dosage (150-450 mg) was investigated. Maximum adsorption capacity and removal efficiency were calculated as 7.96 mgg^{-1} and 95.59%, respectively for the sample (initial concentration = 25 mgL^{-1}, adsorbent amount = 450 mg, agitation time = 60 minutes, T= 298 K, pH = 9). With optimized conditions, percentage efficiency and dye uptake capacity (base modified VG leaves) was obtained as 98% and 8.25mgg^{-1}, respectively. Isotherm models (Freundlich , Langmuir and Temkin) were applied and observed data were found in close agreement with Langmuir adsorption isotherm (R^2 = 0.99). The adsorption kinetic models (pseudo-first/second-order and Elovich) were also applied for adsorption studies. The obtained data best fitted with pseudo-second-order model (R2 = 0.99). Nature of adsorption was predicted by enthalpy (ΔH°), entropy (ΔS°) and free energy (ΔG°) changes. Low ΔG° values (-23.212, -21.664 and -17.417 $kJmol^{-1}$) 323, 303, and 313 K, respectively, indicated the spontaneous nature of the process. 0.1 M HCl was found the best desorbing (25.78%) agent.

Key words: Viburnum grandiflourm, Methylene Blue, Adsorption, Biosorbent.

Introduction

The environmental pollution is the ever increasing problem that is faced by modern human societies and the magnitude of this problem is increasing tremendously due to increase in human population and changes in life styles. Water is the most important compound on this planet and has countless uses. The contamination of surface water is more severe to life because this water is exposed to human/animal use and is the habitat to large number of organisms. Such a contamination of surface water is alarming globally and in the context of Pakistan, this contamination is the most severe as our country is categorized as a water stressed country. Hence, this is the most urgent call of the time to understand the quality of water around us and in case of water pollution; we should put all possible efforts and resources to combat this menace. The monitoring of waste water from industries is important. Also the methods, procedures, materials and technologies for the treatment of waste water are highly desirable. Water pollution is major continuously increasing environmental pollution as a consequence of different anthropogenic activities for example domestic sewage, different types of industrial wastes, agricultural and urban runoff containing fertilizers and heavy metals. In industries, the dyes are used for different purposes and industrial wastewater contains elevated levels of different dyes such as methylene blue [1]. Methylene blue (MB) dye is water soluble and is mostly employed for dyeing leather, cotton, lithography and tannin [2]. This dye causes several health complications in humans [3]. Hence, it becomes imperative to remove this dye from waste water. The adsorption process is an appropriate method on account of the simple experimental setup and capability to remove dyes from polluted water.

Methodology

The VG leaves were washed gently using distilled water, dried at room temperature, properly crushed and converted into fine powder by electric grinder and passed over micro-sieves. The characterization of the adsorbent was carried out using FTIR, SEM and TG analysis. Batch adsorption was studied by adding leaves powder (150 mg) in dye solution (50 mL) in 3 conical flasks (0.25 L each). The flasks

were subjected to heating at 323, 313, 303 and 293 K. After filtration of the resultant mixture, the filtrates' absorbance was measured by UV-Visible spectrophotometer. The effects of different parameters (pH, contact time, temperature and adsorbent dosage) were also studied. Molar solutions (HCl, NaOH, KCl) and distilled H_2O were used for desorption studies.

Results and Analysis

Effect of Contact Time

With increasing contact time, adsorption capacity also increased (0.95-7.96) mgg^{-1}.

Effect of varying initial concentration

On increasing MB concentration (5-25 mg/L), adsorption capacity (0.95-9.98 mgg^{-1}) and removal efficiency (55.73-95.59%) were also increased.

Effect of pH

The maximum dye removal efficiency (97.81 %) was established at pH = 9. Plausibly, such a phenomenon was observed as a result of increased attractive forces between the cationic charges on dye (MB) and negatively charged ions present on adsorbent surface. Higher pH is favorable for increasing negative charge on powdered leaves surfaces.

Effect of Temperature

Adsorption capacity (5.29-7.96 mgg^{-1}) and removal efficiency (79.37-96.73%) increased with increasing temperature (293-323 K) and its maximum value was attained at 313 K.

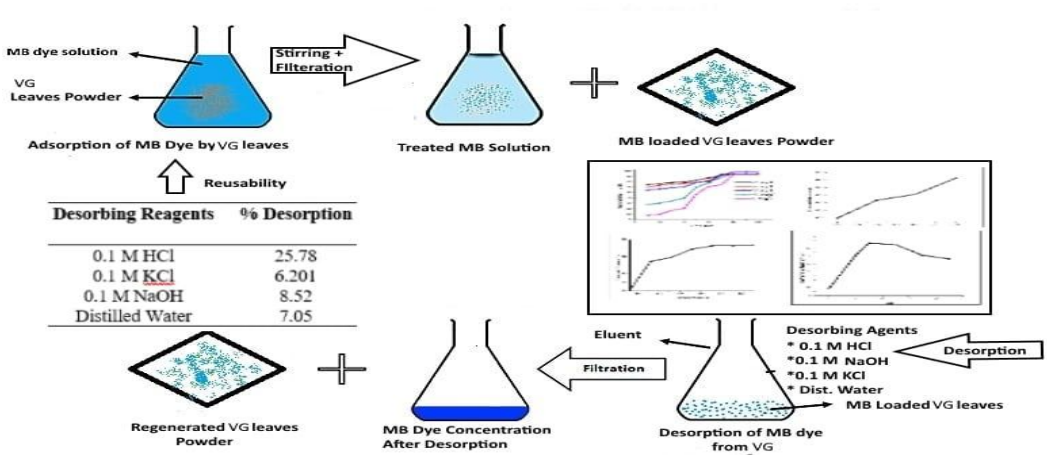

Figure 1. Graphical representation of experiments and important results.

Conclusions

VG leaves powder could be effectively used for MB removal from its aqueous solutions. The morphological studies indicated the proper adsorption of MB on leaves powder. Dye uptake capacity was notably dependent on biosorbent dose. In contrary, increase in contact time, temperature, pH and dye concentration resulted an increase in adsorption capacity. The rate of adsorption was compatible with pseudo-second-order kinetics. The present study could be extended to practical applications for treatment of waste water coming from dying and coloring industries.

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ENVIRONMENTAL POLLUTION FROM WASTE BURNING AT LOW TEMPERATURE AND ITS IMPACTS ON AIR QUALITY

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ABSTRACT

Waste management is one of the major and most significant issue in this modern era with suitable from collection to its final disposal. In developing countries open burning of different types of waste creates toxic gases which goes into atmosphere. Concentration of toxic gases in atmosphere creates air pollution and effects on climate system. When waste is burned in open atmosphere without any controlled temperature it produces more toxic gases in atmosphere which creates air pollution and effects on air quality. Different types of waste management are used to control emissions at its sources. Carbon Dioxide CO_2 is the major source of emission which also increases the earth surface temperature. Concentration of different gases from burning of wastes can be reduces at its sources for improving the air quality. Global warming is one of the major environmental issues which effects on air quality as well as oceans. In this research, major the concentration of toxic gases and their humidity with moisture at low and regular burning temperature was observed with Testo 350 flue Gas Analyzer. It was observed that emissions of toxic gases emits more at usual temperature with waste material as compared to waste management equipment. The results were about 97-99% accurate as compared to waste management technologies. Thus these toxic gases go into atmosphere and create a variety of environmental effects.

Key words: combustible fraction, acid gases, harmful emissions.

Introduction

Different types of pollution come from unusual sources and effects on environment. Waste comes from different sources but there are four core forms of air pollution sources including natural causes for instance windblown dust, volcanoes and wild fires stationary sources for example oil refineries, power plants, factories and industrial facilities, area sources like cities, agriculture areas and wood burning fireplaces, mobile sources – such as buses, cars, planes, trucks, and trains, area sources such as cities, agricultural areas and wood burning fireplaces in cities and villages. Each and every day, many tones of solid waste including municipal solid waste is mainly disposed of at different suitable landfill sites. These types of toxic waste derives from houses, offices, large industries and various other farming and agriculture related activities. These different disposal areas create bad smell if solid and liquid waste is not kept and stored at appropriate site and treated in correct way. It can contaminate the surrounding fresh atmospheric air and can seriously influence the health, our environment, humans, ecosystem and wildlife. The vital sources of solid waste are: Treatment Plants and Sites: Heavy and light manufacturing plants also produce solid waste. They include different refineries, different processing plants, solid mineral extraction plants, large power plants and chemicals plants. Among the different wastes produced by these types of plants contain, unwanted specification products, plastics, industrial process wastes, metal parts just to mention in knowledge but a few and depend upon source of generation. Biomedical waste: This refers to biomedical equipment and hospitals and different chemical manufacturing companies. In private and government hospitals there are many different categories of solid wastes generated. Some of these inorganic and organic solid wastes include patients bandages, drugs, used gloves, paper, food waste, syringes, plastics and chemicals. All these require highly proper disposal or else they will create a huge problem to the environment and the residents people in these facilities. Residential: Residences and houses where

normally people live are some of the main sources of solid waste. Garbage or household waste from these places include food wastes, cardboard, paper, glass, plastics, leather, metals, yard wastes, ashes and special wastes like huge household items like electronics, tires, batteries, old mattresses and used oil. Most homes have garbage containers where they can throw away their solid wastes in and later the bin is emptied by a garbage collecting company or person for further treatment. Commercial: Commercial: Commercial facilities, shopping centres, Healthcare centres and buildings are yet another source of solid waste today. Many commercial buildings and facilities in this case refer to markets, go downs, hotels, restaurants, stores and office work buildings. Some of the solid wastes generated from these places include large amount of plastics, cardboard materials, metals, paper, food wastes, glass, wood, special wastes and other hazardous wastes. Industrial: Industries are known to be one of the biggest contributors of solid waste. They comprise light material and heavy manufacturing industries, fabrication plants, construction sites, canning plants, chemical and power plants. These heavy industries produce solid waste in form of packaging wastes, ashes, special wastes, housekeeping wastes, food wastes, construction and demolition materials, medical waste as well as other hazardous wastes every time. Institutional: The institutional centers like different both private and government schools, colleges, military barracks, prisons and other government centers also produce organic and inorganic solid waste. Some of the common solid wastes obtained from these known places include glass, plastic waste, rubber waste, paper, cardboard materials, food wastes, metals, wood, electronic waste as well as various harmful hazardous waste types. Municipal services: The urban centers furthermore contribute enormously to the solid waste crisis in most countries nowadays. Some of the solid waste brought about by the municipal services consist of street waste and debris cleaning, landscaping wastes, wastewater treatment plants, wastes from parks and beaches and wastes from recreational areas including sludge and semi solid waste**.** Construction and Demolition Areas of different sites: Construction sites means construction of building or any other project, demolition and destruction locations also contribute to the main solid waste problems. In only China the emissions of PM10 from domestic waste burning is equal to 22% and these were mentioned in a report with anthropogenic PM10 emissions which were in high concentration [1]. Construction sites include new construction and repair sites for buildings and roads, road repair sites, building renovation sites and building demolition sites. Some of the solid wastes formed in these types of places including steel materials, plastics, rubber, metal copper wires, concrete, wood material, dirt and glass.

Literature Review

A large number of data collected from different sources with composition of waste, the chemical composition of solid waste and major effects of poor solid waste management at different sites with emission effects.

Conclusion and Important Scope of Future Work

In this research paper, a new and deep research was taken and it was observed that when municipal solid waste, hazardous waste and hospital waste is burned in open atmosphere it results more concentration of gases. It is also observed that when temperature is increases in incineration technology it also burns emissions gas which results less emission of gases into atmosphere. When gases from burning waste goes in atmosphere at very low temperature means without using incineration or other technology it creates large number of gases and creates a very large amount of environmental pollution. It results acid rain and air pollution at every place.

In many countries waste is burned in open atmosphere without using latest environmentally friendly technology and it is a serious problem. Using incineration technology for solid waste it creates very less amount of gases because most of the gases burns in second chamber of incinerator with high temperature which reaches at 1000 ºC to 1350 ºC. Using advanced technology equipment's and research will create less health concern diseases, acid rain and effects on ecosystem and wildlife which are created from air pollution in many countries. Smoke and fine particulate from incinerator and other equipment emits in very less amount of toxic gases. In future there should be ban on opening burning, rigid and strict policies should be created and there should be fine on opening burning and this will leads everyone towards sustainable environment and sustainable future.

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DEVELOPMENT OF COMPOSITE BY USING MICRO-CAPSULE FOR SELF HEALING APPLICATIONS

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ABSTRACT

The self-healing ability in polymers and composites make them classify in smart materials. Epoxy is a thermoset having functional group epoxide and is commonly used worldwide. Graphite is one of the allotropic forms of Carbon. Self-healing is the ability to heal itself upon any damage by any sort of accident. Following microencapsulation, developing the composites has self-healing ability in epoxy polymers and epoxy/graphite. The micro-sized capsules are synthesized and embedded in the polymers and composites during casting. Emulsion and Precursor are prepared first and reacted together with a series of treatments to synthesize the microcapsules. Different tests that include the tensile test, shore hardness test, density test, and TGA analyzed. The composite contain epoxy with 2% capsules and 2% capsules along with 5% Graphite powder. Due to microcapsule Mechanical and thermal properties of the materials affected, the thermal properties have shown resemblance in case of self-healing polymer with the regular polymer.

Key words *Self-Healing, Composite, Micro capsules, Polymer, Graphite, TGA.*

Introduction

The epoxy matrix composites are usually used in structural applications that are likely to be damaged on both microscopic and macroscopic level because of its brittle nature [1-3]. Epoxy has a multipurpose usage in the industries and has been used for several years [4]. In the recent years, the Epoxy based composites has been favored over simple Epoxy. The main reason is that the Epoxy matrix in the composite has improved mechanical properties, thermal resistant, relatively low density, better adhesion and good electrical resistance [5, 6]. Epoxy based composites are better friction resistant and do not need any peripheral lubricants [7]. They are used in space
applications because of its high strength to weight ratio [8]. The self-healing ability in polymers and composites make them classify in smart materials. The self-healing ability in materials has led the world to reach heights which were once regarded as beyond the limits[9, 10]. The self-healing ability in polymers and composites make them classify in smart materials. The self-healing ability in materials has led the world to reach heights which were once regarded as beyond the limits. In this present work the self-healing modern materials was developed that can automatically heal the cracked composite material.[11]

Methodology

The materials employed in the synthesis of the self-healing polymers and composites include Epoxy Resin and Hardener, 37wt% Methanal H-CHO, Urea $CO(NH_2)_2$, Sodium Hydroxide NaOH, Sodium Polyacrylate $[-CH2-CH(CO_2Na)-]_n$, Resorcinol $C_6H_6O_2$, Sodium Chloride NaCl, Polyvinyl Alcohol $[-CH_2CH(OH)-]_n$, and Hydrochloric Acid HCl, Graphite, Distilled Water, Grease, PVC Wiring Ducts, and Duct Tape. A solution of 10% Sodium Hydroxide was initially prepared by dissolving the crystals of caustic soda in distilled water in a beaker. Sodium Hydroxide solution was prepared for adjusting the pH of the later solution. The emulsion was prepared simultaneously with the formation of precursor. The obtained precursor and emulsion were reacted together in a beaker. The graphite rods were crushed to obtain the graphite powder. Four different materials of different recipes were synthesized. Two of them were simple polymer and self-healing polymer. While the other two were simple composite and self-healing composite. After successfully synthesized the polymer composite it was characterizing by using, hardness tester, tensile testing, and differential scanning calorimetry.

Conclusions

Self-healing advanced composite was developed successfully on the laboratory scale. The testing was performed as per standards and results were verified. Composite successfully operating the Self-healing mechanism on working with Resin and Hardener, and described above chemicals and waste substances as the Production of Microcapsules, the analysis is done through the different characterization techniques performed as per ASTM standards such as Universal Tensile Testing, Rockwell hardness, DSC[12] along with TGA, Stereo Microscopy, and Optical Microscopy Microencapsulation method for generating the self-healing capability is easy and economical.[13, 14] The synthesized self-healing polymers and composites have found to have similar properties than the regular ones. Characteristics present the comparison between the thermal and mechanical behavior of self-healing polymer with the regular polymer. There have been slight deviations in case of self-healing composite with the regular composite [15]. The mechanical properties are affected by the introduction of soft microcapsules. But those properties are well inside the limits required for the different application.

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AIR QUALITY MONITORING - AN ARDUINO BASED REAL TIME APPROACH

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ABSTRACT

The increased deterioration in the ambient air quality index of the major cities of Pakistan warrants immediate actions to be implemented through an integrated approach by all the stake holders to prevent climate changes, safeguard public health, and to avoid international sanctions. Effective control measures are only possible through religious implementation of the regulations that are developed after deliberate planning using detailed data on the subject recorded using modern real-time monitoring methods. The existing data is sporadic and is insufficient to design and develop an effective policy and regulations, and may be considered non-existent to scientifically monitor the implementation of the regulations. Modern cost effective and real time solutions are required to increase the capacity of the country to collect and analyze data on ambient air quality from carefully selected multiple locations of the cities such as all type of industrial activity zones, city centers, smog zones, stationary sources of pollution, along roads etc. The paper presents the architecture of an affordable Arduino based sensor system for this purpose. The data will be available anywhere in a/are control rooms on a mobile or stationary system for analysis/monitoring to realize predictive forecasting, formulation of control strategy and policies, and effective monitoring mechanism.

Key words: Arduino; air quality monitoring; low-cost; real-time

Introduction

Air pollution is one of the growing environmental problem [1] in almost all the major cities of the world and Pakistan specifically due to inhibited motorization [2], urbanization [3], unregulated industrial emissions [4], and deforestation [5]. The worst hit cities include, Karachi, Lahore, Faisalabad, and Peshawar. Air pollution amongst many other effects has generally resulted in climate change, smog, and various health issues (commonly different types of respiratory diseases). The data of the World Health Organization (WHO) shows that 22000 premature adult deaths are caused every year due to air pollution in Pakistan [6]. The government of Pakistan has though, over the years, shown concerns about this threat, but has generally failed to take practical measures and allocate /ensure provision requisite budget [7]. The quality of air is generally monitored/scaled using the Air Quality Index (AQI) [8] with a value ranging from 0, for good, to 500, the worst.

The data is collected using instruments installed on site and also using satellites such as Geostationary Operational Environmental Satellites-R (GOES-R) and Joint Polar Satellite System (JPSS). The value of AQI as on 19 Jan 2021 at 1300 hours is given below for major cities of Pakistan [13] are 295, 197 [14], 207, 125, and 152 [15] for Faisalabad, Lahore, Islamabad, Multan, and Karachi, respectively. This study presents architecture of reliable, accurate, cost-effective, efficient Arduino based sensor node system for the air quality monitoring, and assessment and prediction. Such sensor node can be installed at multiple locations to collect air quality data from a city. The data will be available at any locations on a mobile or stationary system for analysis and monitoring. Key contributions of this study will be:

1. Arduino based monitoring of Air quality in the major cities of Pakistan.
2. AI based data analysis to predict pollution
3. AI based intelligent traffic control of city depending upon the concentration of gases

Methodology

This study puts forward a novel and cost-effective Arduino based framework for an ambient air quality monitoring and real time information sharing platform. In this framework, Internet of Things (IoT) and Arduino will be integrated on characteristics layer such as i) perception layer, ii) network layer, data management layer, and information sharing layer. Complete architecture for this study is shown in the Figure 1.

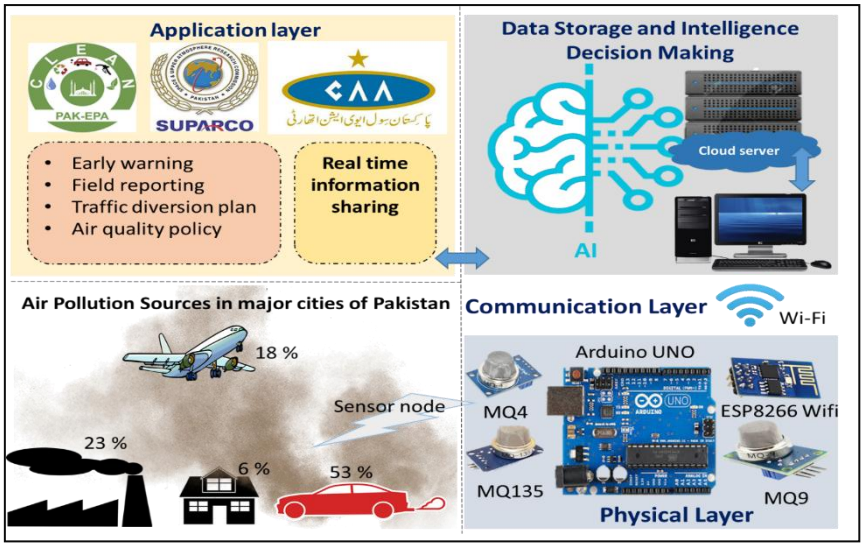

Figure 31: Complete architecture of proposed system

Implementation Plan

The implementation plan for the installation of the proposed system to achieve maximum benefits is shown in Figure 2 and appended below:-

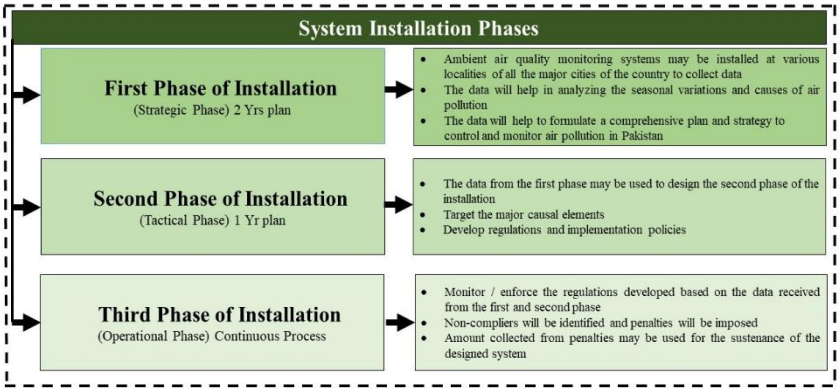

Figure 2 Implementation plan of the proposed system

Conclusions

The uncontrolled deterioration of air quality in Pakistan has though been recognized as a serious problem by the Government and various other organizations, but little work has been done in this regard. No comprehensive air quality legislation exists in the country and the implementation of whatever regulations exists is hindered due to the lack of basic air quality management capacity. The development of the architecture of a real time Arduino based easy to use and install ambient air quality information monitoring and sharing platform, presented in this paper, is a step forward to control the deterioration of air quality in Pakistan.

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ADSORPTION OF SULFUR DIOXIDE USING COBALT BASED ZIF MATERIAL: SYNTHESIS, CHARACTERIZATION, AND APPLICATION STUDY

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ABSTRACT

Sulfur dioxide evolving from usage of fossil fuels and industrial processes, is an ultimatum for human health and environment. In this study, synthesis of a series of Co-ZIF and bimetallic M-Co-ZIF (M = La, Ni, Mg, Zr) adsorbents synthesized (using solvothermal method) at room temperature, using water as a solvent and applied for adsorption of SO_2 at room temperature and atmospheric pressure is reported. The parent (Co-ZIF) and bimetallic ZIF materials (M-Co-ZIF) were characterized by XRD, FTIR, SEM, and N_2 adsorption/desorption., The XRD results confirms the formation of pure phase highly crystalline ZIF materials, similarly rhombohedral morphology was observed using SEM analysis while BET analysis provided high surface area of prepared adsorbents., the adsorption capacities and breakthrough points for modified bimetallic M-Co-ZIF were found to be relatively higher than parent Co-ZIF. Notably, A high SO_2 uptake capacity of 6.95 mmol/g for Zr-Co-ZIF which was higher than CO-ZIF having capacity of 2.7 mmol/g. Finally, the results of dynamic adsorption combined with characterization shows great potential for application of bimetallic ZIF adsorbents for effective SO_2 adsorption.

Keywords: *SO_2 removal, Gas adsorption, Co-ZIFs, Solvothermal, Breakthrough curves*

Introduction

Excessive energy, which involves the wide use of low-grade coal and fuels, is being consumed by ever-growing population and economy. Sulfur dioxide (SO_2) resulted by the burning of fossil fuels is urgent warning to global environment and human health [1]. Various strategies to capture SO_2 have been developed. Such as absorption, chemical/physical adsorption, membranes, cryogenics, amines solvent based absorption and scrubbing of flue gas [2]. But adsorption is the most approved and economical strategy to capture sulfur dioxide by using selective adsorbents. In order to capture SO_2 from gaseous streams adsorption is one of the most viable and widely sued technique [3]. Solid adsorption depends on Selection of suitable adsorbent and Zeolitic Imidazolate Frameworks (ZIFs) show excellent capability for the capture and particular separation of an extensive range of gases, by adsorption. Zeolitic imidazolate frameworks (ZIFs) as a category of Metal Organic Frameworks (MOFs) are zeolites isomorphs assembled by coordinated bonds of metal ions and imidazolate linkers to construct a three-dimensional porous compound [4].

Methodology

Weighed amounts of metal salts and imidazolate linker were dissolved in distilled water separately. Both solutions were mixed and stirred for 6 h. ZIF crystals were collected by centrifugation, washed with water and dried in vacuum oven overnight. The synthesized samples were characterized through X-ray diffraction (XRD), Scanning electron microscopy (SEM), Energy dispersive x-ray spectroscopy (EDX) and Fourier transform infrared spectrometer (FTIR). Later, all adsorbents were tested for sulfur dioxide adsorption in a fixed bed apparatus. The breakthrough curves for the

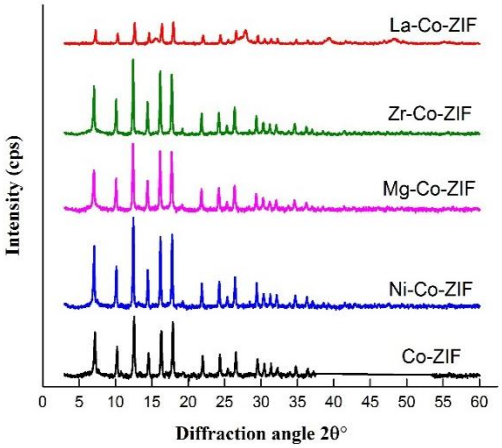

Figure 32. XRD of ZIFs

adsorption of sulfur dioxide (initial conc 100 ppm) on Co-ZIF and M-Co-ZIF were obtained experimentally using a laboratory scale fixed bed column at room temperature with a gas flow rate of 20 L/h.

Result and discussionsThe phase and crystallographic structures of prepared samples were observed by XRD. Sharp peaks at lower diffraction angles confirmed synthesis of ZIF nanocrystals. Major characteristics peaks with respective planes were observed at 8° = 011, 10.1° = 002, 13° = 112, 15° = 022 in XRD patterns as shown in Figure.1. Surface morphology and rhombohedral shape of crystals were observed by SEM and elements present in ZIF crystals were identified through EDX.
To evaluate the feasibility of prepared Co-ZIF and M-Co-ZIFs for the adsorption of SO_2 real-time dynamic breakthrough experiments were conducted and breakthrough curves are represented in Figure.2. Among these prepared samples, the maximum SO_2 adsorption capacity (6.95 mmol/g) and exhaustion time (352 min) was observed for Zr-Co-ZIF.

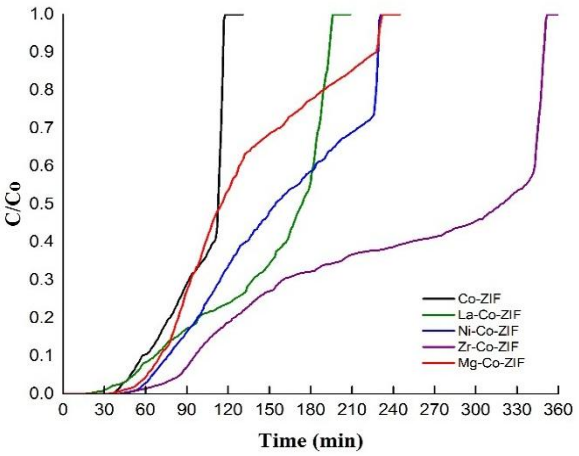

Figure 33 Breakthrough curves of synthesized ZIFs

Conclusion

Co-ZIF and M-Co-ZIF were successfully prepared at room temperature and confirmed by XRD results. Improvement in uptake capacities and breakthrough time was observed for bimetallic Co-ZIF and Highest sulfur dioxide uptake capacity 6.95 mmol/g was observed for Zr-Co-ZIF.

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INFLUENCE OF WATER QUALITY ON STABILITY OF HYDROCHLOROTHIAZIDE DETECTED IN DRINKING AND ENVIRONMENTAL WATER: EXPERIMENTAL AND COMPUTATIONAL ANALYSIS

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ABSTRACT

This work combined experimental and computational analysis to investigate the stability and reactivity of diuretic pharmaceutical hydrochlorothiazide (HCTZ) detected in drinking and environmental waters. The HCTZ hydrolysis and photolysis were investigated in ultrapure and three different environmental waters, at (5±1) °C and (25±1) °C in the dark and under simulated solar irradiation (SSI). The experiments of hydroxyl radical neutralization of investigated samples show that HCTZ has significant interaction with •OH radicals. Accordingly, the efficiency of indirect photolysis HCTZ (H_2O_2/SSI and H_2O_2/UV) was investigated as a possibility for efficient removal from environmental water. The degree of mineralization was determined after direct and indirect photolysis.

Key words: Organic pollutants, Hydroxyl radical neutralization, DFT calculations

Introduction

Active components of pharmaceuticals are widely used in the treatment of diseases for both humans and animals. A significant number of them and their metabolites are excreted unchanged through urine and feces, which reach environmental water due to the inefficiency of processes used in the sewage treatment plants. Many pharmaceuticals are bio-accumulated and persistent in the environment in the concentration ranges of ng/L to mg/L. Hydrochlorothiazide (HCTZ) is a frequently used diuretic and one of the most ubiquitous contaminants in environmental waters. Petrović et al. detected HCTZ in the Republic of Serbia in drinking water, the Danube river, canal water, and municipal wastewater [1]. Therefore, it is very important to find an efficient way to remove organic pollutants from environmental waters by analyzing their reactivity with •OH radicals, as the most efficient ecological way of decomposing organic pollutants [2].

According to the literature, systematic investigation of stability and reactivity of HCTZ in environmental water (Danube river, and Danube-Tisa-Danube canal (DTD), from Novi Sad, Republic of Serbia), tap water, and ultrapure water (UPW) under SSI wasn't performed. In this work, the influence of water quality on processes of hydrolysis and photolysis of HCTZ were analyzed in detail. Also, the results of the degree of •OH radical neutralization in the environmental waters were compared with the UPW. Density functional theory (DFT) has been performed for the investigation of reactive properties of HCTZ with •OH radical. One of the main parts of the present study was the investigation of indirect degradation of HCTZ with H_2O_2 under SSI and UV irradiation. During the processes of hydrolysis, photolysis, and indirect photolysis, 4-amino-6-chlorobenzene-1,3-disulfonamide (ABSA) was observed as the main product of HCTZ degradation. To analyze the degree of mineralization after 180 min of direct and indirect photolysis, a chemical oxygen demand (COD) was determined.

Methodology

Besides the UPW, other water samples used were the Danube river, DTD, and tap water from Novi Sad. All water samples were taken in August 2020, in or near Novi Sad. After sampling natural water,

to avoid microbial degradation, natural water was sterilized by filtration, and all glassware was sterilized by autoclaving for 30 min at 140 °C. The following water characteristics were determined: total and carbonate hardness, iron and chloride contents, conductivity, COD, and pH values. Hydrolysis of 0.05 mM HCTZ solution was carried out in the dark in a volumetric flask. Experiments were performed at (5±1) °C and (25±1) °C. Direct and indirect photolysis under SSI and UV irradiation were carried out in a cell made of Pyrex glass. Kinetics of HCTZ and ABSA were monitored with Ultra Fast Liquid Chromatography with Diode Array Detection. The retention time for HCTZ was (5.9±0.1) min, and for ABSA was (5.1±0.1) min. Degree of hydroxyl radicals neutralization obtained by Fenton's reaction was measured as the ability of hydroxyl radicals to induce lipid peroxidation of liposomal unsaturated fatty acids, followed by formation of colored adduct between malonyldialdehyde and thiobarbituric acid at 532 nm [3].
All DFT simulations were performed using the Jaguar 9.4 program as implemented in the Schrödinger Materials Science Suite 2020.
Results and Analysis
The hydrolysis of HCTZ starts immediately and the peak of ABSA was detected in all samples after dissolution after just one day. The temperature didn't have an important influence on the process. Moreover, water content and pH value were much significant in all investigated processes. All investigated processes were faster in samples of environmental waters. To suggest an effective method for HCTZ and ABSA removal, hydroxyl radical neutralization efficiency was investigated. The results showed that environmental waters exerted a higher degree of hydroxyl radical neutralization in comparison to UPW. An additional increase of the neutralization was noticed in the presence of HCTZ, whereby the most noticeable increase was in the UPW, around 20%, while in the natural waters this increase went from 1% in the Danube's water up to 13% in the DTD's water. These results have focused research to the examination of indirect photolysis in the presence of H_2O_2/SSI or H_2O_2/UV as a process with significant influence of $^{\bullet}OH$ radicals on the stability of HCTZ. The degradation efficiency of HCTZ was higher in the presence of H_2O_2 under UV irradiation. After degradation, the COD results were analyzed, which indicated that the mineralization process is slower compared to the degradation kinetics of the starting compound. To explain why HCTZ hydrolysis is fast, which is not usual for pharmaceuticals, and its reactivity with $^{\bullet}OH$ radical, DFT calculations have been applied. Computational investigation enabled understanding the influence of changes in the structure of HCTZ in the presence of radicals. Also, the results of polar surface areas and p*K* values of HCTZ explain why degradation is faster in environmental water comparing to the UPW.

Conclusions
The results indicate that HCTZ is subjected to hydrolysis in a short time and transforms to ABSA. However, HCTZ was detected in environmental and tap water, which indicates its accumulation in the environment. Based on obtained results, it can be concluded that water quality is essential for the stability of investigated compounds in the environment. An effective way to remove HCTZ from water samples has been proposed based on nontoxic and economic principles.

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DEGRADATION OF ATRAZINE HERBICIDE FROM WATER BY TITANIUM NANO-PARTICLES

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ABSTRACT

As an agricultural country, Pakistan is one of the largest consumer of atrazine herbicide. But as a main ingredient for agricultural, Atrazine also have some negative environmental impacts. In this research atrazine herbicide is detected and degraded by photocatalysis. Continuous flow photocatalytic reactor is designed for the maximum mass transfer. In this research, TiO_2 Nano-particles were prepared from TiO_2 micro size powder by sol-gel technique. Obtained Nano-particles where characterized by SEM, UV, XRD. Degradation results indicate that the activity of TiO_2 as a catalysis gives efficient and fast degradation even at ppb level.

Key words: Atrazine, Titanium Nano-particle, photocatalysis

Introduction

With the advancement of modern agricultural technology, pesticides have come out to be the most vital component in order to control and prevent pests, diseases, weeds and various types of pathogens to limit the loss in yields and keeping the quality of product maintained [1]. Around 2.5 million tons of pesticides is estimated that is being used and its use is increasing [2].

The targeted pesticide is Atrazine, which is among the class of s-triazine herbicides Atrazine is very toxic compound having structure (2-chloro-4-ethylamino-6-isopropylamino-s-tri-azine) which inhabit the growth of susceptible weed species by inhibition of photosynthesis [3]. In this study atrazine is degraded by photocatalysis using titanium nano-particles.

Methodology

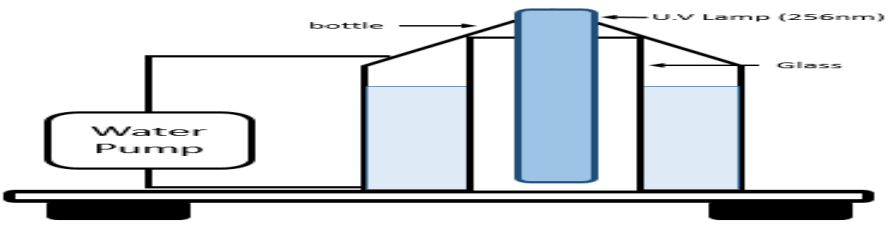
Titanium dioxide nano-particles are synthesized by adding 2 grams of TiO_2 powder in to 45ml of acetic acid and continuously stirring for 45 minutes. DI water was added dropwise until the formation of gel. Finally, the gel was dried in a hot plate at a temperature of 300^oC for 30 minutes. After that powder was calcined at temperature of 900^oC for 3 hours. In last, calcined powder was grounded at agate mortar. After that pure crystalline structure nano-particles are formed. Obtained particles are characterized by SEM, XRD, UV.

Degradation of atrazine herbicide were performed by adding the TiO_2 nano-particle in the sample water in a continuous flow reactor. After the addition, sample was exposed to the UV light. During the degradation process pH was maintained at 5 by adding 1N of HCL. After the one hour samples were taken and passed through syringe filter, and analyzed in UV Vis Spectrophotometer.

Degradation percentage was calculated by using following formula

$$\text{Degradation \%} = \text{Co-C/Co} * 100$$

Where, Co is the initial concentration of atrazine, and C is the final concentration.



Picture 1 Continuous flow reactor

Results and Analysis
Collective study shows that by increasing the dose of TiO_2 increases the rate of degradation, which is because of maximum contact. Different removal percentage gained at different dosages the maximum removal was 90% which obtained at 100mg of TiO_2 nano-particles. Characterization of TiO_2 indicates that it is pure and crystalline structure along with the size between 50 to 400 nm.

Conclusions

In this study, Experiment demonstrated the effect of different concentration of TiO_2 nano-particles to atrazine by photocatalysis. The degradation of atrazine is shown to depend on the concentration of catalysis. Furthermore, time and pH was fixed at this study.

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PHOTOCATALYTIC REMOVAL OF ACTIVE COMPONENT OF PRESOLOL DRUG AND OPTIMIZATION OF UFLC METHOD FOR ITS ANALYSIS IN WATER SAMPLES

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ABSTRACT

The active components of drugs detected in the environmental waters are the compounds with potential risk to the aqueous and terrestrial organisms. In this work, we have experimentally isolated the active component (metoprolol) from the commercially available drug (Presolol), which was detected in environmental and tap waters. A significant contribution was given in metoprolol analytics, where the UFLC method for determining metoprolol in water samples was optimized. Only gradient elution proved effective for the separation of metoprolol from its intermediates formed during the degradation. The main contribution was investigating the photostability of the solution of the commercial formulation of metoprolol, Presolol drug, under simulated solar irradiation (SSI) and UV irradiation. The obtained results showed the inefficiency of direct photolysis in both cases of irradiation. The efficiency of photocatalytic degradation of metoprolol was much higher in the presence of TiO_2 Hombikat. The degradation efficiency of metoprolol under SSI was 15%, while under UV irradiation, it was 96% after 60 min of irradiation.

Keywords: Metoprolol, Presolol, UFLC optimization, TiO_2 Hombikat, Photodegradation

Introduction

It is estimated that 100–250 t of β-blockers are consumed in Germany per year, and several of them are in the top 200 prescribed medications in the United States. Their widespread use and often incomplete metabolism led to the fact that β-blockers are detected in sewage effluents and surface waters, as well as in tap water. For example, the concentrations of metoprolol, propranolol, and nadolol in sewage treatment plant effluents are found in the range of ng/L, even up to μg/L [1]. Therefore, knowing these drugs' environmental fate and determining the risks associated with their presence in the natural ecosystems are an essential part of environmental protection [2]. A promising technology for treating wastewaters containing pharmaceuticals is employing advanced oxidation processes (AOPs). These processes are based on the interaction of light and a catalyst, providing reactive species necessary for the degradation of organic pollutants. One of the most effective photocatalysts for this purpose is TiO_2 [3-5]. In the presented work, the emphasis was on the UFLC method's optimization to identify a commercial formulation of metoprolol in water samples. Afterward, a comparative analysis of the degradation of metoprolol under simulated solar irradiation (SSI) and UV irradiation was performed in the presence/absence of TiO_2.

Methodology

Absorption spectra of metoprolol and standard solutions for the calibration curve generation were recorded on a double-beam T80+UV–vis spectrophotometer (UK) at a fixed slit width (2 nm), using 1 cm quartz cells and UV Win 5 data software. The degradation kinetics of metoprolol were monitored with Ultra Fast Liquid Chromatography with Diode Array Detection (UFLC-DAD). The retention time for metoprolol was (5.9±0.1) min.

Results and Analysis

Standard solutions of metoprolol were prepared to determine the concentration of metoprolol in the Presolol drug (Fig. 1). The determined concentration of metoprolol in the drug was $6.8 \cdot 10^{-5}$ mol/dm^3, while the theoretical concentration was $7.3 \cdot 10^{-5}$ mol/dm^3. Further, the UFLC method for the determination of metoprolol in water samples was optimized. Optimization started as an isocratic elution of analysis with varying the ratio of mobile phases acetonitrile:H_2O (50:50, 30:70, 25:75, and

20:80). Also, the influence of mobile phase flow (1.0 and 0.8 cm^3/min) was examined. Using the isocratic way of elution, efficient separation of metoprolol and its degradation intermediates weren't achieved. Therefore gradient elution was applied in further optimization. The separation was successful at following conditions: the mobile phase was a mixture of ACN and water (the latter acidified with 0.1% H_3PO_4), with the following gradient: 15% ACN at 0 min, which was increased to 30% ACN in 5 min, after which 30% ACN was constant for 5 min; post time was 2 min, flow rate 0.8 cm^3/min (Fig. 1). Besides, experiments show that direct photolysis plays a minor role in the degradation of metoprolol under SSI and UV irradiation. Photodegradation had the highest efficiency using TiO_2 Hombikat under UV radiation, whereby 96% of metoprolol was degraded after 60 min. During the degradation, pH values didn't change significantly, leading to the conclusion that formed intermediates have similar pH values during the degradation process. Also, intermediates are more polar than the parent compound (Fig. 1).

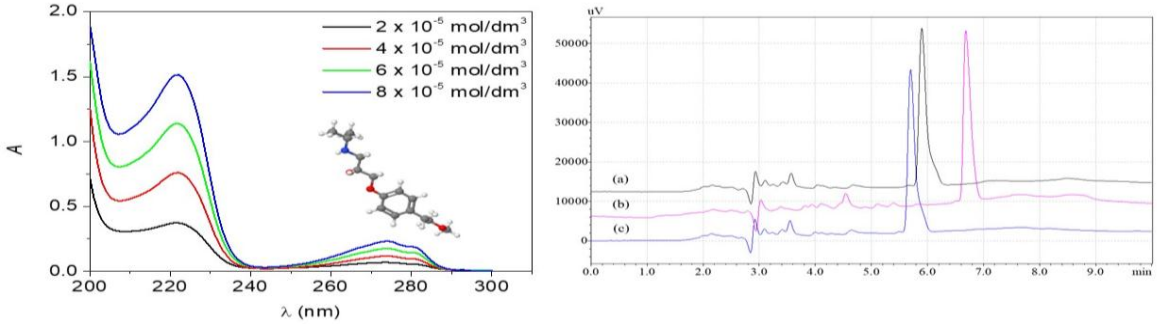

Figure 1. Absorption spectra of standard solutions of metoprolol (left) and influence of different gradient elution at different ratios of ACN and 0.1% H_3PO_4: (a, c) 20: 80 b) 15: 85; and different gradient time (a) t_g = 6 min, (b, c) t_g = 5 min; flow rate 0.8 cm^3/min; λ_{det} = 225 nm (right)

Conclusions

The problem of inefficiency of separation of metoprolol and its intermediates formed during degradation by applying isocratic elution was solved by optimizing UFLC method using gradient elution. Since metoprolol detected in the environment reaches the environment through its pharmaceutical formulations, such as Presolol drug, degradation of this commercial formulation was examined in this work. Therefore, this paper aimed meaningful results in the degradation of metoprolol. Direct photolysis using SSR and UV irradiation wasn't efficient in the degradation of metoprolol. On the other side, the photodegradation of metoprolol was the most efficient by using the TiO_2 Hombikat under UV radiation.

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STRATUM VENTILATION: A VIABLE AIR DISTRIBUTION FOR NIGHTINGALE WARDS TO REDUCE THE RISK OF AIRBORNE TRANSMISSION

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ABSTRACT

COVID-19, an unprecedented infectious disease has greatly affected the overall activities around the globe. The virus through airborne pathogens has posed a major threat to the human health. There are strong evidences that the airborne virus transmission can be occur through asymptomatic patients. Therefore, hospitals facilities, specifically Nightingale wards are the key places at higher risk due to virus transmission by silent spreaders. In order to protect the healthcare staff and patients from respiratory infections, the improvement in air distribution design is one of the important measures [1]. For that reason, stratum ventilation is proposed in this study as a viable option to curtail the exposure risk in large hospital wards. Three configurations of stratum ventilation using architecturally designed flow bar diffusers have been investigated with the aid of rigorous CFD simulations. The distribution of contaminant concentration and effectiveness of contaminant removal under the various SV configurations is compared. The SV configuration (in zone 3) was found better compare to other settings.

Keywords: SV configurations, Nightingale ward, airborne transmission, CFD

Introduction

Healthcare facilities (HCFs) have a variety of closed indoor environments to deal with the patients suffering from various diseases. These indoor environments range from a small isolation room to a large multi-bed ward i.e.; Nightingale ward [2]. The benefits in the context of covid-19 virus elimination in mechanically ventilated closed indoor environment for 2-bed [3, 4], 3-bed [3, 5] inpatient wards have been recorded and investigated thoroughly using different air distribution strategies. However, very few studies found in the open literature focusing on the ventilation performance in multi-bed wards. Moreover, the recent outbreak of covid-19 pandemic has exacerbated the cross-infection risk associated with these healthcare facilities. Thus, this paper investigated the performance of different configurations of stratum ventilation installed with flowbar diffuser in a large nightingale ward.

Research Methodology

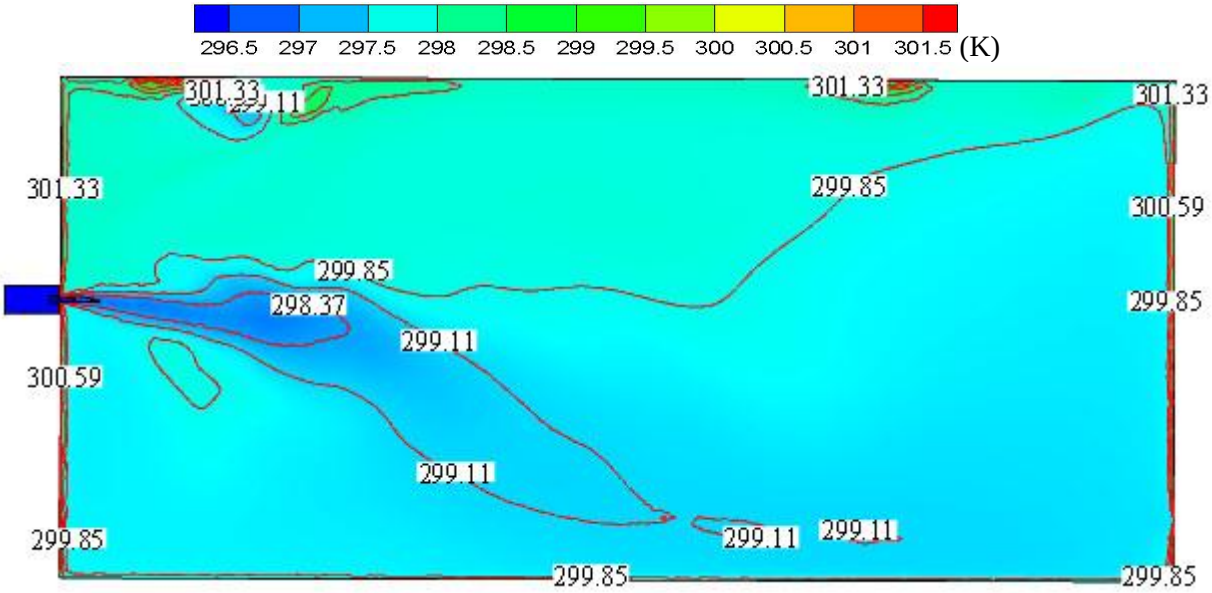
In this study, different SV configurations have been investigated in a large 34-bed nightingale ward. The entire ward comprises of three zones. Investigation is carried out with the aid of computational fluid dynamics program Ansys FLUENT 2020

Performance evaluation parameters**:** The performance of the stratum ventilation method with different configuration settings are compared using following parameters.

- Airflow pattern
- Temperature distribution
- EDTS
- Mean age of air
- Carbon dioxide (CO_2 concentration)
- Contaminant removal effectiveness (CRE)

Results and Conclusion

The findings indicate that the concentration of contaminant in the breathing zone (1.3-1.7 m above floor level) is significantly lower under SV configuration 1 (zone 3); in addition, the effectiveness of contaminant removal is reasonably higher. The results obtained through all three configurations verified the performance of stratum ventilation in minimizing the exposure risk to healthcare staff/patients in the large Nightingale ward. Considerably good airflow throw and temperature distribution were observed in configuration 1 than in configuration 2 and 3. Thus the former configuration is recommended to be considered in large SV applications.



Temperature distribution on a vertical plane at X=4.68m (zone-1)

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BIO DEGRADATION OF SYNTHETIC MELANOIDINS USING INDIGENOUS MICROBIAL SPECIES

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Abstract
In few decades different treatment methods were used for degradation of Melanoidins from distillery spent wash. The objective of this study to isolate and identify indigenous microbial species from spent wash and examines the degradation of Melanoidins using indigenously isolated microbial species for the recalcitrant coloring compounds. The degradation setup 4 to 5 days the maximum color removal was 80-85% and COD removal was 85-95%. Strains were further isolated on petri plates using Sabouraud's Dextrose Agar and Nutrient Agar then 10 bacterial and 6 fungal colonies were taken from grown plates for further degradation setup for 3 days to analyze variation and removal efficiency of optical density, COD, color and pH were 0.15±2.0, 30±96, 6±86 and 5.3±7.3 respectively

Keywords: Melanoidins, DSW, Degradation, microbial species,

Introduction:
Distillery influent spent wash has been treated using conventional anaerobic digestion method that reduces 60-70% of COD and color. The remaining residue has been discarded into an environment which has high organic loading as COD between 40000-60000, dark brown color and Melanoidins concentration. Approximately 0.8 billion liters of spent wash annually generated [1]. Melanoidins have recalcitrant and dark brown to black colored compound like polymer which is formed by Millard reaction [2].Numerous Physico-chemical treatments has been done for removal of Melanoidins from spent wash such as chemical coagulation, flocculation, ozonation, activated carbon adsorption, precipitation, and advanced oxidation [3]. Whereas these treatments have few demerits due to high chemical consumption, high operation cost, a variation of color removal efficiency, generation of hazardous by-products, more energy requirements and it can produce a large volume of solid waste. In diversity, the microbial-based biological treatments for biodegradation methods are the best attention due to their environmentally friendly and cost-effective nature to chemical disintegration processes [4]. Due to the bioremediation of spent wash, the microbial treatments of spent wash which is a less toxic and environmentally safe device [5].
Methodology:
Distillery spent wash used as inoculum from distillery site. Synthetic Melanoidins were prepared in autoclave by adding 4.5 g $C_6H_{12}O_6$, 1.88 g glycine and 0.42 g $NaHCO_3$ in 100 ml Deionized water then 12.5% was used for degradation, 5% spent wash and 5 g soil was used as inoculum, remaining liquid was filled with 100 ml prepared media composition containing 1% KH2PO4, 0.5% MgSO4, 0.5% KCl and 5% NH4Cl then setup was run at pH 7.5 and 5.5 and at temperatures 37°C and 25°C at 150 rpm for both bacterial and fungal species respectively.
The unknown microbial species shows maximum color removal was 80-85% and COD removal was 85-95% at pH 5.5 & 7.5 while 10 bacterial and 7 fungal species which has been isolated from soil and spent wash shown in table.

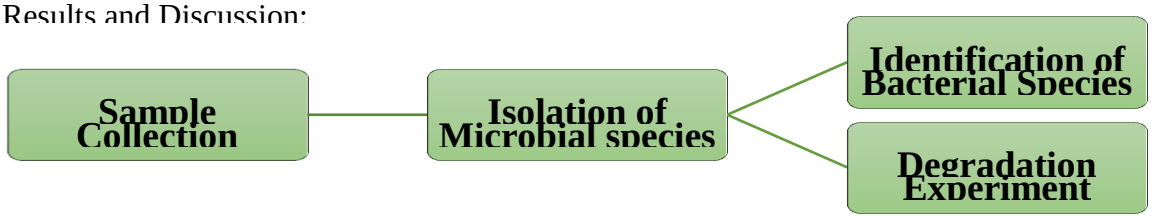
species	pH initial	pH final	OD initial	OD final	Color initial	Color Removal%	COD initial	COD Removal %
B1	**7.5**	**6.88**	**0.262**	**1.976**	**1.5593**	**86.5**	**13400**	**97**
B2	**7.5**	**7.01**	**0.326**	**1.94**	**1.5733**	**86**	**16800**	**95.2**
B3	**7.5**	**6.92**	**0.362**	**1.818**	**1.5716**	**87**	**16600**	**96.8**
B4	**7.5**	**6.99**	**0.387**	**2.003**	**1.5463**	**86.9**	**14300**	**94.8**
B5	**7.5**	**6.94**	**0.303**	**1.915**	**1.5629**	**86.5**	**15700**	**96.3**
B6	**7.5**	**6.69**	**0.245**	**1.366**	**1.4863**	**78.7**	**12600**	**80.3**
B7	**7.5**	**6.90**	**0.158**	**1.372**	**1.4845**	**86**	**11900**	**90.3**
B8	**7.5**	**6.85**	**0.206**	**1.047**	**1.4693**	**82.5**	**13200**	**87.7**
B9	**7.5**	**6.94**	**0.266**	**1.222**	**1.4897**	**78.6**	**13600**	**81.4**
B10	**7.5**	**6.76**	**0.268**	**1.087**	**1.4861**	**75**	**9500**	**75.8**
F1	**5.5**	**6.05**	**0.32**	**1.547**	**1.175**	**98**	**7960**	**53.6**
F2	**5.5**	**5.9**	**0.389**	**1.139**	**0.9237**	**97.8**	**6280**	**73.8**
F3	**5.5**	**6.09**	**0.363**	**1.57**	**1.8448**	**98.5**	**8620**	**60.8**
F4	**5.5**	**6.19**	**0.365**	**1.385**	**1.8409**	**98.4**	**7560**	**96**
F5	**5.5**	**6.07**	**0.311**	**1.635**	**1.9053**	**98.8**	**8760**	**86.3**
F6	**5.5**	**6.08**	**0.47**	**1.384**	**1.7745**	**97**	**6640**	**96.7**
F7	**5.5**	**6.11**	**0.285**	**1.253**	**1.8539**	**91.5**	**6160**	**83**

B= Bacterial, F= Fungal, OD= Optimal Density % COD= Chemical Oxygen

Conclusion:

It has been concluded that the degradation of Melanoidins from distillery effluent spent wash using indigenous microbial species shows acidic pH, increasing optimal density, the maximum COD and

Results and Discussion:



Color removal with environment friendly technique.

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VARIATE RATE SPRAYING TECHNIQUES FOR REDUCING SPRAY DRIFT TO CONTROL THE ENVIRONMENTAL RISKS

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ABSTRACT

Spray drift is the most important issue of environmental pollution in Pakistan with using of conventional sprayers for pesticide application. The present study was conducted to determine the effectiveness of variate rate sprayer in orchard condition on spray drift reduction. The results then compared with Meli's spray drift model. The results show that the drift generated by Variate rate sprayers validated the results of Meli's model. The study provided guidelines researchers, manufacturers and machinery operators.

Keywords: Spray drift, Variate rate sprayer, Effectiveness, Environment

Introduction

The pesticide application is very important for crop protection but have a key side effect of their excessive application in modern agriculture as exposure to hazardous chemicals. Like other countries in Pakistan, the usage of pesticides has controlled the pests, but it has started creating environmental problems in the area. However, in 1954 Pakistan agriculture use 254 metric tons of agrochemical formulation used for plant protection. [1]. After the pesticide application the vegetables, fruits, and grain contains pesticide residues, by contact with contaminated surfaces, or via inhalation of airborne pesticide residues [2]. During the pesticide application, Spray drift continues to be a major problem. The deposition of crop protection chemicals in the off-target zone is called Spray drift. Spray drift can have serious environmental risks such as contamination of water bodies, harmful damaging to sensitive adjacent crops, environmental contamination, people and animal health risk [3]. The major cause of spray drift is weather parameters, and inefficient spray application techniques. In the last few years, researchers develop variate rate spraying technologies for efficient pesticide application in agriculture crops and orchards to reduce the spray drift. These sprayers apply a precise amount of spray with accounting for the weather parameters and crop geometry [4].

The present study was conducted to find out the performance of the variate rate sprayer in citrus orchard conditions and compared the drift produced with Meli's drift model results.

Material and Methods

The experiment was conducted in Ali Raza Gardezi Citrus orchard farm at Pull Rangoon (30°19'20.6"N 71°43'33.3"E). Variate rate sprayer used for pesticide application. Drift poles and Water sensitive papers are used for airborne drift sampling, and ground deposition drift. Figure 1(a) shows the sampling layout.

Spray Drift Mechanism

Spray drift is defined as the amount of pesticides that is move away from the sprayed (treated) area by the action of air speed during the application process. To find out the exposure of a target to a particular drifted product, it is very important to calculate the amount of drift produced during treatment [4]. Drift Mechanism is shown in figure 1. Three drift models result (German, IMAGE, and Meli) compare with experimental results. Meli's model is specific for citrus and air-blast sprayer. All of these models represent the percentage of applied quantity that has drifted (%drift) as a function of the downwind distance from the end of the field (z). This study only considers Meli's model for measuring the drift percentage according to our crop and sprayer type. Table 1 shows models.

Results and Discussion

From these equations, found the drift percentage of these models using different operating distances sharply reduce in the first 5 m and then slowly reduce shows in figure 2(a). The study was conducted in two conditions first was at the temperature 22°C and humidity 75% and the Second was at temperature 35°C and humidity 45 %.

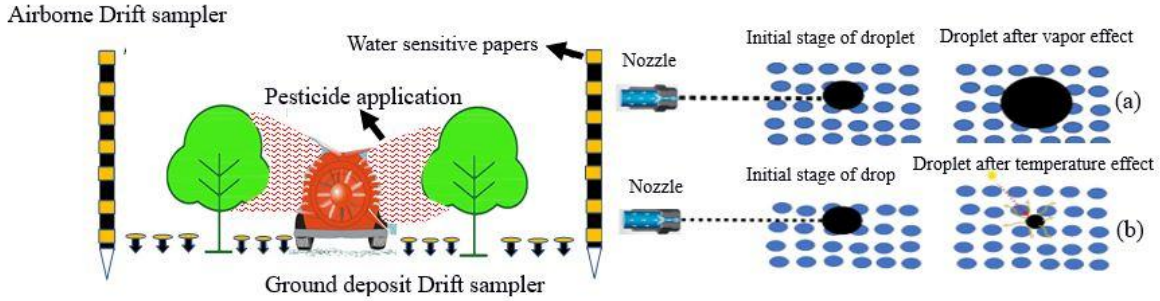
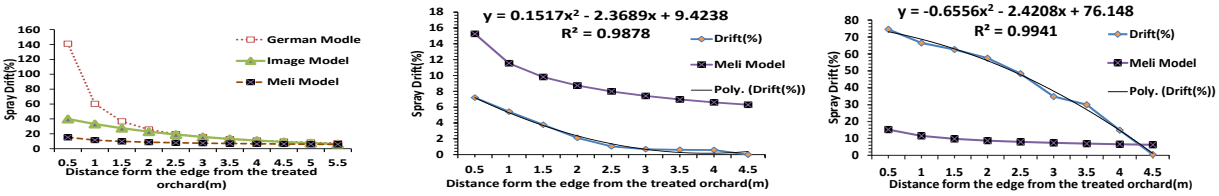


Figure 1. Spray drift Sampling methods. (a) High humidity effect on droplet size (b) the high-temperature effect on droplet

Table 1: Drift Models

Model Name	**Model**	
German model	% drift = $60.36 \times z^{-1.2243}$	(z < 15 m)
	% drift = $298.83 \times z^{-1.8672}$	(z >15 m)
IMAG model	% drift = $48\times e^{-z/2.7} + 0.45 \times e^{-z/0.091}$	
Meli model	%drift = $11.524 \times z^{-0.4026}$	



(a) (b) (c)

Figure 2. Drift percentage of Drift models at various distances (b) Percentage drift at 22 °C Temperature and 75% humidity (c) Percentage drift at 35 °C Temperature and 45% humidity

In figure 2(b) the results show that if the sprayer uses at low temperature (18-30°C) and high humidity (55-80%) condition, and operating distance from 2.5 m to 5 m then spray drift sharply reduce. At the start when the operating distance 0.5-2 m the spray drift 8% and then reducing continuously to 1% at 4.5 m distance. In figure 2(c) the result shows that if pesticide applies with the variate rate sprayer at high temperature (above 35°C) and low humidity (below 45%) then the spray drift produces 75% at 0.5 m operating distance and then reduce slowly with increasing the operating distance between the sprayer and edge of the plant.

Conclusion:

It is concluded that Variate rate sprayer is important for saving the air and groundwater environmental pollution by reducing the spray drift which occurs due to off-target deposition. From the results, it can be concluded that variable-rate spraying technology has great potential in reducing spray drift and helpful in environmental pollution control.

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WHAT HAPPENS TO MANGROVE OF POLLUTED AREA? REVIEW OF SANDSPIT BACKWATER MANGROVE, KARACHI, PAKISTAN

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ABSTRACT

Mangrove are the lungs of coastal areas. They have a unique ecosystem with diverse flora and fauna. Mangrove serve as the sanctuary near coastal sites and are robust breeding grounds for commercially important fishery. They act as a natural barrier against tsunami and sea storms. The mangrove itself is used for food, fuel and fodder. It is also used as herbal medicine among fishermen communities for various ailments. The area of Sandspit backwaters is covered with monospecific *Avicennia marina*, commonly known as grey mangrove or white mangrove. Sandspit backwaters are among the highly polluted areas of Karachi city. The domestic and industrial waste all comes down to these backwaters channel. A detailed study of this area was done where the soil, water microbial flora such as cyanobacteria, diatoms and its associated fauna such as crabs, gastropods were observed. It was found that the species diversity of the mangrove area were highly compromised and replaced by pollution indicating organisms. Also the area is now polluted with heavy metals but despite all the pollution it takes in, the forest and associated microbial flora still persists in some form. These organisms can be explored for mass environmental cleanup.

Key words: Mangrove, Cyanobacteria, Gastropods, Shellfish, Pollution

Introduction

Sandspit backwaters mangrove were surveyed for the presences of microbial flora and forest floor associated flora. The area is situated at the south of Karachi, Sindh province and is considered one of the busiest coastal area of Karachi. The area has modern housing construction and several generation of fisherman community of Maripur area living in there. The area's deep sea is bustling with naval exercises biannually and its estuarine waters are constantly compromised with anthropogenic activities and industrial pollution. As a consequence, the mangrove forest are not what they used to be. The whole area is now one of the most polluted area of Sindh coastline [1]. Yet the forest developed a resilient trait and is not dying. If left alone to its natural devices it may grow back but the polluted conditions have compromised the species diversity and only pollution indicator species thrive. The problem now bears the solution [2, 3]. What it means that the pollution indicating species are filtering nutrients and water in such a way as to sustain this new Mangrove ecosystem. Closer look at the water quality determines the parameters that are sustain life in this compromising system.

Methodology

S-25 site near departmental research hut was selected for the study. The water was sampled in all seasons pre monsoon, monsoon and post monsoon season for one year and water quality nutrients such as nitrate nitrite phosphate and ammonia levels were determined as per spectrophotometric methods. Primary focus was given to the physic chemical properties of water mainly pH, temperature, salinity. Microbial flora was microscopically examined during all seasons. Live culture was used for species diversity. The fauna directly associated with micro flora was also observed on seasonal basis. Observations were done by random sampling in triplicate and quadrate method for fauna survey.

Results and Analysis

It was observed that the nutrient properties of water do not fluctuate drastically within a season, the pH remain alkaline to near neutral even though there is constant input of pollutants. The examination

of Micro flora revealed that filamentous cyanobacteria are abundant that belong to *Phormidium* and *Oscillatoria* Sp. And diatom *Navicula* sp. Associated fauna include gastropods such as Telescopium, Ceratium, Fiddler carbs and mangrove slugs. There was significant correlation between species and water quality.

Conclusions

The study suggests that quality of water is one of the reasons that life is still present in that environment the forest is somehow influencing the water making it sustainable for surrounding environment. These organisms have strong potential to be used bio indicator for environmental monitoring process along the coastline of Pakistan. They may also be explored for environmental cleanup of heavily polluted sites e.g near industrial area that is close to coastal /estuarine sites.

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ADSORPTIVE REMOVAL OF 2, 4, 6-TRICHLORO-PHENOL FROM WASTEWATER BY MAGNETIC COMPOSITES: EQUILIBRIUM, THERMODYNAMIC AND KINETIC STUDY

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ABSTRACT

Magnetic composites (Fe^{+3}/ Fe^{+2} enriched) were prepared by modification of mango seed shell (MSS-biomass) and resulting composites were characterized by SEM, FTIR and TGA. Magnetic property proved best for the adsorption of 2, 4, 6 trichloro-phenol from wastewater. The performance of magnetic composites along native biomass was investigated in batch mode with different parameters such as; pH, temperature, adsorbent dose, concentration effect and contact time. Experimental data was analysed by different kinetic and equilibrium models. Thermodynamic parameters (ΔG, ΔH and ΔS) were also calculated. Recovery and re-usability of adsorbents was investigated by desorption study.

Keywords: Adsorption, composites, trichlorophenol

Introduction

Phenol and phenolic derivatives are key participant of water pollution from the past decades, causing damaging affects in human respiratory and nervous system [1]. Among number of removal techniques, adsorption is considered as leading one due to simplicity of design, cost effectiveness, efficiency and reusability of adsorbents. Adsorption efficiency could be enhanced by recently synthesized composites materials [3, 4]. Current research work was designed for the synthesis of novel magnetic composites by structuring Fe^{+3} and Fe^{+2} on the surface of MSS-biomass. Batch study experiments examined the efficiency of these magnetic composites as compared to simple biomass (native mango shell waste).

Methodology

Magnetic solution (carrying Fe^{+3} and Fe^{+2} ions) was prepared by a reported method [2], dissolving a specific amount of $FeCl_3.6H_2O$ and $FeSO_4.7H_2O$ in distilled water then MSSbiomass was treated with this magnetic solution. Resulted precipitates centrifuged, washed with water and dried overnight at 60°C. Adsorbents MSS-biomass and magnetic composites were used in a comparative study for the adsorptive removal of 2, 4, 6-TCP. Batch experiments were carried out to study one parameter by keeping the other parameter constant.

Results and Discussion:

Characterization: Surface functional groups of MSS-biomass after and before formation of magnetic composites were determined by FTIR spectra recorded at 4000-300 cm^{-1} IR-region and 4 cm^{-1} resolution. SEM-EDS analysis provided morphological information and thermal stabilities of composites were determined by TGA at temperature range 10-900°C.

Batch Study: Experimental data was analyzed by different kinetic, equilibrium and thermodynamic models. The best fitted kinetic models was pseudo-second-order kinetics, similarly best fitted equilibrium models was Langmuir for the adsorption of 2, 4, 6-TCP by magnetic composites. Calculated values of all parameters are given in Table 1. Mechanism followed the monolayer adsorption of 2,4,6 TCP onto homogenous surface of magnetic composites as well as endothermic and spontaneous nature of reaction.

Table 1 The best fitted model's parameters (kinetics, Equilibrium and thermodynamics) for 2, 4, 6 TCP adsorption by mgnetic composites

Pseudo 2nd order kinetics		**Langmuir Isotherm**		**Thermodynamics (at 333K)**	
q_e exp (mg g^{-1})	24.69	k_l	0.007	ΔG (kJ/mol)	8.178
$q_e$cal (mg g^{-1})	25	b	4.153	ΔH(kJ/mol)	43.43
K_1 (min^{-1})	0.05	q_{max}cal. (mg/g)	33.44	ΔS(J/mol.K)	0.164
R^2	0.999	q_{max}exp. (mg/g)	31.27		
		R2	0.986		

Conclusion

In the view of physico-chemical experimental analysis, it was found that magnetic composites synthesized from simple agro-waste biomass are more efficient and reliable as compared to native biomass for the removal of 2, 4, 6-TCP. This kind of efficient composite materials could also be used for the removal of other organic pollutants.

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TREATMENT OF HIGH STRENGTH SYNTHETIC WASTE WATER THROUGH SEQUENTIAL ANAEROBIC-AEROBIC MEMBRANE BIOREACTOR (SAAM)

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ABSTRACT

In this research, An Innovative Anaerobic-Aerobic Membrane Bioreactor (AnAMBR) has been designed to treat high strength synthetic wastewater on a pilot lab scale at USPCAS-W. The SAAM was consisting of anaerobic and aerobic reactors. The reactor was inoculated with sludge taken from an anaerobic reactor near Hyderabad. The operating (Qin) influent limit of the reactor was 30L/d. The anaerobic and aerobic digesters were operated at different organic load rates (OLR). The flat sheet membrane module was used to immerse in the aerobic reactor. The anaerobic conditions were controlled using a directly intermittent internal recycling pump. The SAAM operating parameter of mixed liquor suspended solids (MLSS) was maintained at (3000-4000) mg/l. The reactor of hydraulic retention time (HRT) was maintained. Performance evaluation of the reactor was observed in the terms of COD (mg/l). The pH is maintained at 7.5 to 8. Furthermore, 95% COD (mg/l) removal efficiency has been observed and other nutrients (Total Nitrogen and Total Phosphorous) were also monitored. It has been investigated as a simple, reliable and cost-effective process with a significant removal of contaminants

Key words: AnAMBR, Synthetic wastewater, Anaerobic-Aerobic Reactor, COD removal.

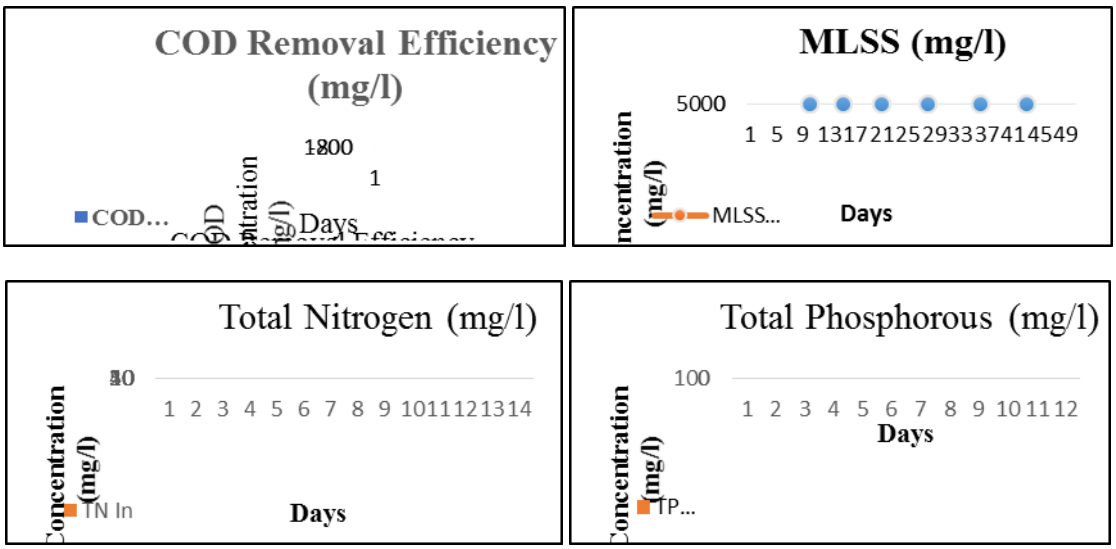
Introduction:
The AnAMBR technology offers many advantages over AD processes, operation at high OLR, ample biomass retention, capacity of handling wide range feed fluctuation and smaller footprints as compared to AD. [1,2]. Industries are looking forward to advancing treatment processes and ready to adopt innovative technologies to overcome environmental liabilities. [3]
Methodology:
The SAAM was consisting of anaerobic and aerobic reactors of the volume 6.5 liters and 5.5 liters, respectively. The membrane module of an effective filtration area of about 0.8 m2 is completely merged in the aerobic reactor. In the bottom, airlift is installed on the aerobic reactor to provide the aeration and to reduce the membrane fouling.
Experimental setup used in this:

1. Synthetic wastewater. 2. Anaerobic- Aerobic membrane bioreactor. 3. Intermittent recycling pump. 4. Membrane module. 5. Stirrer tank. 6. Level sensor. 7. Aeration pump

Analytical Methods:

- ✓ COD "chemical oxygen demand" was measured using Lovibond MD 200, closed reflux calorimetric method.
- ✓ Mixed Liquor Suspended Solids (MLSS), was performed to the Standard Method of American Public Health Association (APHA, 2012).

Results and Analysis:



Conclusions:

The SAAM allows for a much higher biomass concentration to be maintained and a feasible approach to sustainable development. The fundamental purpose of this research was to investigate the optimum operating parameters for the operation of AnAMBR on Synthetic wastewater.

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PERFORMANCE AND EMISSION ANALYSIS OF BRICK KILN USING ZIGZAG TECHNOLOGY

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ABSTRACT

For the last few years, the Government of Pakistan has been trying to change the way bricks are produced in the country using a technology mandate that bans the widespread conventional technology. This research compare emissions level from various brick kilns as fixed chimney bull's trench kiln, natural draught zigzag, high/induced draught zigzag, vertical shaft brick kiln, and tunnel kiln technology. The main purpose of this research to investigate the emission parameters at exhaust of brick kiln using different control technologies. The zigzag technology is designed in brick kilns to minimize the pollutants that are affecting the environment. This technology is based on zigzag path flow, which are produced due to combustion of coal (major fuel of brick kilns). The zigzag arrangement increases the combustion rate, resulted harmful oxides convert into environmental friendly oxides. In zigzag path flow the arrangement of bricks increases the hurdle in flow of gases, that results in the maximum utilization of thermal energy and decrease unburnt fuel contents. The comparison results show that 20% fuel consumption, 40% PM, 26g/kg CO_2, 0.12g/kg black carbon, and 1.71g/kg CO reduction was observed using zigzag technology else of fixed chimney approach. The result portion shows that by converting technology from fixed chimney to zigzag the quality and strength of bricks are enhanced by 25%.

Key words: air pollution, brick kiln emissions, zigzag technology, clean combustion

Introduction

Pakistan and most of developing countries are consuming large amount of fossil (conventional) fuels such as wood, rice husk, saw dust, and coal for combustion purposes. A large amount of emissions gases is produced, by combusting these conventional fuels. Average emission factors per 1,000 bricks were 6.35 to 12.3 kg of CO, 0.52 to 5.9 kg of SO_2 and 0.64 to 1.4 kg of particulate matter (PM) [1]. Currently, sulphur dioxide (SO_2), oxides of nitrogen (NO_x) and suspended particulate matter (SPM) are the main issue pertaining to air pollution problems in developing countries, where it contributes both to urban pollution and to regional acid depositions. The brick kiln combustion gases contain various concentrations of CO, CO_2, SO_2, PM, and NO_x [2]. Zigzag technology is one of the solution to control health hazards emission gases. Its zigzag path flow not only reduced the pollution of environment but also economically beneficial and also improved the quality of product. (Brick *et al*, 2019) investigated both FCBTKs and IDZKs for measuring concentrations of sulphur dioxide, carbon dioxide, particulate matter, and black carbon with diameter less than 2.5 µm. The result shows that converting technology from straight line to zigzag can reduce up to 40% emissions PM 2.5[3].

Methodology

The present research work is majorly based on the emission analysis of FCBTK, single and double zigzag path flow, while the research is initiated with literature review focused on the brick kiln emissions. The extensive literature review helps to study the previous developed model (fixed chimney) and to find the gap in double zigzag path flow brick kiln. This research compared the emission level from various brick kilns as FCBTK, NDZZ, HDZZ, VSBK, and TK. At this stage, the experimental analysis begins, result obtained verify from previously developed theories. Once the required parameter and objectives are obtained the adopted research will be recommended for evaluation in brick kiln industry for additional environmental improvement and implementation

Results and Analysis

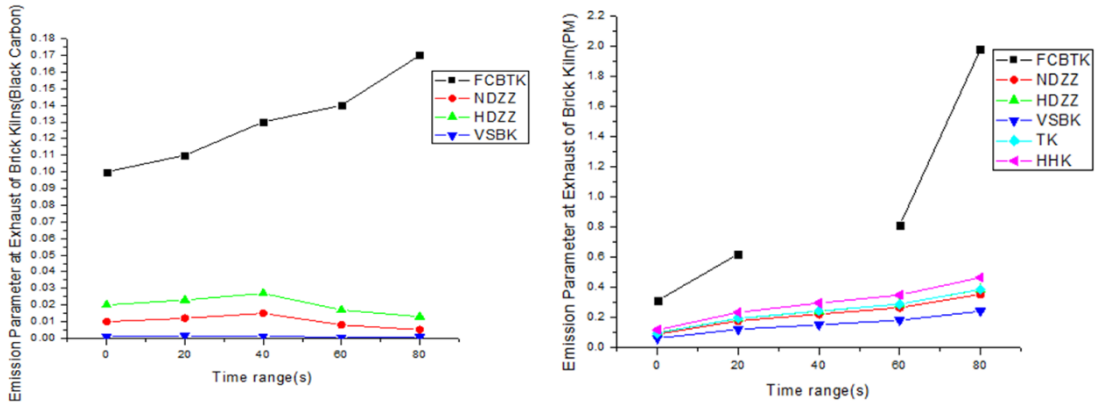

Figure 1 a) Emissions of black carbon verses time b) Emissions of PM verses time

The figure 1 (a), shows the graph between emission parameter at exhaust of brick kiln (black carbon) verses time range, and figure 1 (b) shows between emission parameter at exhaust of brick kiln (PM) verses regular interval of time range. Through figure 1 investigated that FCBTK kiln has maximum emission value of PM and VSBK has minimum emission of PM as compared to other kilns.

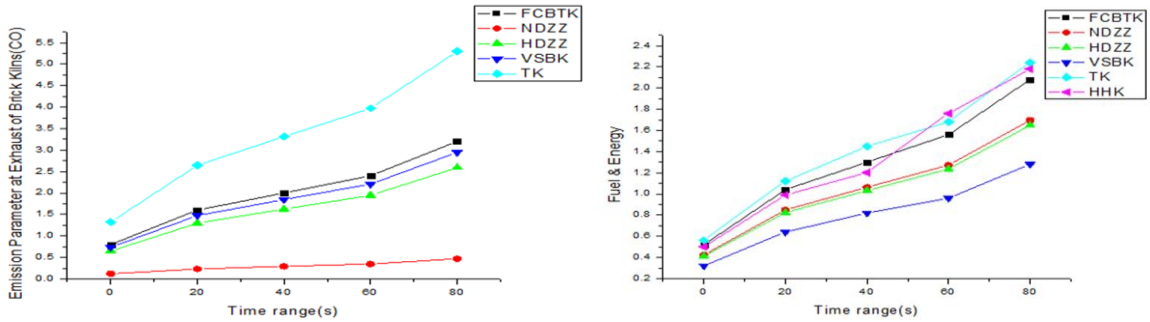

Figure 2 a) Emissions of CO verses time b) Emissions of fuel and energy verses time

From figure 2 a) emissions parameter at exhaust of brick kiln (CO) verses regular interval of time range, and figure 2 (b) shows the graph between fuel and energy verses time range. We observed that TK kiln has maximum emission value of CO and NDZK has minimum emission of CO as compared to other kilns. The specific energy consumption of tunnel kiln is slightly higher as compared to other continuous technologies of brick kilns.

Conclusions

This research compared emissions factors of zigzag technology and fixed chimney brick kiln. In zigzag brick kiln the time of combustion increases and its zigzag path provide obstacle in the flow of gases which reduces the quantity of harmful oxides of carbon, sulphur and PM. Currently, single and double path flow process are using in zigzag technology, but double zigzag path flow produce better results as compare to single zigzag flow and FCBTK. The comparison results show that 20% fuel consumption, 40% PM, 26g/kg CO_2, 0.12g/kg black carbon, and 1.71g/kg CO reduction was observed using zigzag technology else of fixed chimney approach.

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INVESTIGATING SO_2, NO_x, CO_2 AND PARTICULATE EMISSIONS FROM PULVERIZED COMBUSITON OF COAL BLENDS USING DROP TUBE FURNACE

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ABSTRACT

Currently, coal is a cheap energy source in developing countries to fulfill their energy demands. However, gas and particle emissions from coal combustion have serious effects on human health and environment. This study investigated the emissions from coal blends of Duki and Thar in different weight proportions under conventional and oxy-fuel combustion conditions. Consequently, optimum Duki to Thar (D:T) coal blend ratio of 2:8 was obtained which exhibited overall minimum emissions of gas and particulates.

Key words: Emissions, Coal blends, Combustion, Oxy-fuel.

Introduction

Currently, coal is one of the prominent fuels for the power generation, particularly in developing countries (i.e., Pakistan) to meet their energy demands as a result of urbanization and population explosion [1]. Additionally, it is reported that its consumption for power generation has increased significantly in developing countries [2]. The fuel gas emissions such as CO_2, CO, SO_x, NO_x and particulate matter (PM) during coal combustion in coal-fired power plants pose detrimental effects on human health and environment including lung cancer, climate change, and global warming [3]. In this work, combustion of coal blends under conventional and oxy-fuel conditions were performed to obtain an optimum blend ratio for minimal emissions.

Methodology

The samples of Duki (D) and Thar (T) coal were collected from Duki and Thar coal fields in Pakistan, respectively. The samples were ground and sieved through 60 mesh. Then, coal blends in weight percent were prepared with D:T ratios of 2:8, 4:6, 6:4, and 8:2. The combustion of coal samples under conventional conditions (air) and oxy-fuel conditions (O_2/CO_2) was performed in a pilot scale drop tube furnace (DTF) at a set temperature of 1000 ^oC. The proximate and total carbon analyses of individual coal samples and coal blends were performed using American Society of testing Material (ASTM) standards and CS analyzer (144DR, LECO, USA), repectively. Flue gas from DTF was analyzed for O_2 (%), CO (ppm), CO_2 (%), SO_2 (ppm), NO_x (ppm), and particulate matter including $PM_{2.5}$ (particle size less than or equal to 2.5 µm) and PM_{10} (particle size less than or equal to 10 µm) using isokinetic sampler.

Results and Analysis

Results of the study indicated that irrespective of the combustion conditions (conventional and oxy-fuel), Duki coal generated more carbon monoxide (CO), oxides of nitrogen (NO_x), and oxides of sulphur (SO_x) than Thar coal. It might be due to higher nitrogen and sulphur contents in Duki coal as compared to those present in Thar coal. According to proximate analysis, sulphur content in Duki coal was approximately 8% significantly higher than 0.9% found in Thar coal. However, concentrations of carbon dioxide (CO_2) were comparable for both Duki and Thar coal samples under conventional and oxy-fuel combustion conditions. Additionally, under both conventional and oxy-fuel combustion conditions, the concentration of particulate matter ($PM_{2.5}$ and PM_{10}) was high in Duki coal as

compared to Thar coal. The high concentration of $PM_{2.5}$ and PM_{10} in Duki coal was due to higher ash content (mineral matter) of approximately 13.4% in Duki coal than 3.3% obtained for Thar coal as given by proximate analysis of the respective coal samples.

For the case of Duki to Thar coal blends (D:T), under conventional combustion conditions the NO_x concentration was 17.6 ppm for D:T ratio of 2:8, which significantly increased to ppm for D:T ratio of 8:2. This increase in NO_x concentration might be partly due to increase the overall nitrogen content of the respective blend, as the weight percentage of Duki coal with in the coal blends increased from 25% to 75% with changing D:T ratio from 2:8 to 8:2, respectively. Additionally, the increase in NO_x concentration might be partly due to formation of thermal NO by the reaction of N_2 and O_2 at high temperature (i.e., 1000 ^oC) under combustion conditions. However, under oxy-fuel combustion conditions, the NO_x concentration remained fairly similar in the range of 23.6-27.1 mg m^{-3} as D:T ratio was varied from 2:8 to 8:2. This might be due to the presence of CO_2 which reduced NO_x formation under oxy-fuel combustion condition.

Under both conventional and oxy-fuel combustion conditions, SO_2 concentration increased with the change in D:T ratio from 2:8 to 8:2. Under conventional combustion, at D:T ratio of 2:8 SO_2 concentration was 352 ppm which increased by approximately 64% to 577 ppm obtained at D:T ratio of 8:2. Under oxy-fuel combustion conditions, as D:T ratio was changed from 2:8 to 8:2, SO_2 concentration was substantially increased by approximately 700% higher than 64% observed under conventional combustion conditions. The high levels of SO_2 might be due to supply of high O_2 levels in oxy-fuel combustion as compared to conventional combustion conditions. Under conventional combustion conditions, CO_2 concentration decreased from approximately 15% to 6% as the D:T changed from 2:8 to 8:2. This decrease in CO_2 concentration might be due to its thermal degradation to CO and/or O_2. However, for the case of oxy-fuel combustion conditions, CO_2 levels remain unaffected and were in the range of 13.8-15%, relatively higher than the range of 6-15% obtained oxy-fuel conditions for varying D:T ratio from 2:8 to 8:2. The concentration of CO increased with the change in D:T ratio from 2:8 to 8:2 under both conventional and oxy-fuel combustion conditions. For the case of conventional and oxy-fuel combustion conditions, at the D:T ratio of 2:8, the CO levels were 158 ppm and 369 ppm which increased to 881 ppm and 3896 ppm at D:T ratio of 8:2, respectively. In both combustion cases, the increase in CO might be due to thermal conversion of CO_2 to CO. However, the CO concentrations for the oxy-fuel condition were approximately 2.5 to 4.5 times higher than conventional combustion due to presence of CO_2 at high concentration in oxy-fuel environment (i.e., O_2/CO_2). In both conventional and oxy-fuel combustion conditions, $PM_{2.5}$ and PM_{10} increased from 64.8 mg m^{-3} and 220.5 mg m^{-3} to 112.2 mg m^{-3} and 358.3 mg m^{-3} as the D:T ratio was varied from 2:8 to 8:2, respectively. This increase in PM was due to increased weight proportion of Duki coal with high ash content (13.4%) in coal blends as the D:T increased from 2:8 to 8:2. Additionally, in oxy-fuel combustion conditions the concentrations of $PM_{2.5}$ and PM_{10} were slightly lower than those obtained under conventional combustion conditions. It might be due to the presence of CO_2 in oxy-fuel combustion conditions which reduced the vaporization of metal oxides.

Conclusions

Under both conventional and oxy-fuel combustion conditions, the emissions of SO_2, NO_x, and PM ($PM_{2.5}$ and PM_{10}) for Duki coal were higher than those obtained for Thar coal due to high sulphur, nitrogen, and ash contents in Duki coal. For the case of Duki to Thar coal blends (D:T), under oxy-fuel combustion conditions, CO and SO_2 concentrations were higher than conventional combustion, which might be due to thermal degradation of CO_2 to CO and high O_2 concentrations in oxy-fuel operation, respectively. Also, $PM_{2.5}$, PM_{10}, and NO_x levels in oxy-fuel combustion were lower relative to those obtained in conventional condition, which might be due to presence of CO_2 which inhibits NO_x formation and vaporization of mineral matter during combustion of coal blends. Optimum D:T blend ratio of 2:8 showed lowest emissions.

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PARAMETRIC STUDY OF EMERGENCY VENTING SYSTEM OF NUCLEAR POWER PLANT

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ABSTRACT

Filtered containment system is a passive safety system that is used in nuclear accidents to maintain the integrity of containment and keep the environment and people safe. The objective of this system is to control over-pressurization and remove radioactive products like Iodine. It is very important to study iodine removal in depth in order to get maximum removal efficiency. Effect of variation of liquid flowrate on the removal efficiency of iodine was observed by using self- priming submerged venturi scrubber. Results showed that removal efficiency increased with increasing liquid flowrate. Maximum removal efficiency of >99% was achieved which fulfilled the requirement of Filtered containment venting system.

Key words: Filtered Containment Venting System (FCVS), Iodine Removal, Venturi Scrubber, Nuclear Safety System, Environment Safety

Introduction

Nuclear powerplants are reliable, clean and high capacity source of energy. The impact of accidents like Three-mile island, Chernobyl and Fukushima on the people and environment led to the development of a safety system named Filtered containment venting system (FCVS). In nuclear accidents, over- pressurization can cause explosions releasing all the radioactive products into the environment. So, over- pressurization is controlled by sending some of the containment air to this safety system [1]. This air contains radioactive products among which Iodine- 131 is a major product with half life of 8 years. It is hazardous to health and can cause thyroid cancer. This system ensures the safety of people and environment by scrubbing the air from radioactive products like iodine and the clean air is then vented into the environment [2]. Removal of radioactive Iodine is very important to avoid its hazardous effects. So, it is very important to study the effect of operating parameters to get the maximum removal efficiency [3]. Many types of scrubbers are used in FCVS for removal of radioactive Iodine. Venturi scrubbers have been in use for centuries for efficient removal of hazardous gases. The objective of present research was to study the effect of liquid flowrate on removal efficiency of iodine by using self- priming submerged venturi scrubber.

Methodology

Experimental setup for this research can be seen in Fig 1. Compressed air simulating the incoming air from nuclear power plant was sent to pressure regulator followed by a moisture separator and then then volumetric flowrate was measured by rotameter. Air was then heated to 125^{o}C to keep iodine in sublimed form, otherwise iodine would get deposited inside the line. This heated air, then got mixed with 1000 ppm iodine solution that was prepared in ethanol and was being injected by a diaphragm driven dosing pump. Iodine laden air then entered the 2 m high scrubbing column containing venturi and the scrubbing solution. Trap bottles were employed at the inlet and outlet with 200ml (0.1 M KOH) solution. Afterwards, the UV- VIS spectroscopy analysis of the inlet and outlet traps was performed. The liquid flowrate was varied from 0.0048 to 0.0056 m^3/hr., gas flow rate was kept at 4.5 m^3/hr. and 0.2 % sodium thiosulphate and 0.5% sodium hydroxide were used in the scrubbing solution.

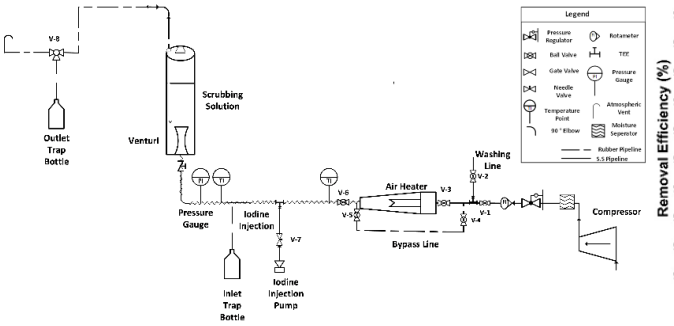

Figure 1: Schematic Diagram of FCVS Setup

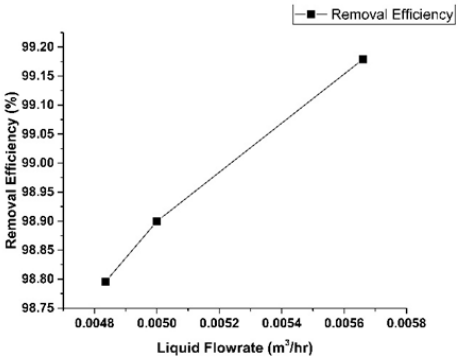

Figure 2: Effect of Liquid Flowrate on Removal Efficiency of Iodine

Results and Analysis

The effect of liquid flowrate on the removal efficiency of iodine was studied. Liquid flowrates were varied by varying the static head of liquid column. When the compressed gas reached the throat of venturi, its velocity became high and pressure dropped. This created a pressure difference between outside and inside of throat. The pressure difference caused liquid containing scrubbing solution to be sucked into the throat of venturi via orifices of venturi. This liquid then got disintegrated into droplets when it came in contact with the incoming gas via inertial impaction. The gas got captured by the droplets due to concentration difference. The gas then reacted with the scrubbing solution and got retained. Effect of liquid flowrate on removal efficiency of iodine has been shown in Figure 2. Results showed that the removal efficiency increased with increasing the liquid flowrate. Increase in static head led to the increase in the liquid flowrate causing more water to enter via orifices. Increase in droplets caused more droplets to be formed thus, increasing the contact between liquid and gas, causing more iodine to get retained.

Conclusions

In case of nuclear accidents, iodine can get dispersed into the environment and can cause thyroid cancer and other hazards. A nuclear safety system named filtered containment venting system removes iodine and ensures safety of people and environment. A lab scale setup of FCVS based on submerged venturi scrubber was developed. The purpose of the setup was to study the design and operational parameters that effect removal efficiency of iodine. Present research was conducted to study the effect of liquid flowrate on the removal efficiency of iodine. The liquid flowrate was varied from 0.0048 to 0.0056 m^3/hr. It was observed that removal efficiency increased with increasing liquid flowrate. Maximum removal efficiency of 99.17% was obtained which agreed with the requirement for filtered containment venting system.

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ENVIRONMENTAL FRIENDLY SPECIALTY CHEMICAL PLANTS FOR DEVELOPING WORLD: A ROADMAP FOR ECONOMIC DEVELOPMENT AND SUSTAINABILITY WITH WASTE REDUCTION

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ABSTRACT

Energy has been one of the main determinants in the Capital expenditure (CAPEX) and Operational Expenditure (OPEX) studies. Plant design heuristics are mainly being preserve on the basis of energy consumptions per ton and the running cost of the plant. In developing countries industrialization been facing a slow progress especially in the field of the specialty chemical. The tradeoff between the CAPEX and OPEX with influx of renewable energy based chemical manufacturing plant for readily available chemicals in utilization of small and medium textile industries manufacturing; can be established. [1]

Key words: CAPEX, OPEX, Specialty Chemicals, Energy, Textile, Unit Operations

Introduction
Developing countries are mainly facing the short fall of foreign remittances. The production cost due to energy and import duty is relatively high. [1]. Renewable energy resources are a new domain for relative sustainable and definite energy availability [2]. Solar energy among various renewable resources is highly cheap and readily available due to location of South Asian and Far East countries [3]. Solar powered, micro-chemical production facilities shall subsidize per ton production cost and whilst saving remittances at individual country level required for specialty chemical imports. Energy mix and intensification of unit operations, utilities and process portfolios will bring forth a balance between conventional and renewable energy systems with intensified process for economical availability of specialty chemicals for the local, small and medium industries, a partner in economic development [4].
Methodology:
The energy requirement of solar powered Micro Magnesium sulphate plant, a 10-ton day facility, a textile chemical will be calculated using analytical tool. The design parameters of unit operations and process shall be optimized and intensified using process modeling tool, ASPEN Plus V.10 for the classifying the minimum energy loss and maximum utilization system energy, mainly low-pressure steam and cooling water utilities. The model is environmentally friendly, sustainable and shall produce a circular model with no waste streams. Computer aided studies for feasibility analysis shall be carried out for comparison. In addition to it, model predictive control loop shall be incorporated for increasing viability at optimal parameters and energy mix (Conventional fuel powered generation and solar powered generation for 10-ton $MgSO_4$ Production during and after peak hours).
Results:
The intensified process produces a reduce per unit cost of 45% based on OPEX and CAPEX for the local manufactured specialty chemical in comparison to imported chemical. Internal waste reduced by 30% using a recycle stream. In the past the solar load has been established for the single parametric studies. Co-joining the energy with unit operation and process track a sustainable gradient. The predictive control measures an enlighten data and clustering of data maintains the energy mix for the Magnesium Sulphate production as per crystallization process values and running load capacity with total recycle and 30 % decrease in waste stream as per recycle system. In addition to it, studies using model predictive controls for increasing viability at optimal parameters and minimum stages.

Conclusion:

A prospective study has been carried out for the production of a textile and pharmaceutical oriented chemical, $MgSO_4$ 99% at capacity rate of 10 ton per day. Process intensification based economic studies produced a reduction of 45% in manufacturing cost and as compared to imported chemical cost. The environmental and hybrid energy study has been carried out using computer aided tools. The energy mix requirement was duly divided on solar power generation and conventional fuel powered system for 10-ton $MgSO_4$ process. The process data analysis and statistical analysis gives a deep understanding of quantitative and qualitative parameters of the process chemistry and energy engineering. The use of solar powered system reduces the carbon emission and greenhouse gases in environment by 70%. The waste stream reduction and recycle of 30% waste stream bring forth a sustainable model. A decrease in raw materials and heat recovery within a system maintains an eco-friendly, economical and sustainable cycle.

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UAV SPRAYERS USE FOR MANGO ORCHARDS SPRAYING TO CONTROL THE ENVIRONMENTAL POLLUTION

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ABSTRACT

Spraying on mango orchards is a very difficult operation, due to the irregular geometry of the plant more spray drift produces with a conventional sprayer. Unmanned Aerial Vehicle (UAV) is recently introduced for spraying on orchards which will help to reduce the spraying problems on mango orchards in Pakistan. The present study was conducted to investigate the optimal droplet distribution (droplet deposition, area of coverage, droplet penetration, and spray drift) in mango trees using a UAV. The results showed that the operation parameters of UAV have significant effect on spray deposition and penetration in the mango plant. The size and shape of plant has also significant effect of spray performance.

Key words: UAV sprayer, Spray deposition, mango plant, spray penetration, drift

Introduction

Spraying on mango orchards is a very difficult operation due to irregular geometry, long height, widespread canopy area of trees, and diseases (Blossom Blight/Powdery mildew) attack on flowering stage have minimum control by conventional sprayers. Unmanned Aerial Vehicle (UAV) is recently introducing for spraying on orchards [1] which will help to reduce the spraying problems on mango orchards in Pakistan. The use of hydraulic and hydro-pneumatic sprayers for mango orchards is undeniably widespread in conventional applications. The wide spreading of the pesticide is called spray drift. Recently, UAVs have been used to perform variable rate application tasks such as selective ultra-low-volume herbicide application [2, 3]. Due to the long height and widespread canopy of the mango tree spraying with a conventional sprayer was difficult and the maximum amount of spray loss in the form of airborne and ground deposition[4]. Spray drift is very effective for human health it causes heart problems, skin issues, eye irritation, and ground water pollution. The spraying machinery for the large canopy trees especially for the mango plant is a challenge for the farmers. As these plants need a large amount of spray volume and pressure to penetrate the spraying liquid into the plant canopy. On the other hand higher pressure and volume generate the spray drift which leads to and environmental risk in the vicinity of the application areas In this study UAV sprayer use for mango orchard spraying to check the effectiveness of the drone sprayer on environmental protection. The aim of this study to evaluate the pesticide deposition and spray drift reduction.

Methodology:

In this experiment, the droplet deposition efficiency of the UAV sprayer on the mango plants was studied. UAV speed and operational heights are main variable/ factor were considered. Droplet deposition and coverage and spray penetration was observed in target and off target areas. Spray application and sampling method is shown in figure 1.

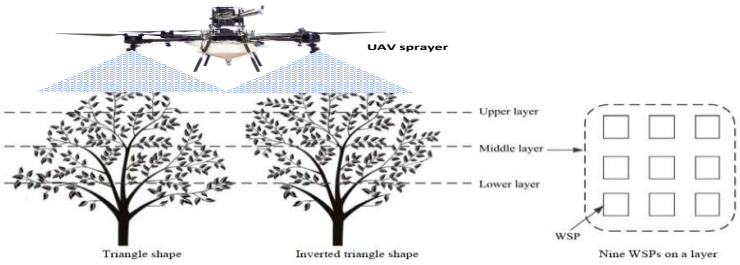

Figure 1 Schematic view of sampling

Results and Discussion

The mango plants mostly have higher canopy height and thus this plant height also effect the spray deposition and drift. In general deposition reduced with the mango canopy height. Thus, it was observed that that most There was low penetration on the lower layer of the plant. Therefore, the adoption of UAV sprayer in the mango orchards needs significant effort. The associations between droplet deposition parameters and working height were examined using the average value of each mango canopy layer droplet deposition parameters representing the droplet deposition.

Figure 2 Water sensitive paper Sampler and UAV sprayer spraying on mango plant

So, the optimal operation height was 1.5 m, which had a better UAV spraying effect. The results showed that the flight height and flight path on the plant canopy have significant effect on the spray deposition. A higher flight height develops a widespread spraying span and droplet drift, and a lower flight causes a narrow spraying span as most of those droplets concentrated in the upper canopy, while the inside regions had fewer or no droplet deposition. Further, it was also observed that significant differences between flight directions and flight path. Zhang et al [5] also conducted study to find the effect of operation parameters of UAV on spray deposition on the citrus plant .

Conclusions

The operational parameters of UAV sprayer have significant effect on the spraying efficiency and spray penetration in mango plant. The upper plant canopy has higher degree of spray deposition as compared to lower layer of plant canopy. The plant shape and height also significant effect the sprayer performance. Thus, need further work for effective utilization of the UAV sprayer in orchard conditions

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IMPACTS OF SPATIAL TRENDS ON CLIMATE CHANGE VULNERABILITY ALONG INDUS RIVER IN PAKISTAN

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ABSTRACT

It is evident that rapid urbanization is harmful and impacting climate and natural eco-system. Therefore, this study is conducted to analyze the climate change vulnerability due to spatial trends along the Indus River. The methodology adopted to use dimensions of socioeconomic, physical and environmental vulnerability and added up to form the vulnerability index and the climate change vulnerability. The data identified that contributing factors behind the vulnerability differs by geographical characteristics, access to appropriate infrastructure, level of education, livelihood characteristics and much more. The research contributes in mapping the climate vulnerability of the districts in Pakistan along the Indus River under a climate perception. The result of research would help in identifying the major lying causes and the measures suitable to reverse changes of climate.

Key Words: Climate Change Vulnerability, Index based approach, climate change mapping

Introduction

In their 2007 Fourth Assessment Report, the IPCC has predicted regional impacts of climate change. Conferring to the report by 2050s, for Asia the fresh water accessibility is anticipated to diminish and climate change is anticipated to put extraordinary weights on natural resources alongside rapid urbanization. (Meehl et al., 2007). While taking into account the impacts of extreme climatic change the whole structure of the society comprises of the physical and societal would disrupt especially along Indus River. Therefore this research undertakes the identification of physical, socioeconomic and environmental indicators of climate change in order to measure the climate change vulnerability along Indus River using index based approach. The area of study selected for this research has the River Indus as its main entity as the monetary existence of Pakistan extensively depends on the stream of Indus River Basin, About over 80% of the Indus stream achieving the Punjab fields is gotten from regular, changeless snowfields and chilly soften from Himalaya (Immerzeel et al., 2010). The extent of the study has been selected as the district level with the time frame selected of 2005, 2010 and 2015 as data only available for these fifteen years.

Methodology

The methodology adopted for this research includes the development of an index by using the data obtained from various sources and then compares the change in vulnerability in the districts along Indus River. The data had been collected from various sources like Pakistan Social and Living Standard Measurement (PSLM) report, Development Statistics reports, and Multiple Indicator Cluster Survey. and the further steps involved data normalization, data standardization and data inversion techniques to develop a final climate change vulnerability indicator. The Indus river is passing through 33 districts in three provinces of Pakistan i.e. Punjab, Sindh and KPK. The data of selected indicators collected from various sources of 33 districts and compiled for three intervals to measure climate change vulnerability i.e. 2005, 2010 and 2015 as latest data of detailed selected indicators was available upto 2015. The extent of vulnerability maps of these districts also prepared using index based approach.

Results and analysis

To observe the change in vulnerability in climate, the trend has been observed for three different time series. The results have showed that there are certain districts whose vulnerability has increased over the time while some of them have depicted a decrease in vulnerability. On the other hand, there are regions who have showed a variation or arbitrary trend in the vulnerability. The reason that noted increase or decrease of vulnerability over time is due to certain indicators like education, sanitation

facilities, conversion of cultivated area for other uses, decrease in forest cover, diversification in livelihood, usage of efficient building material and increase in industrial activity.

Conclusion

The main reasons that are behind the vulnerability are the insufficient health and education institutions and infrastructure, insufficient access to improved water and sanitation sources, increased population and road density, people's dependence on agriculture, ownership status and the construction approaches adopted, increased industrial activities and the degradation of the agriculture as well as the forest area. Furthermore, the extreme changes happening are leaving the water reservoirs scarce and contaminated and the most affected are those who cannot afford these necessities.

In the light of this it is quite reasonable to say that the coming years will have variance in the susceptibility to the dangers connected with the change in climate. The vulnerability of the people will determine the extent of damage to be caused by these climatic events. There is a need to cope such factors that caused increased in vulnerability rather to manage effects. This study provides indicators that can reduce the vulnerability of climate change.

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EFFICIENCY CHARACTERIZATION METHOD FOR OPERATIONAL AND ENVIRONMENTAL BENCHMARKING OF WASTEWATER TREATMENT SYSTEMS

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ABSTRACT

A perfectly efficient system or a process is characterized by the relative change in the inputs and outputs for achieving the desired product or solution. Typically, mechanical processes are designed in light of human health and well-being, with the objective of producing high quality products at a low operating costs and long-term sustainability. In case of wastewater treatment, numerous technologies are designed to produce high quality effluent for pollution-free and sustainable discharge into the environment. Analysing the effectiveness of these technologies as a function of the resources consumed with respect to their environmental impact is a substantial method to benchmark standards for further development. Life Cycle Assessment (LCA) and Data envelopment analysis (DEA), the two methods researched in this paper, are designed to assess the environmental impact and analyse the operational efficiency of the study systems. Based on relevant studies and published work, Lifecycle assessment method is appreciated as a framework to classify the environmental impact of a system, structured to acknowledge the processes leading to the product and by-products. Data envelopment analysis is the mathematical model designed to calculate a production function based on the operational parameters from disparate systems. Utilizing the framework from the lifecycle assessment to develop the production function based on the data envelopment models is the discussed conclusion of this paper with the suggested application of the method to establish efficiency benchmarks for water quality and treatment.

Key words: Environment, Lifecycle assessment, Data envelopment analysis

Introduction

Every human activity is associated with water in one way or the other. From only 2.5% of fresh water on earth, 3.1 trillion litres are consumed daily for domestic and industrial activities. Water the super solvent, carries along the contaminations to lakes, rivers and groundwater reserves polluting the only 2.5% of fresh water [52]. A wastewater treatment process is considered most effective when it clears away the carcinogenic microbiological and chemical solutes both at low cost and with minimal operational and maintenance requirements [51].

Globally, the wastewater is treated through a wide range of technologies. Activated sludge, trickling filters and sequencing batch reactors (SBR) are commonly utilised wastewater treatment technologies in Kingdom of Saudi Arabia, India, China and Turkey [3, 43, 71]. Tertiary treatment is achieved through media filtration, ozonation and ultraviolet filtration systems before distributing or releasing the water to the environment.

These wastewater treatment processes; originally designed to minimise the impact on the environment in view of long term ecological sustainability and safe recycling of natural and economic resources; must be evaluated based on energy consumption, operational costs, environmental emissions and land usage pertaining to process optimisation and economic development [15, 48, 50]. Numerous methods and techniques are developed to evaluate the potential of a system in terms of producing maximum output from a given set of inputs and the environmental impacts associated with achieving those outputs [21, 36]. Statistical data analysis in terms of BOD, COD and TSS removal is an applied method for quantitative assessment of the wastewater treatment process. LCA (Life Cycle Assessment); one of the methods researched in this article; analyzes the performance of a product or system in terms of its environmental impact over the period of its life cycle. This method is accepted by various government bodies, local authorities and municipalities as a decision support tool for assessment of environmental systems [28, 37, 44]. DEA (Data Envelopment Analysis) is the

mathematical model for evaluating the relative efficiencies based on inputs and outputs parameters of selected systems resulting in development of frontiers and benchmarking standards [14, 66].
Goal of this paper is to perform critical review of the standard methods leading to characterization of a perfectly efficient or the most efficient system benchmarked as the standard reference for policy-making, regulatory development and planning. Life cycle assessment and Data envelopment analysis are the two methods discussed in terms of application, methodology and benefits to valuate the operational and environmental performance of the selected systems.

Methodology:

Efficiency characterization

Efficiency characterisation model for any system is indirectly a representation of the system's economics directed towards fulfilling the policy making and planning requirements. Efficiency characterisation can be summarised as measurement of the resource intensiveness and limits to the undesirable outputs of any given system within the framework of producing expected outputs [21].
For a wastewater treatment plant, efficiency will be characterised based on the environmental impact and ecological sustainability with respect to energy consumption, contaminant removal, atmospheric emissions and sludge production [25, 32]. These categories are briefly explained in the sections below in terms of their average values, measurement units and parametric variables with graphical representation of actual data values collected from literature and online data sources.

Energy Consumption

An average range of 0.23 kWh to 0.7 kWh is consumed to treat 1 m3 of wastewater using secondary treatment methods [19,63]. Large scale systems are reportedly less energy-intensive due to higher flow rates providing steady conditions for microbial action. Nevertheless, energy-intensiveness is relative to the function and design of the treatment system and is measured as kWh consumption per grams of contaminant removed or per population equivalent or per cubic meter of influent flow [19, 40]. Figure 1 is a graphical representation of range of energy consumption for common secondary wastewater treatment technologies.

Contaminant Removal

Biological oxygen demand (BOD), total suspended solid (TSS), metals, faecal coliforms and nutrients are the typically found contaminants in influent wastewater in addition to emerging contaminants [10]. Treatment of these contaminants is a measure to prevent oxygen depletion, pathogenic growth, endangering diversity and aquatic habitat, aesthetic degradation and recreational losses [10]. Concentration value of 25 mg/L is recommended for Biological Oxygen Demand (BOD) and Suspended Solid (SS) concentration, while 1.25 mg/L for ammonia in the discharge stream of a wastewater system [60]. Figure 2 is a representation of contaminant removal range for common secondary wastewater technologies.

Atmospheric Emissions

Carbon dioxide (CO2), Methane (CH4) and Nitrous Oxide (N2O) produced during the wastewater treatment processes contribute to climate change and air pollution [7]. Biological treatment (clarification, aeration, nitrification & denitrification and anaerobic digestion) and electric power consumption (pumps, degritters, basins, blowers, agitators) are the main sources of direct and indirect atmospheric emissions respectively [25,31]. These emissions are measured in kg CO2 equivalent per kWH and per kg COD removed. Contribution of wastewater treatment plants is estimated to be 9% for CH4 emissions and 3% for N2O emissions globally. Figure 3 is representation of atmospheric emissions for common technologies for secondary wastewater treatment.

Sludge Production

An average production rate of 35 to 85 grams is recorded for sludge produced per capita. The daily sludge production is measured in gTS (grams Total Solids) per PE (Population Equivalent) per day [26]. The sludge in wastewater is produced from the suspended solid content in the influent wastewater, therefore the sludge production rate from a wastewater treatment process can be expressed in grams of suspended solids removed per capita (gSS/capita). Sperling, 2007 [61] has calculated the sludge production rate as a factor of COD removal in reference to relation below: 0.1 kgCOD / capita / day = 0.056 kgSS / capita / day (2) Where COD is carbonaceous oxygen demand and SS is suspended solid concentration in the influent wastewater. In reference to the influent concentration and loading rate per capita in table 3, relation in eq 2, holds true. Figure 4 is

representation of sludge production for common secondary wastewater treatment technologies excluding biogas production. Performance appraisal of a WWTP is a method to benchmark the existing treatment process in terms of contaminant removal, sustainable operations and ability to meet higher treatment requirements. Typically resulting in development of analytical reports and datasets, a WWTP efficiency analysis can lead to significant improvements in design and treatment processes.

Results and Analysis

Efficiency assessment

Maximising the outputs with the given set of inputs is the efficiency objective of any system or process. A novel approach for efficiency assessment is the expression of a system's efficiency in reference to a perfectly efficient system using a production function [21,23].

In case of a wastewater treatment system that comprises of further subsystems and specific processes [27], a 'cradle to gate' approach that includes all the environmental and operational parameters and the associated potential impacts [37] from the conception of the system to its present state, can lead to a comprehensive efficiency assessment model [37, 56]. Lifecycle assessment method explained in section 4.1 is that 'cradle to gate' approach applied by various authors and environmental practitioners for studying the waste water treatment systems.

The efficiency assessment for the operations and environmental sustainability of these wastewater treatment systems can be expressed through the physical input and output data compiled during the inventory analysis phase of the Lifecycle assessment method [27]. Equation 1, is the mathematical form of a simple productivity equation [17] which represents the efficiency as a function of the ratio of total output to total input.

$$\boldsymbol{Efficiency} = \sum \boldsymbol{y} / \sum \boldsymbol{x} \quad (3)$$

Where y is the output and x is the input value of the data collected in the inventory [13]. The equation for the marginal rate of technical substitution (MRTS) given in equation 2, is similar to equation 1, except this is the expression of relative change in the quantity of one parameter with respect to another parameter while maintaining constant output [64]

$$\boldsymbol{MRTS} = \Delta \boldsymbol{K} / \Delta \boldsymbol{L} \quad (4)$$

Where K is the parameter on the y axis and L is the parameter on the x axis. The solution of equation 2 where the output is kept constant, the combination range of the K and L parameter can lead to development of a non-linear curve on a cartesian plane. This non-linear curve provides the basis for development of an efficient production function and the efficiency frontier for a perfectly efficient system, as discussed above. Pioneered by [21], this is the principal concept of the data envelopment analysis method discussed in section 4.2, for assessing the operational and environmental efficiency of a wastewater treatment system along with examples of work published from various authors.

For multiple systems or DMUs (Decision Making Units) with more than one input and outputs, the results obtained from mathematical models based on equation 1, can lead to a substantial assessment of the efficiency.

Life cycle assessment

LCA or Life Cycle Assessment is a 'cradle to gate' approach to quantitatively analyse the environmental performance of a system based on the footprint of the generated product or results [44, 56].

LCA studies are designed to quantify sustainability with the onset of improving the environmental performance of a system through analytical modelling of a particular function/process or the entire chain of functions/processes [30a].

Process Framework

Any Life Cycle Assessment (LCA) study initiates with definition of goal and scope to adequately identify the intended use of the study. The required levels of detail, functional unit and the system boundaries are defined in this phase. Followed by Life Cycle Inventory Analysis, the second phase of an LCA study, where the input and output data is collected for the system defined in the goal of the study. Data quality analysis, data estimation and data validity is checked during this phase to amplify the consistency and accuracy of inventory data. Third phase, Life Cycle Impact Assessment (LCIA) is

an evaluation of potential environmental impact on the system based on the process flow and data collected in the inventory. An iterative interpretation of the information collected during each phase is summarised in the Life Cycle Interpretation phase, leading to development of a conclusion and results of the study [30a, 36, 37].

LCA studies within the field of wastewater treatment began in 1990s. Since then various authors have documented the application of LCA method to characterise the environmental loadings and their potential sources [14a]. These emissions or loadings are the impact categories analysed in the LCIA (Life Cycle Impact Assessment) based on the data collected in during the life cycle inventory analysis phase. A recommended LCA study should include all the phases of a product; from manufacturing to end-of-life: construction, installation, operation, maintenance and transportation. For wastewater treatment systems the operation and maintenance phases are mainly focused on due to the high resource consumption and excessive emissions to air, water and land [28, 44].

Inventory Development

According to the LCA guidelines, the data collected during the inventory analysis should include the resource consumption details and the emissions to the environment [37]. For wastewater treatment systems a well developed inventory would include energy and chemical consumption, concentration of pollutants in the influent and effluent streams, CO_2, CH_4, N_2O and other emissions to air measured according to the IPCC (Intergovernmental Panel on Climate Change Guideline) or similar guidelines [55]. Data collected during the LCI phase is translated to category indicators for each impact category prior to weighting, normalisation and data quality analysis [35]. Typical impact categories in wastewater system assessment include Eutrophication potential, Acidification potential, Climate change (Global warming, Ozone depletion) and Abiotic (natural resource) depletion [14a, 24, 35, 41a]. Table 4 is a brief overview of the classification and characterisation of common impact categories for wastewater treatment systems.

Relevant LCA studies

Table 5 is the anatomy of LCA studies on wastewater treatment, according to the ISO framework. The listed assessments were published by various authors globally with the common objective of quantifying the environmental performance of wastewater treatment systems tabulated with respect to the definitions and phases defined by the ISO standard.

Interpretation and Results

Outcome of an LCA study is typically the summary of the data collected during inventory analysis phase interpreted with respect to the impact categories defined during the impact category analysis. [37] has agreed that the ISO standard requires further development when it comes to interpretation phase of the LCA method. According to [35], interpretation of an LCA study is the conclusion drawn from classification, characterisation, normalisation, grouping and weighting of the inventory data with respect to the impact categories and the defined goal and scope of the study. Piao et., al and McNamara et., al [53, 44] used the CML2 method with net environmental benefit and data sensitivity model. (McNamara, et al. 2014) concluded that the eutrophication potential of a biological treatment system is 80% higher compared to a similar system with nitrification/denitrification with an excess 15 kWh/p.e. energy consumption for the latter [44]. For the impact categories mentioned in table 5, the treatment system with nitrification/denitrification producing cleaner effluent has a higher global warming and abiotic depletion impact with a lower eco-toxicity and ozone depletion potential.

Garfi, Flores and Ferrer [28] used the ReCipe analytical method with a sensitivity analysis to conclude that the mechanical treatment plants have higher environmental and economic implications compared to nature based treatment systems, mainly due to the high electricity consumption required for the operation of the plant. In case of nature based systems, the construction phase contributes up to 65% of the total impact with up to 6m2 of land requirement per population equivalent. The impact due to sludge transportation and disposal was reported to be less than 5%.

Data envelopment analysis (DEA)

Data Envelopment Analysis is a data-oriented, programming technique to evaluate the efficiency of DMUs (Decision Making Unit) [11] in reference to an envelopment surface or the efficient production frontier [57]. A DMU or a Decision Making Unit is an entity process that converts input(s) into output(s) [14]. DMUs with an efficiency value equal to 1 are deemed efficient so they rest on the efficient frontier else are deemed inefficient. This method is especially useful in determining relative efficiencies of DMUs when assessed based on similar input and output parameters.

Numerous studies have documented the use of data envelopment analysis (DEA) methodology for efficiency assessment of wastewater treatment systems. Based on the relative quantity of the consumed resources (inputs) and the generated products (outputs), the efficient frontier is the slope of the DMUs that consumes minimum resources to produce the expected product (input oriented) or the systems that produce maximum output by consuming a set amount of resources (input oriented) [9]. In other words, an input-oriented measure of efficiency is the amount by which the input can be reduced while maintaining the current levels of output. Similarly, an output-oriented measure of efficiency is the increase in output at the fixed level of inputs [11].

Efficiency of the DMUs is assessed on a relative scale through various mathematical models resulting in classification of the DMUs into efficient and inefficient. The DMUs categorised as efficient form a frontier enveloping the inefficient DMUs, therefore the analysis method is named as Data Envelopment s

Cooper, Seiford and Zhu [14] have defined the DEA as the method to assess the efficiency of a process by comparing the relative efficiencies of DMU(s).

Review of relevant work

Wang et al, work on four waste water treatment plants in Toronto, Canada, is a very good example of data envelopment analysis method to develop efficiency benchmarks. Using the cost of resources as inputs and the quality of effluent from the treatment system as output, they concluded that the size of the treatment plant had an inverse relation to the efficiency ranking of the systems, mainly due to the variation in flow rates and the concentration of contaminants in the influent wastewater stream.

They applied the input oriented method to a variable return to scale, BCC (Banker-Charnes-Cooper) model to estimate the possible reduction in the resources consumed to generate the required effluent quality.

The methodology adopted by [38], highlights the undesirable outputs resulting from treatment of wastewater to achieve the desirable product (quality effluent). The slack based measurement (SBM) method was used based on input oriented, variable return to scale model. Operating cost, electricity consumption and number of employees required to run the plant were set as the input while the percentage of COD (chemical oxygen demand) and NH3-N (ammonia) removed with treated water yield was set as the output for the model. Additionally, the amount of sludge produced was set as the undesirable output.

The study of 861 treatment systems concluded that operating cost, electricity consumption and number of employee were the prominent factors leading to the variation in efficiency of the systems. Contaminant loading rate is a key influencing factor in efficiency assessment.

Guerrini et al, studied 127 activated sludge treatment systems with cost of energy as input and the percentage of removal efficiency and sludge produced as the output. Based on an output oriented model with variable return to scale assumption, the results calculated using a double bootstrap method concluded that the treatment rate and the type of aeration method were the two factors impacting the operational efficiency of the treatment system.

An increase of 0.22 € per m3 in energy cost was noted from large to small treatment systems. For the range of activated sludge system, the aeration from diffusers added to the cost of the treatment system up to 0.29 € per m3 of reclaimed water yield in comparison to the systems without aeration at 0.08 € per m3. The average DEA score observed for the group of treatment system equals 0.458.

Conclusions

Further research work in from of case studies and assessment studies of mechanical treatment systems will help establish a baseline of the application of the integrated method and highlight any limitations or considerations required to assess the efficiency leading to development of benchmarks for reference systems.

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ANALYSIS OF GLOBAL WARMING POTENTIAL REDUCTION BY TECHNOLOGY SHIFT FROM COAL FIRED POWER PLANT TO RLNG COMBINED CYCLE POWER PLANT AND ENVIRONMENTAL & ECONOMIC BENEFITS OF COMBINED COOLING AND POWER GENERATION FROM RLNG COMBINED CYCLE POWER PLANT

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ABSTRACT

The emissions from burning fuels are triggering the climate change, hence there is an increasing need to limit these emissions in order to keep our environment liveable. This research was carried on emissions of coal fired and RLNG based power plants installed in Punjab, Pakistan, and global warming potential (GWP) of both types were analysed. The study suggested that GWP index of later type is 470 points less than that of former one. Moreover, existing Vapour Compression Cooling System (VCCS) of RLNG based power plant was replaced by Vapour Absorption Cooling System (VACS) utilizing waste heat of the power plant, that resulted to limit more emissions and conserve energy. The minimum and maximum heat energy available from exhaust gas of RLNG based power plant was calculated to be 2.96 GJ/hr and 6.2 GJ/hr respectively that was used to run VACS to cater 300 TOR of cooling load of power plant. The proposed system saved 1214.5 MWh of electricity and avoided 255.58 Ton of CO_2 emission annually. Moreover, the running cost of propossed VACS was observed to be 46% less than the existing VCCS. So after paying back the installation cost in 8 years, VACS would generate profit of 5.39 Million USD through out the operational life of power plant. The findings suggested that proposed system had great fuel and emission saving potential and was useful in reducing GWP.

Key words: Super-critical coal-fired, RLNG combined cycle power plant, GWP Index, Carbon dioxide equivalent (CO_2eq), Waste heat recovery.

Introduction

With the passage of time, energy demand is increasing resulting into more fuel consumption. As the fuel consumption increases, the emissions also increase resulting global warming. It is required to devise ways to limit emissions without compromising energy supply. Bhawna Singh et al. tried to reduce GWP directly by capturing CO_2 from natural gas power plant emissions. Life cycle assessment of combined cycle power plant was performed with post-combustion carbon capture, transport and storage. It was observed that 70% of CO_2 could be avoided from emission to atmosphere by utilizing Carbon Capture Storage (CCS) process thus reducing GWP. However, CCS increased the running cost of plant and reduced the electricity output [1]. So the best way to limit emissions is to conserve existing energy supply.

Power generation plants lose a lot energy which can be conserved in different ways for utilization. Pattanayak et al. utilized cold energy released during regasification process of Liquified Natural Gas (LNG) in three different ways to study thermodynamic performance of CCPP [2]. Luis Perez et al. analyzed that with the enhancement in quality life style, 50% of total energy of building is consumed by HVAC system [3].

A research should be performed to develop a system that not only conserve energy but also help to reduce GWP without addition in cost and reduction in electricity generation. The research

understudy is based on the operational data of 2x660 MW coal fired super critical power plant (say PP-1), 1180 MW RLNG CCPP (say PP-2), 1223 MW RLNG CCPP (say PP-3), 1230 MW RLNG CCPP (say PP-4) and 1263 MW RLNG CCPP (say PP-5). All the five (05) mentioned power plants are installed at region of Punjab, Pakistan, so the socio-economic effect of all power plants remains the same.

Methodology

VACS is designed on the basis of maximum and minimum exhaust heat energy availability. In second step, mass flow rate and temperature of exhaust gas of each operational mode of PP-2, PP-3, PP-4 and PP-5 are calculated. The values are further used to calculate exhaust heat energy available. Then power plant with minimum exhaust heat energy value is selected for further analysis. The cooling load of different buildings of that selected CCPP is calculated. Finally, the amount of maximum and minimum cooling that can be generated from available exhaust heat energy through VACS is calculated. Vapor absorption chillers will be installed for each building which will generate the cooling through absorption system. At the end, energy conservation and emission saving analysis shall be performed.

Results and Analysis

- VACS designed on the basis of maximum and minimum heat energy available can cater maximum and minimum cooling load of 300 TOR and 100 TOR respectively.
- The total cooling load of PP-4 is 632 TOR calculated using HAP software. Since maximum 300 TOR of cooling load can be catered due to heat constraints, five (05) buildings are selected which shall be provided with VACS.
- Electricity consumption of proposed VACS is 162 KW as compared to 302 KW of electricity consumption of existing VCCS as shown in Table 8. Proposed VACS would save 46% of electricity being consumed by cooling system of PP-4.
- Similarly, annual running cost of proposed VACS is 0.1778 Million USD as compared to 0.3319 Million USD for VCCS of same capacity. Proposed system would save 0.1541 Million USD annually.
- PP-4 emits 207.54 kg of CO_2 per MWh of electricity produced. Since, proposed VACS is saving 3.374 MWh of electricity, it would avoid 255.58 Tons of CO_2 from emission annually.
- Capital Cost of CO_2 Capturing Unit installed in any typical RLNG CCPP is 10 USD per MWh of Electricity Produced. Since 3.374 MWh for electricity is being saved by proposed VACS, the cost saved in terms of capturing CO_2 is 34.81 USD per day and 0.01271 Million USD during operational life of power plant.
- The installation cost of proposed system is 1.28 Million USD. This cost would be recovered with in time span of eight (08) years approximately. Since the life of power plant is 40 years, the remaining 32 years would be profit year amounting to accumulative profit of amount 5.39 Million USD.

Conclusions

Pakistan is experiencing acute power crisis, increase in fuel prices and climate change. All these issues have collectively decreased the growth rate of the country. Increasing the power generation capacity is one of the solution but has its demerits also. It requires new infrastructure to be installed and increase in fuel demand which will cost foreign reserves of the country. Moreover, increase in power generation will tend to increase emissions thus adding to carbon footprint of the country. Before enhancing power generation capacity, the methods should be devised to conserve existing power. This study is a step forward towards energy conservation. The proposed VACS powered by heat recovery system in CCPP is based on principles of energy conservation which has proven emission and cost cutoff potential.

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ASSESSMENT OF HEAVY METALS IN SOIL IRRIGATED WITH WASTEWATER

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ABSTRACT

Heavy metals accumulation in soil has become a serious environmental threat in countries like Pakistan where wastewater is used for irrigation. A survey research was carried to assess the impacts of wastewater on heavy metals accumulation at Saggian, Lahore. Source of irrigation water applied at Saggian, Lahore was wastewater arising from sewerage and industries. Twenty soil samples were collected from depth of 0-15 and 15-30 cm at distance of 200 m covering an area of 2 km. Heavy metals Lead, Copper, Zinc, Nickel, Cadmium and Chromium in soil samples were analyzed by using Atomic Absorption Spectroscopy. Results indicated that all the tested heavy metals concentration in soil was above the permissible limits. Wastewater applied to soil for irrigation purposes is a major source of heavy metals accumulation in soil.

Key words: Wastewater, Heavy metals, Agricultural soils, WHO permissible limits

Introduction

Recently, the reuse of wastewater in agriculture has become a widespread practice in regions where water deficits are most pronounced. In general, this resource contains substantial amounts of beneficial nutrients and toxic pollutants, which are creating opportunities and problems for agricultural production, respectively [1]. Long-term use of industrial or municipal wastewater in irrigation may lead to the accumulation of heavy metals in agricultural soils. Soil quality and health show the status of soil function in ecosystem including soil chemical, physical and bio properties. Contamination resulting from toxic metals above limit values are destroying natural ability of soil to maintain ecosystem [2]. Wastewater irrigation cause salinity in soil, alkalinization or acidification, changes in structure and results in reduction of productivity of soil [3].

Methodology

An initial survey was conducted at Saggian, Lahore for identification of sites where wastewater was applied to agricultural soils. Twenty representative soil samples were collected from 0-15 and 15-30 cm with the help of auger. Irrigation water sample was also taken for heavy water analysis. In the laboratory, all samples were air-dried in ambient conditions and passed through a 2-mm mesh sieve. Non-soil particles e.g. stones, wooden pieces, rocks, gravels, organic debris were removed. To measure concentration of heavy metals in soil samples Atomic absorption spectrophotometer was used. The Guideline for maximum limit of heavy metals (Zn, Cu, Pb and Cd) in soil was adopted from the reference by WHO (Table 1).

Results and Analysis

The variations in the heavy metals in soil with the application of wastewater is described in Table 1. An increasing trend in the heavy metals concentration of soil can easily be observed with wastewater application. The irrigated soil was contaminated with Cr (121.05-126.9 mg kg^{-1}), Pb (106.5 to 112.9 mg kg^{-1}), Zn (30.8-33.8 mg kg^{-1}), Cu (47.75-48.75 mg kg^{-1}), Ni (45.2-45.3 mg kg^{-1}) and Cd (0.54-0.57 mg kg^{-1}). The highest concentration of Cr was accumulated in soil with wastewater. Trend of heavy metals concentration in all samples was Cr>Pb>Cu>Ni>Zn>Cd.

Table 1: Heavy Metals Concentration in Soil

Heavy Metals	Concentration (mg kg^{-1})		Permissible Limit in soil (mg kg^{-1})
	Soil (Depth 0-15)	Soil (Depth 15-30)	
Cr	121.05	126.9	100
Pb	106.5	112.9	85
Zn	33.8	30.8	50
Cu	48.75	47.75	36
Ni	45.3	45.2	35
Cd	0.54	0.57	0.8

Conclusions

The results of the study clearly indicate that the wastewater-irrigated soils were moderately enriched with Cr, Pb, Cu, Ni, Zn and Cd relative to FAO/WHO permissible limit. Our results revealed high risks of heavy metal accumulation in our study area and a great health risk to the local human and animal populations. Thus, preventive measures must be taken to reduce heavy metal pollution of irrigation water and soils.

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INDUSTRIAL DYE DECOLORIZATION BY PARTIALLY PURIFIED MICROBIAL LACCASE FROM BACILLUS *SP*

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ABSTRACT

The progress of textile industry increases the risk for human health associated with effluent discharge in water bodies which ultimately contaminates water bodies with various agents. There is a great demand of time after COVID-19 shutdown that world should restart its potential sources and, in this domain, effluent treatment is the leading demand to decrease the risk of future pandemics. It should be mandatory for all the leading countries to treat the processing plants water before accessing it into water bodies. In the current study, a promising hydrolyzing agent was isolated from soil which was identified as *Bacillus subtilis*. This bacterial strain has immense potential for hydrolyzing malachite green dye up to 40µl concentration. This enzyme production was optimized under BHM which showed to be most promising medium for the cultivation than MSM, BMSM, BSM and NDM. The maximum laccase production was obtained at 40°C, pH 5.0±0.2 after 24 hours of fermentation period. The successful media contain Glucose (0.5%), Yeast extract (0.5%), Ammonium nitrate (0.25%), K2HPO4 (0.25%), CaCl2 and MgSO4 (0.1% each). The current research work concluded that *Bacillus subtilis* which was isolated from textile areas of Karachi has maximum potential to produce laccase enzyme which helps in the hydrolysis of Malachite Green. This study reveals that this bacterial isolate and its enzyme efficiently used for bioremediation purpose of textile effluent.

Key words: *Textile effluent treatment, Malachite green, bioremediation, Optimization, microbial enzyme*

Introduction

Rapidity of industrialization and urbanization produced huge amount of pollutants into environment which is responsible for further pollution. [1]. Environmental cleanliness and sustainability is crucial for human wellbeing but modern-day industrial pollutants that effects air, water and soil can directly as well as indirectly compromises human health and environment [2].The usage of dyeing material in textile industry has serious hazardous effect due to the discharge of these recalcitrant pollutant to the environment, specifically to the water bodies. [3]. among all industrial sectors textile plant is categorized as the highest polluting sector. The enzymatic decolorization of such stable pollutant is a green and sustainable approach due to the requirement of less energy and minimum impact on environment. [4]. Degradation based on enzyme is a sustainable approach as its efficiency, cost effective and environmental friendly.

Methodology

The bacterium *Bacillus.subtilis* that has potential to decolorize industrial dye was isolated from the soil of textile industry. After that a newly modified fermented medium i.e. Bushnell and Hass medium (BHM) was selected which undergoes different physico-chemical factors (pH, temperature, time, medium composition and dye concentration). By adapting the gradient salt method bacterial enzyme was partially purified and enzyme assay was performed.

Results and Analysis

The results of the present study showed that, high production of microbial enzyme that has the tendency to decolorize dye was obtained at different physico-chemical parameters.

Conclusions

In the current study, Laccase producing bacterial strain with the potential of hydrolyzing malachite green was isolated from soil nearby textile industries located in Karachi, Pakistan. Textile dyes are the major elements for imparting stain in industrial waste water. The discharge of the colored effluent in aquatic bodies causing disturbance in the production of the aquatic organisms and sunlight process. The isolated strain was further identified as *Bacillus subtilis*, on the basis of morphological and biochemical characteristics. The isolated strain was further used for the production of laccase and it was observed that *B.subtilis* produced laccase in maximum concentration with BHM at 40°C, pH 5.0±0.2 after 24 hours of fermentation period. It was also observed that glucose, yeast extract, ammonium nitrate. K_2HPO_4, $CaCl_2$ and $MgSO_4$ has promising effect on laccase production. The 40µl concentration of dye showed maximum decolorization rate which suggested that laccase produced by *B.subtilis* has ability to hydrolyze malachite green effectively with laccase enzyme. Therefore, it is suggested that *B.subtilis* could be a promising source for the hydrolysis of malachite green in textile containing effluent.

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SITING AND ENVIRONMENTAL ISSUES CONCERNING BRICK KILNS: PERCEPTIONS OF BRICK KILN OWNERS IN LAHORE

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ABSTRACT

Air pollution is perceived as a serious environmental issue in cities of developing countries. The city of Lahore is no exception where smoke from brick kilns is one of major contributor to this problem besides industrial emissions, the burning of crop residue and solid waste. In particular, nearly all the brick kilns have to be shut down in winter which not only results in joblessness of the labor force working in these kilns as well as related organizations like construction companies but also contributes to rise in construction cost. This research investigates the siting and environmental issues concerning brick kilns in Lahore involving assessment of views of stakeholders for adoption of technologically proficient option to produce cleaner bricks while simultaneously performing land-use suitability analysis for siting of brick kilns. The research identifies barriers as well as suggest measures to promote cleaner technology with the view to mitigate the impacts of emissions from brick kilns.

Key words: brick kilns, land-use suitability analysis, environmental issues

Introduction

Air Pollution is a serious problem in cities of developing countries and so is the case with Pakistan [1], especially in Lahore, which is now considered as one of the top ten most polluted cities in the world in terms of air quality [2]. The city of Lahore has extremely low visibility due to smog during winters. A large number of small and medium industries are found as contributors in worsening the situation. Emission of dense black smoke from the chimneys of brick kilns are also perceived as one of the major factors that influence the curse of smog. As one of the policy measures to diminish the impact of smog over the health of citizens, brick kilns are closed temporarily with the exception of those using cleaner technology to produce bricks [3]. This directly increases the bricks cost and ultimately the construction cost besides causing unemployment. Efforts are also being made at the Government level to promote cleaner technology based kilns. However, there are issues in adoption of cleaner technology for cleaner production of bricks. This research aims to assess the views of stakeholders so as to highlight barriers and suggest measures to encourage adoption of cleaner technology in brick kilns. It also assesses the existing pattern of location of brick kilns with the view to suggest appropriate locations for siting the brick kilns.

Methodology

The methodology involved selection of case study, review of literature, and collection and analysis of secondary and primary data. The Lahore district was selected as a case study. The literature review consisted of the strategies to control emissions from brick kilns in developing and developed countries. Secondary data collection comprised of review of newspaper articles and reports as well as collation of data on number and location of brick kilns in Lahore in addition to data about wind direction and speed prevalent in Lahore during various months of the year. The primary data collection involved structured interviews with concerned officials of Environmental Protection Department Punjab as well as the Lahore Development Authority, representatives of brick kiln Association and selected brick kiln owners. The analysis of secondary and primary data involved siting criteria analysis, land use suitability analysis, processing of views of regulators and brick kiln owners and performing cost analysis of technology options to produce cleaner bricks.

Results and Analysis

The siting criteria analysis demonstrate that in Lahore a good majority (80%) of the brick kilns are lying within 3km from the urban extent, thus violating minimum distance considered safe from sensitive land uses like residential. The land-use suitability analysis helped to identify four alternative environmentally safe sites for brick kilns within the urban extent of Lahore, appropriate with respect to location and wind pattern. Interviews with concerned officials reveal that there is weak environmental and land use control respectively to reduce emissions and regulate the siting of brick kilns in the city. Analysis of results from interviews with selected brick kiln owners show that key barriers in adoption of cleaner technology in brick kilns are low level of awareness, upfront capital cost and risks associated with such an investment. Nevertheless, the results indicate that brick kiln owners are willing to adopt new technologies and shift from congested areas to some appropriate location only with Government assistance.

Conclusion

The brick industry in Lahore like elsewhere in South Asian countries is un-regularized and operating without due care to environmental considerations. Survey revealed that most of the brick kilns are functioning by employing old technology while few have converted to zig-zag technology and achieved cost efficiency by ensuring the increase in brick production per day while using same quantity of fuel thus enhancing environmental efficiency. In order to encourage use of cleaner technology as well as address the emissions problem, there is to ensure provision of interest free loans, adoption of mechanism to train labor and phase-wise shifting of some brick kilns at appropriate locations.

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COMPUTATIONAL FLUID DYNAMICS (CFD) STUDY OF SCRUBBING AIR POLLUTANTS THROUGH A VENTURI DEVICE

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ABSTRACT

In this work Computational Fluid Dynamics (CFD) simulations were performed to computationally analyze the scrubbing or removal of radioactive iodine from containment air of a Nuclear Power Plant. A mathematical model of iodine mass transfer has been developed and embedded in Fluent software to carry out these simulations. venturi device was used for scrubbing the radioactive iodine from air through water as scrubbing solution and the results were compared with experimental data to validate the CFD results. Eulerian model of two-phase flow was used for modeling with realizable k-epsilon model as the turbulence model. The results obtained from CFD simulations matched well with experimental ones, thus validating the mass transfer model and CFD simulations.

Keywords: Venturi scrubber, CFD, mass transfer model

Introduction

The natural environment gets contaminated when foreign particles of dust, ash, NO's, SO's, radioactive iodine or other pollutants are released into the ambient air directly. These foreign particles in atmospheric air have very serious health concerns for the community residing nearby. The most serious issues of concern are the heart, lungs, eyes, kidney and skin problems. They also affect the inhabitants in the winter season by restricting their mobility over large areas due to generating fog as is the case in Punjab province of Pakistan. On the other hand, Pakistan is continuously increasing its nuclear power production over the last few years. So the release of radioactive iodine from a nuclear power plant, in case of a severe accident as happened in Fukushima Daiichi Japan Nuclear Power Plant (NPP) on 11 March 2011, is also of great concern. The Computational Fluid Dynamics (CFD) has now become a powerful tool to design, optimize or analyze complex flow problems. However, analyzing the flow through a venture scrubber requires the development of a mass transfer model, which is not available in commercial CFD software at present. So there is a need for such model to be developed. There are numerous models available in literature [2] but they have not been transformed into a numerical model so far. In this study, the mathematical model of [2] has been transformed into a computational model and embedded in Fluent software to carry out CFD simulations. Venture scrubber is a wet scrubber and has two modes of operations as; forced feed mode and self-priming mode as shown in figure 1 below.

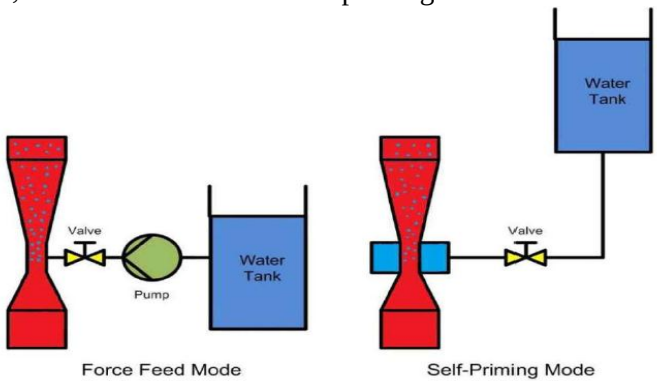

Fig. 1. Difference between Force Feed Mode and Self-Priming Mode Venturi Scrubber [1]

CFD Simulations

In this study CFD analysis of, scrubbing radioactive iodine from air through water, was performed using Fluent software. The scrubbing process was captured by developing and embedding a scrubbing model in Fluent through User Defined Function (UDF). This model captures the amount of iodine scrubbed from air and absorbed in water at each computational cell. Air with a small percentage of iodine enters the venture device as shown in Figure 2. The water enters the venture at the throat section through small orifices and interact with the air containing iodine. As a result the iodine is scrubbed through water and clean air leaves the venture scrubber. The CFD simulations were conducted using Eulerian multiphase flow model with two phases, such that each phase has two component. One phase (gas) has air and iodine as two components and the other phase (liquid) has water and iodine as the two components. The iodine is scrubbed from gas phase to the liquid phase.

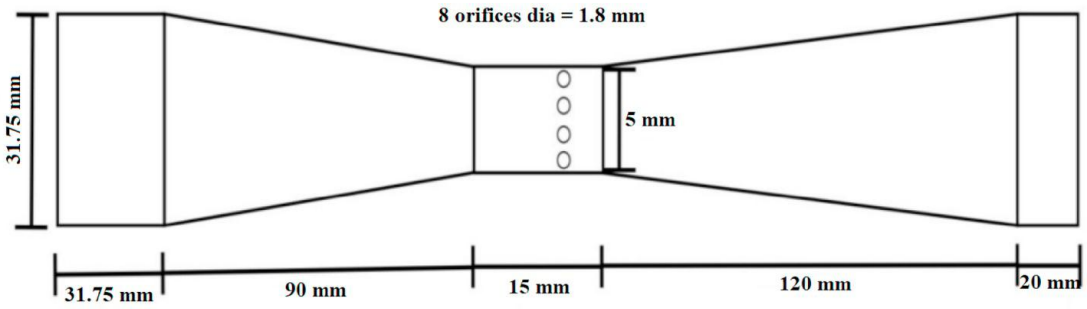

Fig. 2. Geometry of venture scrubber [3]

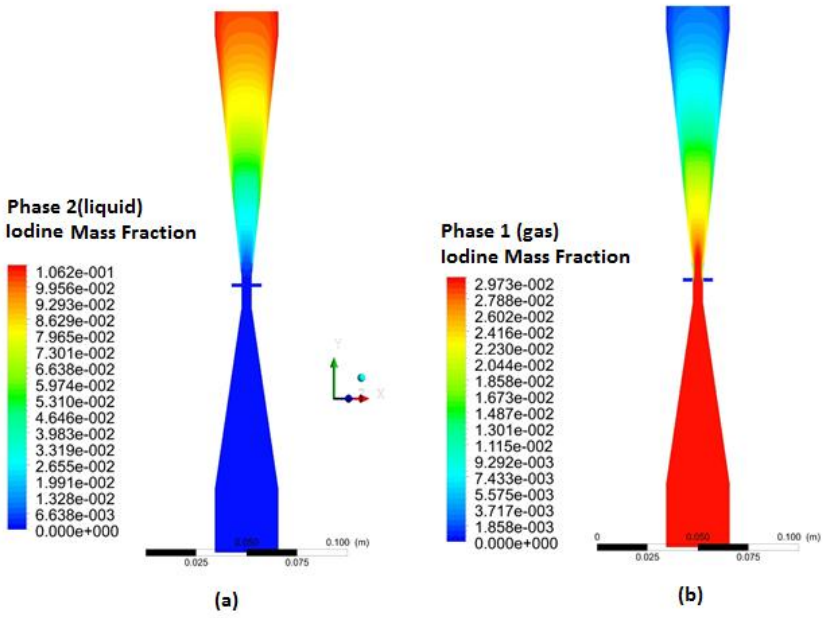

Fig. 3: Mass Fraction of Iodine in (a) liquid and (b) gas phases

Results and Discussion

The CFD results of mass fraction of iodine in phase 1 (gas) and phase 2 (liquid) have been shown in figure 3 below. It shows that mass fraction of iodine is increasing in the liquid phase and decreasing in the gas phase past the throat section as a result of scrubbing process. The amount of iodine transferred from gas phase to liquid phase can be observed in figure 4. It can be seen that as the water enters the throat section it is pushed towards the periphery around the air jet formed at the center. Due to the intense turbulence the mass transfer is maximum around this air jet formed at the

throat. In figure the volume fraction contours of phase 1 and phase 2 have been shown. It can be seen that the volume fraction of phase 2 is zero below throat section (figure 5 (a)) as there is no water below the throat and as the water enters at the throat its volume fraction increases. Figure 5 (b) shows that the air volume fraction is maximum (100%) below the throat but decreases as the water enters at the throat and the mass transfer starts.

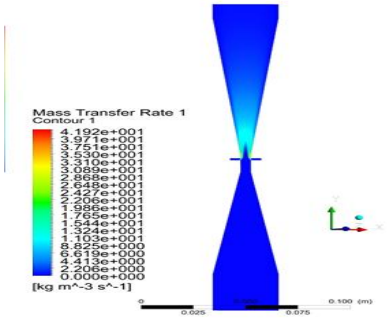

Fig. 4: Mass Transfer rate of Iodine from gas phase to liquid phase

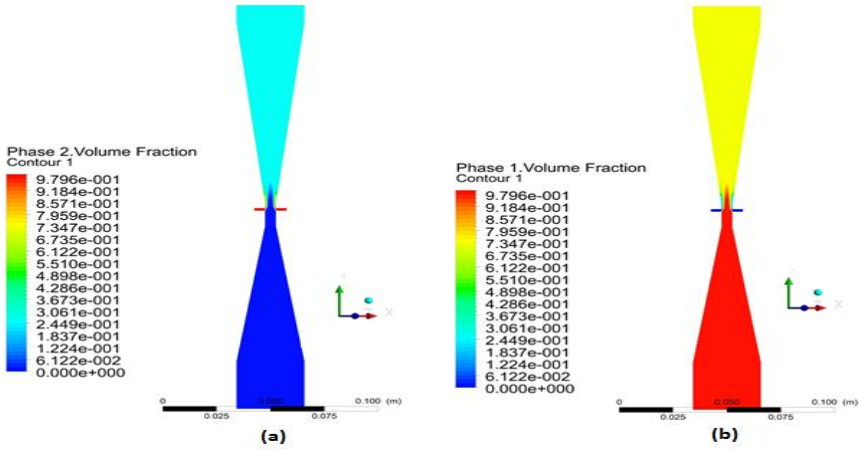

Fig. 5: Volume fraction of (a) Phase 2 (liquid) and (b) Phase 1 (gas)

Conclusion

Numerical computations of iodine scrubbing from air have been performed with water as scrubbing solution using Fluent software. The scrubbing was modeled through a User Defined Function (UDF), developed and embedded in Fluent. The outcome of the model have been validated and analyzed to have a better understanding of the scrubbing process.

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UNMANNED AUTONOMOUS ABABEEL SYSTEM FOR SEED PLANTATION UTILIZING SPECTRAL CAMERA ANALYSIS USING DRONE TECHNOLOGY

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ABSTRACT

Drones have already become an integral part of the agriculture sector, where these drones are serving the farmers to several benefits and help them overcome the arising farming challenges. But the use of this technology in the forest sector can be a game-changer because in some cases, access to a particular area is difficult and seeds cannot be planted according to traditional techniques. In this paper, an excellent solution to this current problem of deforestation, in which, an Unarmed Aerial Vehicle (UAV) and its integration with IoT, therefore, "ABABEEL" serves as a feasible solution to restore the fertility of the land in restoring the forests, monitoring the fecundity of soil in the remote areas.

Keywords: food insecurity**,** visual data, digital image processing, soil compaction, optimal phenological stage, soil spectroscopy, telemetry, ArduPilot

Introduction:

Ecosystem loss and climate change is an alarming condition due to deforestation, therefore, tree plantation is the solution to this problem. Nevertheless, drone technological advancement proved to be the best solution for this major barren land issue. [1]

The main objective of this research paper is to design a motor-controlled drone that disperses seeds in different regions on the earth for reforestation. The paper has been divided into the following three major parts, which are, hex copter, a computer-controlled seed dispenser/gun and software. The software controls multiple sections of the drone-like the seed dispenser, accurately design a mission trajectory through GPS coordinates, efficiently control the drone movements and communication with the operator at the ground station via mobile application as well.

The hex copter, for efficient dispersal of seed, carries the weight of the other hardware components. It consists of a multispectral camera that creates a 3D map using visual data and a seed dispenser, which disperse seeds into the ground from a certain height. The seed dispenser has a container to store seeds and a controlled mechanism for dispersing those seeds. The hex copter motors regulate the flow of seed dispersal on an assigned path.

The Multispectral camera has been also been used to capture images of the land under evaluation. Those images then are analysed to identify the vegetation, barren land, and water body areas. Moreover, digital image processing of the soil images from the camera is done to examine the fertility of the soil. Also, the area images captured by the camera to provide a 3D map of that region for monitoring purposes.

This research mentioned in this paper is aimed to develop an android application which with the help of GPS changes the traditional techniques of human guides. This application has unique features and users can benefit from it by simply installing it on mobile phones.

Literature Review:

Drone technology traces back its origin from 1849 when the Austrians used unmanned balloons loaded with explosives to attack the city of Venice. Their invented technology led to further advancements, however, DJI's Phantom 4 introduced smart computerized drones that intelligently tracked the animals and people and was used in photography. This innovation was a major milestone in drone photography and consumer drones [2]

Based on this fact of limitations the autonomous flying vehicles- the drones are now an important part of the agricultural sector around the world as people are shifting to sustainable agriculture [3]. In this regard, many research works have been done like AIRBOARD AGRO Industrial Crop Spraying Drone. This drone is designed with a capacity of 100 litres of pesticides and fertilizers and is 50times faster than manual spraying at 6 hectares an hour [4]. Though research of drone reforestation is founded by the ex-NASA engineer Lauren Fletcher and his team of twelve (12) are working on the drone to address the industrial scaled issue of deforestation [1]. However, little work has been done recently, on the models that might aid in reforestation and to promote forest health

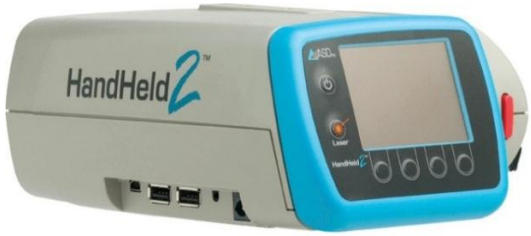

Figure 34: Field Spectroradiometer [5]

Moreover, agricultural and plantation soil is one of the most treasured natural resources whose pH level, nitrogen content, humus content, humidity, and other certain parameters must be regularly checked, monitored, and regulated. Different research works have been done to check these parameters of the soil of which one is hand-held Field Spectroradiometer shown in figure 1. It has been widely used either in the laboratory or for in-situ soil monitoring. It provides the highest available spectral resolution and thus high information content for estimating soil properties with multivariate methods.

The research work Ababeel system holds some competitive advantages over other similar existing systems. A comparison between Ababeel and the existing similar system has been done and recorded in table 1. From the table, it's clear that the Ababeel system is way more efficient in terms of seed sowing, monitoring, soil fertility check, android control application, and price-wise as well.

Research work /Properties	Drone Coria	Robin	SeedDrone	Ababeel
Seed Sowing	✓	✓	✓	✓
Monitoring	✗	✗	✗	✓
Soil Fertility check	✗	✓	✓	✓
Tourism App	✗	✗	✗	✓
Android Control App	✗	✗	✗	✓
Price/$	1875	3750	3125	469

Table: 1 Comparison of the existing products in the market with Ababeel

Conclusion:

This proposed system, brings a valuable contribution to the reforestation and restoration of ecosystems, because, its easy, safe, and cost-effective without involving any use of laboratory instruments or any machinery. The main objective is to eliminate exertion caused by manually planting trees or sowing seeds and also covered a huge area where the human approach is almost impossible.

The other objective of the proposed research is the development of an android application, which not only enhance the vision of tourist by providing location-based services for better site viewing along with the prime objective of seed sowing.

Conflicts of Interest: The authors declare no conflict of interest.

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BIOSURFACTANT ASSISTED MYCODEGRADATION OF HYDROCARBON.

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ABSTRACT

Biosurfactant production can enhance hydrocarbon biodegradation. The hydrophobicity of these hydrocarbons reduces their degradation rates. Significant attention was given to bacterial hydrocarbons biodegradation. However, there is a scarcity of reports for fungal biosurfactant's capacity for enhancing hydrocarbon remediation. This research work identified the potential of biosurfactant production for hydrocarbon mycodegradation. The selected biosurfactant-producing fungal strains belonged to *Aspergillus*, *Penicillium*, and *Candida* genera. These strains were compared with hydrocarbon-degrading biosurfactant non-producing fungal strain. The highest biodegradation was noted for *Aspergillus niger* FA5 (90.70%), followed by *Penicillium chrysogenum* FP4 and *Aspergillus terreus* FP6 (87.40 and 85.03%, respectively), and lastly, *Candida sp.* FG2 (80.10%). The degradations by *A. niger*, *P. chrysogenum*, *A. terreus* FP6, and *Candida sp.* FG2 were 1.32, 1.27, 1.24, and 1.18 times higher than the degradation by BNP *A. flavus* FP10 (68.60%). The hydrocarbon degradation can be increased up to 12 to 22% if a fungus can produce biosurfactant compared to the non-producers.

Keywords*:* Bio-surfactant, fungi, hydrocarbon, biodegradation, hydrophobicity

Introduction

Pollution of petroleum hydrocarbons, having hydrophobic properties, induces deleterious impacts on territorial and aquatic systems [1]. If they remained in the environmental matric, these notorious contaminants are ingested or inhaled, leading to rapid absorption due to their physicochemical properties [2]. Biological methods to treat petroleum hydrocarbons and other organic and inorganic contaminants are gaining interest over time [1,2]. Biosurfactants are biological mimics of synthetic surfactants. They enhance hydrocarbon solubilization and degradation of organic substances. They do so by reducing hydrocarbon surface tension and increased emulsification [1-3]. The selected advantages are low finance, energy, labor, and chemical recurring need to carry out the operation and natural and ecofriendly approach [3]. Among many methods used in the bioremediation of contaminates, one of the adopted approaches is biosurfactant-producing microorganisms [2.3].

Methodology

1. Preliminary substrate utilization test of selected fungal strains
2. 2.2. Screening of biosurfactant production
    a. Drop collapse test
    b. Biosurfactant quantification and qualitative characterization
        i. Biosurfactant harvesting and quantification
        ii. TLC based characterization of biosurfactants
    c. Surface tension measurement
    d. Emulsification index (E24)
    e. Cell hydrophobicity
3. Biodegradation experiment
    a. Fungal inoculation and incubation conditions
    b. Total petroleum hydrocarbons (TPHs) measurement
4. Statistical Analysis

Results and Analysis

The result of hydrocarbon degradation (%) by fungi is presented in Figure 1. Biosurfactant production significantly enhanced hydrocarbon degradation. The statistically significant difference between the hydrocarbon degradation percentages was noted among biosurfactant producing, non-producing, and negative control. Among biosurfactant-producing strains, the highest biodegradation was noted for *Aspergillus niger* FA5 (90.70%), followed by *Penicillium chrysogenum* FP4 and *Aspergillus terreus* FP6 (87.40 and 85.03%, respectively), and lastly, *Candida sp.* FG2 (80.10%). The degradations by *A. niger* FA5, *P. chrysogenum* FP4, *A. terreus* FP6, and *Candida sp.* FG2 were 1.32, 1.27, 1.24, and 1.18 times higher than the degradation by BNP *A. flavus* FP10 (68.60%). In the negative control, ~1% of hydrocarbon reduction was noted. Hydrocarbon degradation can be enhanced using biosurfactants. It is achieved by enhancing microbial substrate accessibility and easing the interaction between the hydrophobic substrate and microbial cell surface. Due to improved cellular surface hydrophobicity, the microbial cells associate easily with hydrophobic contaminants like hydrocarbons (Shekhar et al., 2015). Hence, it can be inferred that hydrophobicity plays a significant role in microbial attachment to the hydrophobic surfaces.

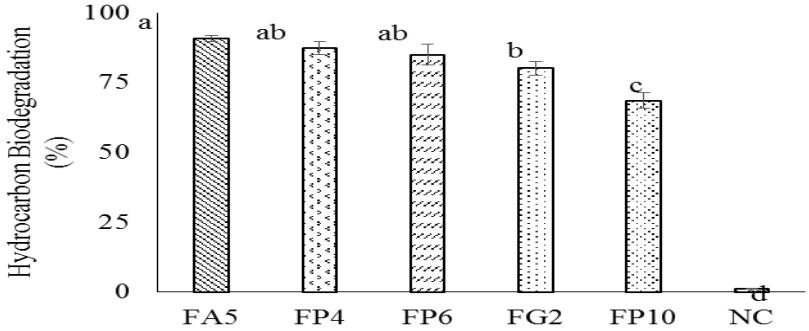

Figure 1. Biodegradation of hydrocarbons. FP10 is a biosurfactant non-producing fungal strain, and NC is the negative control. Alphabet in the label of bars represents the statistical difference. Alphabet "a" represents a significantly higher mean compared to the later alphabets.

Conclusions

The ecological acceptability of biosurfactants is one of the most prominent advantages over synthetic surfactants. Synthetic surfactants can cause damage to the environment, resistant to degradation and accumulate in the natural ecosystem. The fungal strains were screened for biosurfactant yield, surface tension measurement, emulsification index (E24), and cell hydrophobicity. The hydrocarbon degradation increased by 12 to 22% by using biosurfactant producing hydrocarbon-degrading fungal strains. This work can be extended to the field by carrying it out in soil with fungi and degradation in natural conditions; reducing surface tension and effect on the overall microbial population can be observed. The nutrients availability affected fungal biosurfactant production and also can impact the bioremediation of hydrocarbon.

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REDUCING pH OF INDUSTRIAL AND MUNICIPAL WASTEWATER USING CARBON DIOXIDE

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ABSTRACT

Experiments reviled that, the use of carbon dioxide reduces the pH significantly and can be used in hybrid processes for advance treatment even for the biological process too. The uses of other acids, like sulfuric acid, hydrochloric acid, peroxide acid, which are expensive and difficult to use and harmful for the human body. The consumption of carbon dioxide, for the pH treatment, reduces the expense of advance treatment process. It produces carbonic acid in the medium which reduces the pH. The handling of carbonic acid is much easier than others. Thus it reduces the risk losses and economical for the industry to reuse the surpluses carbon dioxide. Carbon dioxide can be used for reducing the pH of wastewater as pre-treatment.

Key Words: industrial and municipal wastewater, ph, co_2

Introduction

Treatment of industrial wastewater and municipal wastewater is a serious issue for developing countries. Various methodologies are being adopted for the treatment purposes i.e., chemical processes and biological processes [1]. Due to the prolong HRT of biological processes industries prefer to use advanced technology. The major problem of industrial wastewater is high pH, massive COD, BOD, and other pollutants [2].

Methodology

The pH parameter with high value is a major issue during the wastewater treatment process. Numerous techniques were adopted during pretreatment of wastewater which does not reduce the pH significantly. However, the advance wastewater treatment techniques reduce the pH significantly and other parameters as well, but it costs high.

Results and Analysis

The use of carbon dioxide reduces the pH significantly and can be used in hybrid processes for advance treatment even for the biological process too. The uses of other acids, like sulfuric acid, hydrochloric acid, peroxide acid, which are expensive and difficult to use and harmful for the human body. The consumption of carbon dioxide, for the pH treatment, reduces the expense of advance treatment process. It produces carbonic acid in the medium which reduces the pH. The handling of carbonic acid is much easier than others. Thus it reduces the risk losses and economical for the industry to reuse the surpluses carbon dioxide.

Conclusions

Carbon dioxide can be used for reducing the pH of wastewater as pre-treatment. It is economical and easy to use and manage as compared to other treatments.

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IMPACT OF SULFATE INJECTION ON SOLAR PHOTOVOLTAIC CELLS WITH SPECIAL REFERENCE TO NORTH AMERICA

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ABSTRACT

Global warming is one of the world's biggest problems. Many techniques and tools are available to solve this problem, one of which is solar radiation management(SRM). In the SRM technique, the world atmosphere is artificially modified to have a greenhouse effect. Sulfate aerosol injection is one of the promising SRM techniques where aerosol particles inject in the stratosphere layer that partly reflects solar insolation in space and decreases earth temperature. In this report, we discuss the impact of these particles on photovoltaic (PV) cell generation in North America. The multiple years data of CMIP5 RCP 4.5 scenario data and GeoMIP G4 HadGEM2-ES experiment are evaluated on different years of RCP 4.5 data. Results suggest that solar irradiation is decreasing but the temperature in North America is rising by the use of RCP4.5 scenarios. In the presence of sulfate aerosol particles, the PV cell production is also measured. The negative trend and percentage difference in power output indicate that power will also decrease, corresponding to RCP 4.5.

Key words: GeoMIP, CMIP5, Global warming,

Introduction

Solar radiation management (SRM), also known as solar geosolar engineering, is a method aimed at reducing some of the impacts of climate change, such as global warming, with small amounts of incoming sunlight returning to space[1]. Its idea came from a volcanic eruption known in the Philippines as Pinatubo in 1991. Scientists have found that the earth's temperature has decreased by 0.5°C for a period of two to three years by this volcanic eruption. On further analysis the drop in temperature was found to be due to the sulfate particles injected into the stratosphere as a result of the volcanic eruption. These sulfate particles contributed to the reduction of the Earth's temperature by reflecting tiny quantities of sunlight back in space [2]

Methodology

Solar radiation and temperature data was collected from the World Climate Research Program (WCRP) in Network Common Data format (NetCDF) for all eight models.The data for both the CMIP5 RCP4.5 scenarios and the GeoMIP G4 experiment for all 8 models. With the aid of NetCDF and pandas, we extract the data using Python 3.7. Appendix A contains the python script. Then we insert the data into the map in ArcGIS 10.2. We have also analyzed sulfate aerosol particles for the data on solar radiation and temperature, calculating the difference between sulfate aerosol particles and future climate models without sulfate aerosol component. We have compared these data to study temperature change and solar radiation caused by sulfate aerosol particles. As we know that solar radiation and temperature depend on the power output of PV cells, we also measure the changes in PV output due to potential climate changes and the injection of aerosols by sulphate.[3]

Conclusions

PV power generation also decreases annually in North America, which corresponds to the average difference between all coordinate results.

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GREEN FINANCE AND CORPORATE SOCIAL RESPONSIBILITY: A WAY TO HANDLE ENVIRONMENTAL DEREGULATION

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ABSTRACT

Key words: Environmental deregulation, ecological conservation, pollutant emissions, green finance, ISM

Introduction
The developmental projects occur at the expense of harms to the environment. Increasing population, urbanization and industrialization stands as the major reasons for environmental deregulations around the globe. This alarming situation diverted the attention of general public towards ecological conservation through implementation of green practices. The industries are also under the pressure of adopting green practices to achieve Green Corporate Social Responsibility objectives. Due to this reason, they must also mitigate their repercussions on the environment by curtailing their developmental and energy projects. It is pertinent for corporations now to develop their projects through application of green finance strategies as a means to leverage cleaner output with minimized pollutant emissions. But attempting to follow the premise of green finance is a daunting task for many of them.
Methodology
This research is intended to establish the structural model of obstacles to implement the idea of green finance as a means to address the environmental deregulation. The literature and subsequent consultations with academic and industrial experts have identified the relevant obstacles to the introduction of green financing. Structural relationships between these obstacles were established and an ISM methodology focused on structural barriers to green financing in Pakistan is built. In addition, a MICMAC analysis is also used to identify obstacles based on dependence and driving power.
Results and Analysis
This paper also describes the various aspects in which these obstacles can be overcome. Better knowledge of these barriers will allow organizations and policymakers to allocate their resources and plan them efficiently and effectively, so that as many environmental conservation programs in Pakistan as possible can be implemented.

Conclusions

The developmental projects is increasing pollution at an alarming rate. The solution is to find ways to mitigate pollutant emissions without hampering the pace of development. One of the ways to achieve this is through implementation of green practices. This research identified the obstacles to green finance implementation as well as finding the contextual relationships between them based on their dependence and driving power. This will help the policy makers to allocate their resources and plan them effectively.

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FRACTURE ENERGY OF FIBER-REINFORCED AND RUBBERIZED CEMENT-BASED COMPOSITES: A SUSTAINABLE APPROACH TOWARDS RECYCLING OF WASTE SCRAP TIRES

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ABSTRACT

Using crumb rubber particles obtained from end-of-life tires as aggregate in concrete can reduce the environmental overburden caused by the huge accumulation of these scrap tires. However, a reduction in mechanical properties is observed with the incorporation of rubber aggregates. To counter this detrimental effect of rubberized concrete, amorphous metallic fibers are also added to balance the loss in strength and sustainability issues. Mechanical characteristics along with the fracture energy of rubberized fiber-reinforced mortar is presented here. Four mortar mix compositions were investigated; first one is reference mortar (control mortar), second mix containing 30 kg/m^3 of metallic fibers, third mix containing 30% of rubber aggregates as replacement of sand by equivalent volume and fourth containing both rubber aggregates and metallic fibers with the dosage 30% and 30 kg/m^3 respectively. Deformation capacity, residual post-cracking strength and fracture energy of these composite mortar mixes were evaluated through uniaxial direct tension tests. The fracture energy is determined from the obtained complete softening curves. Test results show reduction in mechanical properties with the incorporation of rubber aggregates in mortar. However, a significant increase in fracture energy was observed in fiber-reinforced mortar mixes. Moreover, the mortar mixes containing both rubber aggregates and metallic fibers show positive synergetic effect i.e. by enhancing the post-cracking residual tensile strength, strain capacity and energy dissipation capacity.

Key words: Recycling, rubber aggregates, fiber-reinforcement, uniaxial tension tests, softening behavior, fracture energy, sustainability.

Introduction

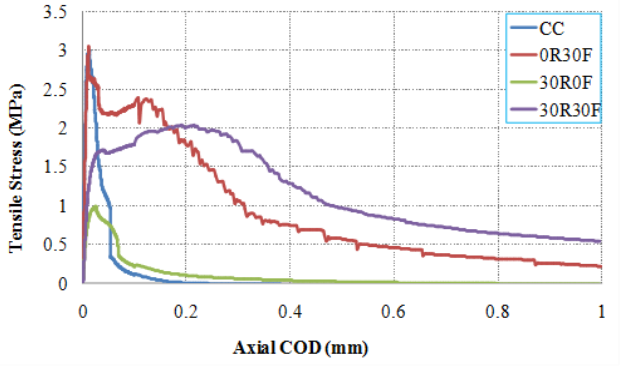
Recycling of waste products is one of the suitable solutions to reduce the environmental overburden. To discard used tires in landfill cause certain environmental and economic issues [1]. Besides environmental benefits, the use of scrap rubber as a crumb rubber in concrete mixes is considered beneficial to enhance certain concrete properties, like toughness [2], ductility [3], impact resistance [4], fatigue [5] etc. To dispose of the discarded tires, many researchers recommended the utilization of crumb rubber aggregate obtained from end-of-life tires and to produce a sustainable concrete. However, there is a limited relevant information available on the direct fracture properties, i.e. fracture energy which is investigated in this research work.

Methodology

Direct tension tests were carried out on prismatic notched specimens to study the behavior of rubberized and/or fiber-reinforced cement-based composites. Tests were controlled by Crack Mouth Opening Displacement (CMOD) in accordance with RILEM recommendation (RILEM TC 162-TDF., 2001). These tension tests indicate deformation capacity corresponding to peak load (strain capacity), residual tensile strength beyond peak load and softening curves. Based upon the complete softening curves obtained through uniaxial direct tension tests fracture energies were computed and presented here.

Results and Analysis

Tension test results for studied mortar mix compositions are presented in Figure 1. Results show reduction in tensile strength for rubberized mortars (30R0F), but at the same time improved strain capacity is observed for mixes containing rubber aggregates i.e. about 1.5 times of control mortar. For fiber-reinforced mortar (0R30F), post-peak residual tensile strength is significantly enhanced as shown in Figure 1. For rubberized fiber-reinforced mortars (30R30F), a positive synergetic effect is observed, showing enhanced strain capacity and residual post-cracking strength simultaneously. This synergetic effect can also be observed in Figure 2 showing fracture energies (Gf) calculated from complete softening curves.



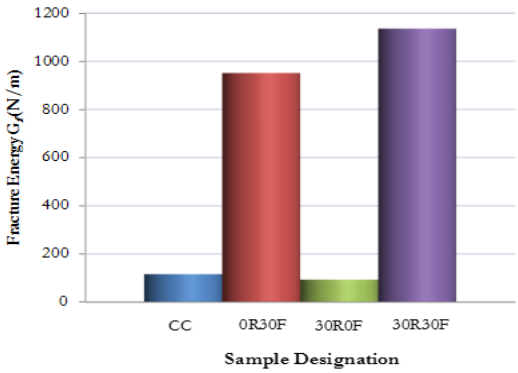


Figure 1: Effect of fibers and rubber aggregates on strain capacity

Figure 2: Impact of fibers and rubber aggregates on fracture energy

Conclusions

- For rubberized mortars reduction in mechanical properties (compressive strength, modulus of elasticity and tensile strength) is observed. At the same time, rubber aggregate incorporation in mortar is beneficial to enhance the deformation capacity.
- For fiber-reinforced mortars (0R30F) significant increase in residual post-cracking tensile strength is observed due to bridging action provided by fibers at crack location.
- For fiber-reinforced mortars significant improvement in fracture energy is observed. Even, this phenomenon is more pronounced in rubberized fiber-reinforced mortars (30R30F) due to positive synergetic effect provided by the combined use of metallic fibers and rubber aggregates.
- To utilize rubber aggregates obtained by grinding end-of-life tires in cementitious composites can be considered as a sustainable solution towards recycling of waste tires, which in turn helpful to reduce environmental overburden and to promote a circular economy.

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IMPACT OF URBANIZATION ON SPECIES RICHNESS AND INVASIVE SPECIES POOL

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ABSTRACT

The dramatic increase in urbanization has influenced the vegetation cover negatively, and positively encourages the establishment of invasive species. In current study sampling was done in different zones of the Shahdara valley Islamabad, on the basis of intensity of urbanization. In the densely populated zones of the studied region native species cover was reduced while the invasive species were dominated and vice versa in less populated and un-urbanized zones.

Key Words: Species richness 1, Urbanization 2, Invasion 3, Important Value Index 4.

Introduction

Vegetation is the vital driving force of our environment but the incessant increase in urbanization poses a significantly negative impact on this important asset of our ecosystem, disquieting its structure and functioning. In recent anthropocene era, due to urbanization and industrialization the pollution load increases. It significantly threatens the quality of life and sustainable development by changing vegetation cover and heat distribution [1]. It ultimately results in high energy consumption, deteriorates water and air quality, and influences the human health [2]. However, vegetation is first to suffer and it filters out the negative urban effect because they are the key indicator in the prediction of prevailing environmental condition [3].

The human activities such as landscape modification also facilitates the rapid increase in establishment and spread of exotic species [4]. These exotic mainly invasive species inclines the native biodiversity and resource availability to other species, the invasive vines prevent forest regeneration and encourages the tree mortality [5]. The preliminary observations indicated the impact of anthropogenic activities on vegetation richness and also addresses existing threats of urbanization to the natural vegetation.

Methodology

A field study was carried out during 2019 and 2020, to assess the native vegetation structure its richness and invasion rate in different zones (less urbanized, moderately urbanized and highly urbanized zones) of the studied area i.e., Shahdara valley, Kothathyal and Barakahu. The quadrat quantitative ecological technique (randomized) was used for vegetation sampling, the size of the quadrat i.e., 10 x10 m^2, 5x5 m^2, 1x1 m^2 for trees, shrubs and herbs respectively. Soil samples were collected from each quadrat following standard protocols. Species richness, density, cover, frequency and important value index were evaluated.

Results and Analysis

A total of 197 plant species were recorded from sampling sites but the species richness was greatly inclined due to urbanization. Preliminary data of eighty-five plant species (average; 3.54) were recorded in twenty-four quadrats with minimum invasion in zone-I, Zone-II comprised of eighty plants in the same number of quadrats (average; 3.33) having a slight increase in the invasion. However, the densely populated zone consisted of eighty-eight plant species (average; 2.93) in thirty quadrats but witnessed as more invasive species dominating the area with high IVI values such as *Broussonetia papyrifera* (L.) L'Her. ex vent., *Lantana camara* L., *Cannabis sativa* L., and *Parthenium hysterophorus* L.

Conclusions

The results revealed that urbanization has a significant impact on the vegetation structure, distribution pattern, composition and supports the growth of invasive species. Therefore, high anthropogenic activity clearly demands better conservation management and urbanization mitigation strategies in the region.

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AN ECOLOGICAL AND ENVIRONMENTAL ASSESSMENT OF THE BUNDAL ISLAND (SINDH COAST) IN THE BACKDROP OF CURRENT PLANS OF ITS DEVELOPMENT INTO A MEGA REAL ESTATE

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ABSTRACT

Bundal Island is a barrier island located at the southwestern edge of the Indus delta in the vicinity of metropolitan city of Karachi. The island provides many products (e.g. fisheries, fodder, timber) and ecological services (e.g. nursery grounds, protection) worth millions to local coastal communities. The study was conducted in Nov-Dec 2020 to document the geomorphology, ecology, biodiversity, pollution status and threats by using standard methods. Results indicate great significance of the Bundal Island in terms of fisheries, mangrove services, coastal protection and as nursery and feeding ground of a variety of marine species. The survey results suggest that developing island into a real estate will be extremely costly and will require high maintenance budget. Therefore, it is recommended that the island should be preserved in its current form as an ecotourism focused Marine Protected Area (MPA) due to its great ecological significance, vital role in integrity of coastal areas of Karachi and for sustainable use of natural resources.

Key Words: Bundal Island, Geomorphology, Ecology, Sustainable, Ecotoursim

Introduction

Bundal Island bordering Korangi creek and the Malir River outfall on the west receives enormous solid waste, industrial and domestic effluents. Its eastern boundary adjoins the Phitti Creek (Port Muhammad Bin Qasim Channel) further adding to its significance. It has immense ecological, economic and aesthetic value due to presence of variety of habitats *viz.* sandy beaches, back waters/channels, tidal inlets, mangrove swamps, sand dunes and mud & sand flats. The study was conceived and designed in the backdrop of current plans of federal government to develop this island into a grand real estate and tourist resort. The main objective of the study is to document the geomorphology, ecology, biodiversity, pollution status and other currently prevalent threats.

Methodology

A total of 04 survey stations covering all four corners of the island were studied. The standard methods used in the study included: beach profiling (Emery, 1961), grain size analysis (using mechanical sieve shaker), quadrate methods for intertidal fauna, transect methods for beach litter monitoring, belt transect for mangroves, Point Centred Quarter Method (PCQM) for avifauna. In addition, ancillary information on coastal hazards by using Coastal Hazard Wheel (CHW), fisher interview surveys for fisheries and socio-economics was also collected.

Results & Analysis

Some key results are presented in a sequential manner. Beach profiling and grain size / mineralogy analyses indicated that all the beaches of the island are dissipative (flat) in nature with a slope variation range of 0.8 ° to 2.5° and grain size skewed more to +phi values i.e. smaller grain sizes.

Dominant mineral recorded in the sands of all beaches were SiO_2 66.82%, R_2O_3 10.27%, Ca^{+2} 10.77% and Mg^{+2} 1.42%. Intertidal fauna studies indicated bivalve molluscan (>30 spp.) and polychates (12 spp.) as the most common taxa on all survey stations with low inter-tidal beach segments being most diverse. Mangroves (01 species i.e. *Avicennia marina*) are only distributed on the northern flank of the island being a leeward side with an estimated density of 5 trees / 7 m^2. Few tree trunks showed girth of approx. > 1 m indicating long age. Some evidence of another rare mangrove species in form of germinating seeds was also collected. Deforestation was recorded specifically in the interior of mangrove strands. Three species of algae and 20-25 species of vegetation were also recorded.

A total approx. 30 species in tens of thousands of marine and land birds were recorded including some 10-15 migratory species. Mainly terns, gulls, waders, birds of prey (raptors), pelicans, cormorants, herons, bee eaters and Indian roller were observed. Other biodiversity recorded include: butterflies (3 species), moths (1-3 species), rodents (2-3 species), mongoose?, and feral dogs. Fisher community interviews indicated that the Bundal Island has great socio-economic importance for fisherfolk in terms fishing grounds in the surrounding, fish drying, net cleaning and repair, short stays in fishing season, social gathering on a famous shrine present near the southeastern edge. Common fisheries include shrimp, sardines (oil fishes), small pelagic and razor clam (*Marura* in Sindhi). Fishing methods recorded gillnetting, beach sienes, bottom trawling, fishing lines. Solid waste on the beaches was recorded in the following order: plastic > processed wood & timber > cloth and textiles > Paper & card board > Miscellaneous. It is speculated that the onset of SW monsoon (Jun–Sep) the beaches are swept clean of the solid waste due to stronger waves. In heavy metals Lead (Pb) concentration was found to be 33.41 µg/g of collected sediment sample. Concentration Nickel (Ni) and Zinc (Zn) were recorded above the probable effect level (PEL).

Conclusion

This Initial Environmental Examination (IEE) of the Bundal Island was conducted with the aim of pre-assessment of its geomorphology, ecology and socioeconomics and possible future impacts due to its development. Dissipative (low energy: slope range = 0.8 ° to 2.5°) beaches with fine grained sediments and silicate (> 66%) as major sediment mineral was observed. Southeastern margin of the island at the sea front is facing erosion while deposition on southwestern flank with minor but consistent changes in sediment budget. Marine litter was prevalent in great variety and quantities with plastic, cloth and processed wood being top categories. Some heavy metals e.g. Ni, Fe, Zn, Pb were recorded above Probable Effect Level (PEL). Intertidal fauna mainly featured bivalve, gastropods and polychaetes. Special significance of the island as nesting, foraging, breeding and as temporary habitats for avifauna was highlighted. *A. marina* mangroves covering 10.47% area of the island represents a key productive habitat supporting variety of life and acting as buffer against natural climatic disasters e.g. cyclones, storm surges and protecting Karachi coast. An estimate of economic worth of mangroves of the Bundal Island is 32.08 Million PKR per years. In light of these findings, it is suggested that the island should rather be developed into an ecotourism focused marine protected area as per IUCN MPA Categories (Category # 6: Protected Area with Sustainable Use of Natural Resources).

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WASTE DISPOSAL PRACTICES AT HOUSEHOLD LEVEL AND ITS IMPACT ON HEALTH OF PEOPLE IN PERI-URBAN AREAS OF FAISALABAD

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ABSTRACT

All content which is not necessary by the owner, processor or manufacturer is called waste. In under developing countries, waste administration is poor and wastes are discarded on the side of roads and into open areas, threatening health and enticing insects. People around the world are well attentive of the effects of waste dumping practices, but the adverse attitude about law enforcement lead to chaos. If people are well informed about household waste, they can protect themselves from serious illnesses and save their atmosphere clean. Most companies define waste as "nothing that creates value." People need to know how to dispose of and manage waste. Disposal procedures that include spillage, landfills and open defecation. The present study was designed to investigate the waste disposal practices and its impact on health of peri urban areas in Faisalabad. Respondents were selected by convenient sampling technique. Faisalabad Tehsil was selected by using convenient sampling technique. Four peri urban areas were selected by convenient sampling technique adjacent to urban Areas of district Faisalabad. The sample size was 160 household heads, 40 household heads was selected from each selected peri urban areas by conveniently. Well-structured interview schedule was designed for data collection. Data collected, thus fed to computer for analysis. The data was analyzed by the statistical package for social sciences (SPSS). The research findings showed that 33.1% of respondent belongs to age group of 28-35 years and majority of the respondents i.e. 78.8% dump the garbage after 1-2 days. A majority i. e 80.6% of respondents was identifying 50-100% kitchen waste in their house. More than 45.7% of respondents waste disposes by heap of garbage. A majority i. e 68.8% of respondents said no regular garbage collection service in their house area. A great majority 85% of respondents use the garbage bins in their house. A Majority 63.8% of respondents in favor of reuse of waste at household level. More than half 55.6% of respondents were throwing garbage in vacant plots, streets openly. A majority i. e 63.8% of respondent said open defecation is a thoughtful threat for human health. About 33.8% of respondents faced in skin diseases. Better utilization of aiding and funding sources and encouraging internal investment towards water, sanitation and solid waste management should be done. Residents need to increase environmental awareness. Usage of modern machinery and equipment for safe and convenient disposal of solid waste should practice.

ARTIFICIAL INTELLIGENCE AS AN OPERATION EXCELLENCE TOOL FOR THE POWER SECTOR

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ABSTRACT

The current scientific focus in deploying artificial intelligence (AI) based data analytics is notably seen in industrial automation and manufacturing systems. However, the value creating analytics implemented at complex and large scale power systems are scarcely reported in literature. Therefore, this research is conducted in developing AI based operation excellence tool for the large scale power facility. AI based comprehensive data processing and visualization techniques are incorporated to remove the erroneous observations. Subsequently, advanced statistical techniques in combination with state of the art AI modelling tools are employed to eliminate the insignificant variables present in the data. The relevant dataset developed as a result is fueled to construct AI based process models like artificial neural network (ANN) and support vector machine (SVM). The model performance is evaluated by extensive internal and external validation tests. The models are tested for validity on non-training data and robustness. The criteria of evaluation adopted were performance parameters like co-efficient of determination (R^2), root mean square error (RMSE), normalized root mean square error (NRMSE) and mean absolute percentage error (MAPE). Monte-Carlo simulations and operational physics driven design of experiments are constructed and simulated on the robust and validated AI process model. A 660 MW thermal power plant is considered as a case study and three operational states of the power plant, i.e., component level, system level and strategic level are considered. Finally, the data-driven power curve of the generator is constructed at 95% confidence interval as an example for component level studies. Similarly, the effective parametric operating ranges for optimal SO_2, Hg, NO_x and dust emissions are established for limestone forced oxidation (LSFO) flue gas desulphurization (FGD) system to demonstrate system level optimization and strategy development. In addition to that, the overall thermal efficiency and power generation from the power plant are also optimized for strategic level performance enhancement. The research has achieved process sustainability and energy efficiency for the power plant and thereby contributes to industry 4.0 vision for industrial systems and the United Nations Sustainable Development Goals 2030.

Keywords: Artificial Intelligence, Modelling and Optimization, Operation Excellence, Power Sector

Introduction

The advancement in information communication technologies has led to the improved capabilities to store and retrieve the operational data of industrial systems [1]. The data is valuable to simulate the large-scale industrial operations and thereby can be fueled to develop effective operational strategies for complex and interdependent industrial processes [2]. In this regard, AI based research

studies are reported in literature mainly focusing manufacturing and petrochemical industries [3, 4]. However, the potential applications of AI are anticipated for energy and power sector [5]. In this paper, artificial intelligence as an operation excellence tool is developed for the power sector and a 660 MW thermal power plant is taken as a case study. Advanced data processing, visualization and dimension reduction techniques are incorporated and the representative datasets for three operational levels, i.e., component level, system level and strategic level of the power plant are prepared.

Methodology
The data is fed to construct the validated process models like ANN and SVM and the performance comparison of the models provides the basis of the selection of the best model. As a result, the model is deployed for simulating the Monte Carlo experiments and operational physics driven design of experiments to optimize the performance of the power plant. Consequently, data-driven power curve of the generator is plotted at component level studies. Similarly, 35 % and 42 % reduction in SO_2 and Hg emissions are achieved respectively at system level process optimization of limestone forced oxidation (LSFO) flue gas desulphurization (FGD) system. Moreover, savings in energy spent equal to 7.20%, 6.85% and 8.60% are identified corresponding to 50%, 75% and 100% power generation capacity, respectively. Similarly, 1.74%, 1.80% and 1.0% increase in power generation is predicted corresponding to 50%, 75% and 100% power generation capacity respectively by parametric adjustment.

Conclusions

In this paper, artificial intelligence as an operation excellence tool is developed for three operational levels of the power plant. The tool is utilized for developing the optimum operational strategies for component level, system level and strategic level of the power plant. Consequently, 35% and 42% reduction in SO_2 and Hg emissions, 7.20%, 6.85% and 8.60% savings in energy spent and 1.74%, 1.80% and 1.0% increase in power generation is predicted at 50%, 75% and 100% unit power generation capacity respectively.

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ANALYTICAL EJECTOR MODELLING FOR LOW-TEMPERATURE HEAT DRIVEN ENERGY SYSTEMS

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ABSTRACT

This paper presents a new, direct, thermodynamics based, analytical model for the prediction of on-design thermal performance (entertainment ratio) of an ejector. This model is based on the concept of reversible entrainment ratio (RER). RER is the maximum possible entrainment for an ideal (reversible) ejector which has no losses. In this model, first, the RER value is calculated for the available operating conditions and then an RER efficiency value is assumed to account for all the losses in an actual ejector. Engineering Equation Solver has been used to program the proposed model. This presented model is suitable for system optimization because of its direct and simpler calculation method. RER efficiency of 25.5 % has been obtained by fitting the RER model results with commercially available performance results of ejector. The presented model has been validated with the CFD model for R245fa working fluid and with results reported in literature. The validated model has been used thermal systems simulations and to produce ejector performance curves for R245fa working fluid. This model can be conveniently used for thermal system design and simulation for any working fluid and for any range of operating conditions.

Keywords: Ejector, Entrainment Ratio, R245fa, Simulation, heat recovery; Refrigeration, thermodynamics

Introduction

Low-grade thermal energy is abundantly available from many different sources such as waste heat from industrial processes, and geothermal and solar energies. Utilizing low-grade heat leads to increased energy efficiency and the share of renewable energy in the global energy mix. In turn, the recovery of waste heat contributes to reduced carbon emissions, which is very critical in meeting our obligations to rein in global temperature rise. Among the myriad devices that can readily be deployed to derive useful energy from waste heat streams is the jet pump or ejector. Ejectors are thermally driven compressors which can effectively utilize low-grade heat via various system configurations, such as, when used in conjunction with appropriately matched refrigerants or organic fluids. Ejectors have been studied for use in various low-grade heat driven applications such as ejector refrigeration systems (ERS) [1]–[5], ejector enhanced organic Rankine cycles (EORC) [6], and combined cooling and power (CCP) systems [7]–[9]. There are complex thermo-fluidic processes happening inside the ejector and therefore it is challenging to develop an analytical model of ejector which can be integrated with the overall thermal systems' modelling equations. This paper presents a new analytical model which is direct (no need of iterations) and easy to integrate with EES or MATLAB models of thermal systems. The methodology, validation and application of the model has been presented in detail.

Methodology

Engineering Equation Solver (EES) has been used for simulations. The modelling concept and equations are presented, and the model is developed in EES. Thermodynamic analytical relations have been developed for the proposed model which are coded in EES. The RER efficiency of 25.5% has been obtained by fitting the RER model results with experimental results. The so-called RER model has been validated with the CFD model for R245fa working fluid. The presented model has also been validated with published results reported by Federico et al. [10], Huang et al. [11], Chen et al. [12], and Riaz et al. [13].

Conclusions

- A new, direct, analytical model of ejector is presented which is based on reversible entrainment ratio (RER) concept.
- The RER model has been used for the simulation of low-grade heat driven systems; Ejector Refrigeration System (ERS), Ejector Enhanced Organic Rankine Cycle (EORC)
- The RER has been used to produce ejector performance curves for R245fa working fluid.
- The RER model along with a validated CFD model (for RER efficiency determination) can be utilized for any working fluid and for any range of operating conditions.

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ENERGY ASSESSMENT AND TECHNO-ECONOMIC ANALYSIS OF INTERLOCKING BRICK MACHINE FOR CONSTRUCTION INDUSTRIES

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ABSTRACT

Due to an increase in the cost and a low thermal efficiency of the bricks in construction industry, an alternate approach is needed for cost savings and increasing the efficiency. Further due to an increase in population, a rapid increase in houses is observed which further stimulates a research for reliable, easy, and cost-effective solutions for wall construction. Recently a global trend has been observed for energy efficient interlocking bricks that provides a feasible alternative to both of the above-mentioned issue for construction industry. Although the use of these bricks is not currently popular in Asia, they are constantly being deployed in European countries. This study explains the use of these bricks in common households of Pakistan and then analyses the resulting energy saving potential, environment friendly prospects, and finally cost savings.

Key words: Energy Assessment, Inter-locking bricks, Construction industry, PHPP

Introduction

Construction industry is currently amongst the largest energy consuming subsector mainly due to use of energy intensive technologies [1]. A significant share of this industry is occupied by brick manufacturing which has now obliged the researchers to look for energy saving options by promoting efficient technologies [2]. The new techniques will provide an economical, efficient, and more durable solution as compared to conventional bring manufacturing [3]. This study identifies the use of interlocking brick machine as a possible solution which along with being more energy efficient, will provide an economical solution. The purpose of this research is to use the different product's like fly ash & wood residue that giving the better result's as compressive strength, impact, flexural strength and thermal conductivity for obtaining the mechanical and thermal properties.

In the present research study, experimental assessment of interlocking energy efficient bricks (IEEB) was carried out and comparative analysis was performed for the applicable alternative low-cost construction technologies in building sectors. This study identified that the use of interlocking brick machine is a possible solution for more energy efficient bricks and cost efficient at the same time. After conducting comprehensive literature review it was identified that the mechanical and thermal properties was improved with the use of interlocking bricks. In the result section of research study, a detailed comparative analysis of interlocking bricks was done in terms of compressive strength, impact, flexural strength and thermal conductivity and other significant properties of IEEB bricks and other conventional bricks.

Methodology

The research methodology in this study performs an extensive literature review for analysing the basic parameters involved in the study. This includes assessment of both conventional and interlocking energy efficient bricks. Further, an experimental setup has been designed for production and creation of these interlocking bricks. A detailed methodological overview is provided in the figure 1.

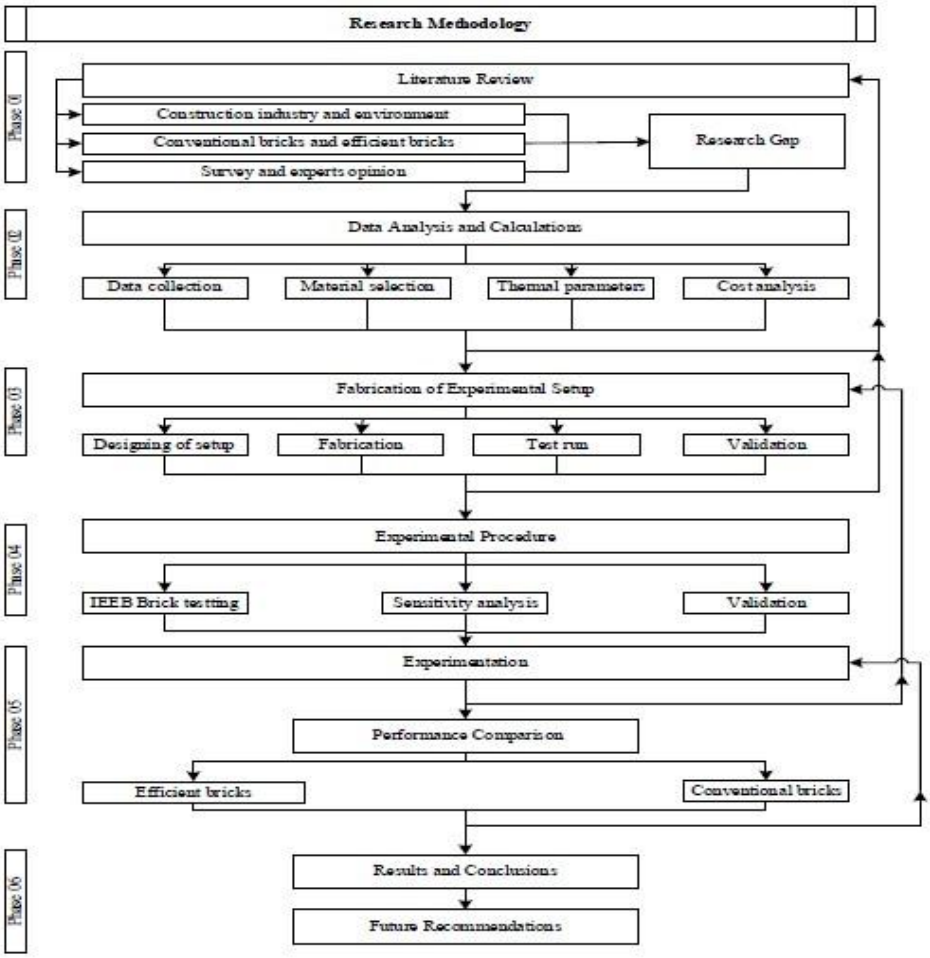

Figure 1: Methodological overview of the study

Results and Analysis

The results obtained from both experimental and theoretical analysis depicts that IEEBs have far less energy consumption as compared to traditional bricks, and they further offer better economical advantages. Strength of IEEBs was also found to be more than conventional bricks. The cost factor of the IBM machine fabrication is lowest as compared to others as the usage of IBM machine can reduce the carbon footprint and energy/carbon emission compared to conventional method of construction. Interlocking bricks reduced the heat factor in machines, thus contribute to reducing the carbon emissions.

Conclusions

IEEB bricks can be highly needed and utilized in construction sectors. IEEB reduced the time and increased the productivity. Performance and the safety of the operator also improved. It possess better reliability and workability under loading than others. Therefore, at any construction sites like tower buildings, hospital, industries are main applications of IEEB bricks.

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BIOGAS; A CLEAN SOLUTION TOWARDS PAKISTAN ENERGY CRISIS

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ABSTRACT

Food and energy are the basic necessities of mankind. Due to the rapid increase in the world population and heavily dependence on the fossil fuel developing countries have major share in the greenhouse gas emissions and environmental pollution. The bulk quantity of animal dung is generated by the growing animal industry in Pakistan that causes serious environmental issues such as air, water, and land pollution. On the other side Pakistan facing serious energy crises since last decade. The best route to address these problems are to utilize bulk quantity of biogas and biomass resources. Due to huge population of livestock sector there are 652 million kg dung produces every day in Pakistan only from buffalo and cattle. By collecting, handling and efficiently use this manure as a feedstock for biogas production there are 16.3 million m^3 biogas produce on daily basis with 20 M tons bio fertilizer generation every year. A biogas plant of 10 m^3 size is capable to save almost Rs.92062 per year on account of conventional fuels spent otherwise. Beyond this, there remains potential for domestic plants to utilize currently underexploited biogas substrates such as kitchen waste, weeds and crop residues. Thus there is a need for research into reactors and processes which enable efficient anaerobic biodegradation of these resources. The government is financing many projects related to biogas energy development in the country, but still lot more efforts are needed for harnessing full potential and taking maximum benefit out of this important renewable energy resource.

Key words: Biogas, Animal manure, Renewable energy

Introduction

Since the last decade the nations are try to move towards renewable energy sources for their energy requirements. In the last few years the renewable energy sources gain significant importance due to abundance feedstock availability, access to remote areas, environmental pollution control, good performance, biomass residue reduction, energy transfer and low cost. Energy describes the economic growth and social status of the country. Per capita energy need showed the socioeconomic growth of any nation. Biogas generally produced by the anaerobic digestion it is the biological process comprises of microorganism conversion of organic materials into biogas in the absence of oxygen [1].

Biogas Potential of Pakistan

Around 70 percent population of Pakistan lived in rural areas uses biomass for their cooking and heating purpose which leads negative environmental impact on surrounding. Almost 46 percent of rural population of Pakistan has access of electricity and the remained peoples lived without basic energy requirement. These rural areas are rich with man power and renewable energy sources. The solution of this energy problem lies in in the utilization of renewable energy sources [2]. Pakistani government should take step to use these energy sources for their energy requirement. The best route for energy production to remote areas is biogas generation from different substrates like

agricultural residues and animal manure. Livestock is the valuable source of income for the rural sector and rural development. Almost 8 million families are directly involved in this business and driving 35 percent income from livestock. This sector play crucial role in foreign exchange, improve economy of the country and poverty alleviation of the marginal peoples [3].

Table.1: Pakistan Livestock Papulation

Species	**2017-2018**	**2018-2019**	**2019-2020**
Cattle	46.1	47.8	49.6
Buffalo	38.8	40.0	41.2
Sheep	30.5	30.9	31.2
Goat	74.1	76.1	78.2
Camels	1.1	1.1	1.1
Horses	0.4	0.4	0.4
Asses	5.3	5.4	5.5
Mules	0.2	0.2	0.2

Source: Ministry of National Food Security and Research Pakistan

Economic benefits of using biogas over conventional fuels

According to an estimate, expenses on conventional biofuels like LPG, fuel wood, dung cakes, chemical fertilizer account for Rs.3550 while health maintenance costs account for Rs.1000. Bio slurry can substitute chemical fertilizer to an amount of Rs.600 monthly. Whereas in Community Organizations (COs) of Punjab have reported that biogas plants produced enough gas for their daily use and they found it far better than conventional biomass energy sources. This clearly depicts the economic viability of biogas units as keeping in all above estimations; a biogas unit can save up to Rs.5150 month [4]. Another source confirmed that a biogas digester of 10 m^3 showed saving of Rs.7672 PKR monthly and 92,062 PKR as annual saving equivalent. The total cost of 5 m^3 is Rs.35000 hence per cubic meter cost of gas production is just Rs.7000. It is established fact that cost of biogas plant cannot be reduced other than by using the biogas plant and the generated gas in an efficient way. A study on the "Optimal biogas plant size daily biogas consumption pattern and conventional fuel saving" indicated that whole quantity of dung collected from yards is not fed to the biogas digester, according to an estimate only 4.77 kg of dung/cubic meter of digester was being fed in Nepal, while the recommended quantities are reported to be 6 and 1.5 kg in hills and terrain regions. Among indirect benefits, considerable reduction in diseases was found. A study on residential biogas models in Panam[5].

Conclusions

Pakistan have tremendous amount of renewable energy resources through which animal dung and crop residue are major commodities. Biogas as a clean, reliable and cost effective fuel option. Necessary knowhow about most of the biogas energy technologies already exists. There is just a need to allocate necessary resources for improving their energy requirements and plan their widespread dissemination. Better coordination between existing institutions is required to avoid use of conventional fuels for their energy requirement.

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EFFECT OF ABSORBER INTERCOOLING AND RICH SOLVENT RECYCLE ON POSTCOMBUSTION CO_2 CAPTURE SYSTEM

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ABSTRACT

CO_2 is the major greenhouse gas. Due to severe global warming and climate change issues, the reduction in CO_2 emissions is necessary. Fossil fuel-based power plants are the main source of CO_2. Among all available techniques, Post combustion CO_2 capture using the amine solvents is the most effective and has advantage of being retrofitted the existing power plants. To cope the challenges of high regeneration energy requirements of amine solvents, intercooled absorber and rich solvent recycle are among the most significant techniques.

Key words: Post combustion CO_2 capture, intercooled absorber, rich solvent recycle, modeling and simulation.

Introduction

It is widely accepted that CO_2 being a greenhouse gas is a major source of global warming and climate change. According to the BP statistical review of world energy in 2017, CO_2 emissions have been increased by 55 % in last 25 years [1] and Asia Pacific is at the top of the list with 48.2 % CO_2 emissions. Approximately, 72 % energy needs are met by fossil fuels around the globe and the combustion of the fossil fuel for electricity production has the major contribution in these emissions. Therefore, the interest in reduction of CO_2 emissions from power plants has been increased over the years to reduce the impact on the global warming and climate change. It is found that the reactive absorption using amine solvents is the most effective and promising technique for combatting CO_2 emissions from the power plants at the tail end. However, the high regeneration energy requirement is one of the major disadvantages and the energy is provided by extracting steam either at low pressure turbine section or through feed water heater sections of solvents. It is found in literature that the amine-based CO_2 capture plant can reduce the efficiency of power plant up to 7 to 12 % upon integration [2]. Further, intercooled absorber, rich solvent recycle or combination of both is an important and useful technique which may save energy requirements for an MEA-based post-combustion carbon capture [3-6]. In the present study, base case model will be developed in Aspen Plus® and effect of loading, temperature, CO_2 concentration, solvent concentration will be analyzed. The specific reboiler duty, overall energy requirements and required packing area will be reduced and rich solvent loading will be enhanced.

Methodology

The rate-based model of CO_2 capture absorption/desorption was developed using Aspen Plus® Fig.1. Around 90% CO_2 capture was achieved using ELECNRTL base where a part of flue gas from the power plant was introduced from the bottom and 30% wt.% MEA lean solvent was introduced from the top of the Absorber column. Rich solvent leaving from the bottom of absorber was introduced to the stripper/desorber column where MEA solvent was regenerated to reintroduced to the absorber.

Results and Discussion

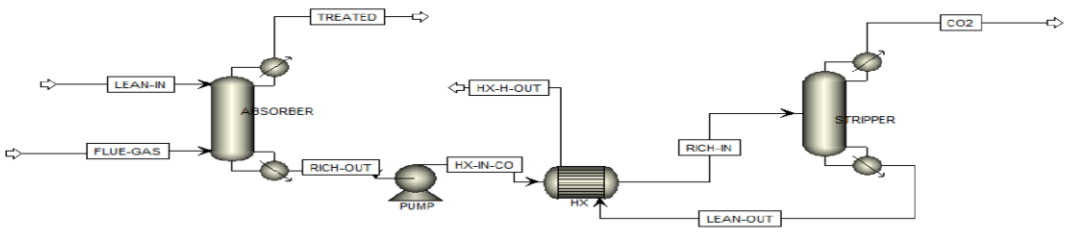

Figure 1. Developed rate-based model of CO_2 absorption/desorption in Aspen Plus

It is expected to achieve around 11-15% reduction in overall work by intercooled absorber and rich solvent recycle and combination of both.

Conclusions

In conclusion, intercooling, rich solvent recycle and their combination will help in optimization of the above-mentioned parameters along with reduction in the overall energy requirements.

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A SUPPLY CHAIN SYSTEM TO TRANSITION FROM NON-COMMERCIAL HAZARDOUS ENERGY SOURCES TO SUSTAINABLE BIOENERGY

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ABSTRACT

This study describes the procedure to form a supply Chain that will allow the rural waste of Livestock manure, Agricultural residues and forestry products-whose untraditional and inefficient burning results in rural health hazards-to be commercially utilized at a nearly located small scale biorefinery. The Supply Chain will include the representation and responsibilities from local farmers (responsible for resource supply), management (responsible for waste collection and sorting), and the producers (responsible for energy production through efficient technologies of Bio-Methane Engine, Ethanol Engine, and Gasification Steam turbines that are already operating in the country). The resulting energy will be in the form of Biofuels (Ethanol, Biodiesel), Gaseous Fuels (Methanol) and Power in the form of both Heat and Electricity.

Key words: Energy Assessment, Inter-locking bricks, Construction industry, PHPP

Introduction

Due to the constant depletion of indigenous fossil fuels, high cost associated with their imports, and a constant industrial growth, a paradigm shift is needed from traditional to renewable energy resources. Pakistan is an agriculture-based economy having an employment and GDP share of 50% and 24% from agricultural commodities respectively. Since, biomass is rendered feasible only as long as it does not compete with food sector of the country. Through Data collected from Bureau of Statistics, we performed a theoretical assessment to analyse the potential of energy generation through the province of Punjab using common agricultural products. It was observed that Punjab annually generates 70 Million tons of Crops (Wheat, Rice, Sugarcane, Maize, Rapeseed, Jatropha, Wheat, and Sunflower) which based on crop to residue ration can generate up to 93 Million tons of feedstock. Based on crop Phenology (Moisture content, oil content, and Yield), this waste can be treated through use of Ethanol Engines, Combustion Steam Turbines, Biomass Water Heaters to Produce Electricity, Biofuels, and Heat Energy.

Further, bioenergy supply chain targets five main sustainable development goals (SDGs). Traditional use of biomass resources results in over Million Deaths each year. Unlike this, commercial use is renewable source which will result in cleaner rural areas (SDG-3 and 11). Commercial use of Residue, Livestock waste is completely renewable and can provide a technical potential of 342236 TJ/year and 3 GWh/year respectively. The given value is calculated considering the resources in rural areas of the country (SDG-11). Utilization of bioenergy resources will reduce the dependency on fossil fuels. Indigenous resources of oil and gas are already depleting which results in high import cost and consequently environmental issues. Bioenergy can provide a sustainable solution since the country can rely on its own resources.

Further, the technological penetration will improve the infrastructure within the country (SDG-8 and 9).

Methodology

The methodology adopted for quantification and developing supply chain feasibility is graphically depicted in the figure below

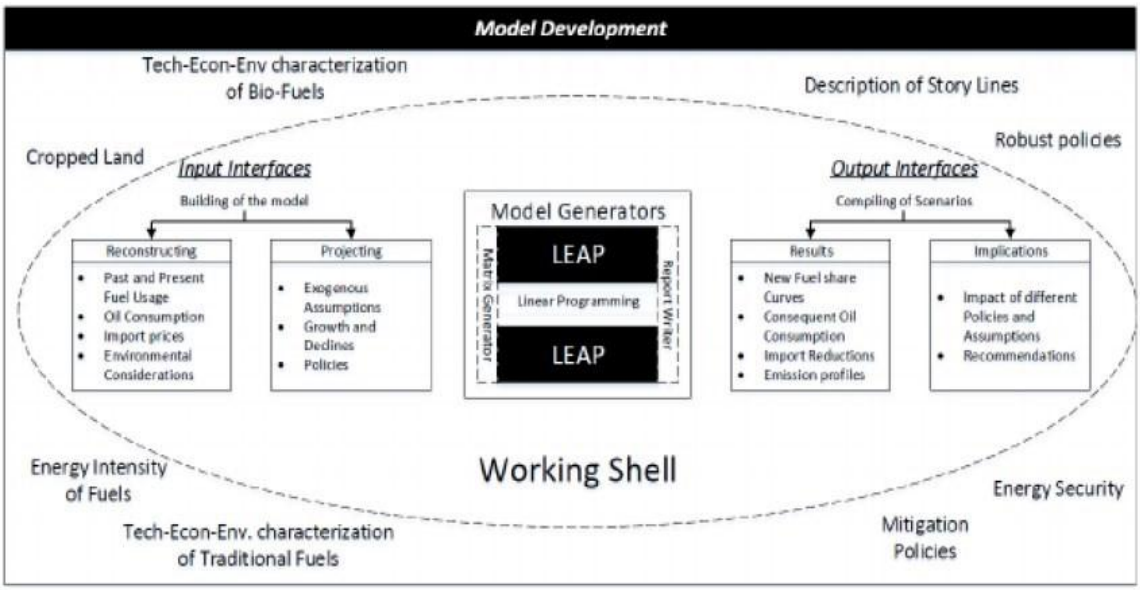

Figure 1: Methodological overview of the study

Results and Analysis

Apart from some quantification results discussed in the introduction section, the study analyses both the technical and theoretical potential of bioenergy resources. The adopted methodological approach can be applied anywhere to quantify bioenergy and assess its potential to be treated on a commercial scale. Furthermore the supply chain analysis determines that implementation and initiation process will take around 9-12 months with activities as indicated in the table below.

Implementation Stage (0-3 Months)	**Phase-1 (3-6 Months)**	**Phase-2 (6-12 Months)**
Campaign and printing of awareness materials	Construction of Primary and Secondary Collection Points	Process for connecting refineries to the national grid (if they are not currently)
Rental of Necessary Equipment	Development of BCC program and printing of awareness material	Formulation of Policy Pathway involving incentives for local farmers to enhance their willingness to sell their product.
Start of Development of comprehensive unusable waste disposal system.	Involvement of Public/Private Sector Bodies.	Commencement of the Program.

Conclusions

The bioenergy supply chain process pose significant prospects for rural empowerment. Such supply chains along with providing energy sufficiency will result in many social advantages as

well. This includes employment opportunities, relief from hazardous energy sources, and health hazards as well.

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PERFORMANCE EVALUATION OF GRAVITATIONAL WATER VORTEX HEAT EXCHANGERS

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ABSTRACT

A naturally generated vortex flow is called free vortex, whereas a forced vortex is formed by a solid body rotation in a viscous fluid. Vortex flow has the capability to exchange heat to another fluid present at the exterior surface of the basin. In the past, spiral flow channels (SFC) were constructed around the basin wall and the heat exchange potential was determined. Because of the roller coaster effect, the time and area of contact between the two separate fluid streams for the sole purpose of thermal exchange limiting the heat transfer. The proposed new configuration circulates hot water in a shell with baffles (SWB) constructed around the basin and thus, the primary aim of the current work is to inquire and compare the performance of SWB and SFC. Moreover, the present study also used a mixer driven by a gravitational water vortex to further enhance the heat transfer without the application of any external power. Results show that SWB configuration exchanges more heat than SFC irrespective of the presence of the mixer. Also, the addition of the mixer to generate forced vortex has adverse effects on the heat transfer and is therefore, not suitable in GWVHE for heat transfer enhancement.

Key words: gravitational water vortex heat exchanger, mixer, shell with baffles, spiral flow channel

Introduction

Vortex flow is one of the important flow configurations which is not given much consideration from heat exchange point of view. In vortex flow, the fluid particles circulate around a central axis and can be of two types; forced vortex and free vortex [1]. The former type is produced because of external forces and can be created by rotating the basin or by impellers or solid body rotation in the fluid. In latter type, no external force is required to rotate the fluid, hyperboloids of revolution are formed by fluid particles under the action of gravity. In all the previous studies, energy transfer in gravitational water vortex has been hydraulic to mechanical energy conversion only. The only study conducted at GIK institute had suggested that a huge potential exists in terms of heat transfer for gravitational water vortex if basin is designed in such a way that secondary fluid is directed on the exterior side of the basin [2]. The current work intends to experimentally analyze the heat exchange characteristics of a newly designed configuration of GWVHE, containing shell with baffles (SWB) on the exterior wall of the basin. For the same testing conditions, the results of SWB design needs to be compared with the previous model of GWVHE having spiral flow channel (SFC), on the outer periphery of the basin, to investigate any potential performance improvement in the former configuration because of heat exchange area enhancement. Moreover, the two configurations also need to be investigated from the heat exchange potential point of view both, in the presence and absence of mixer.

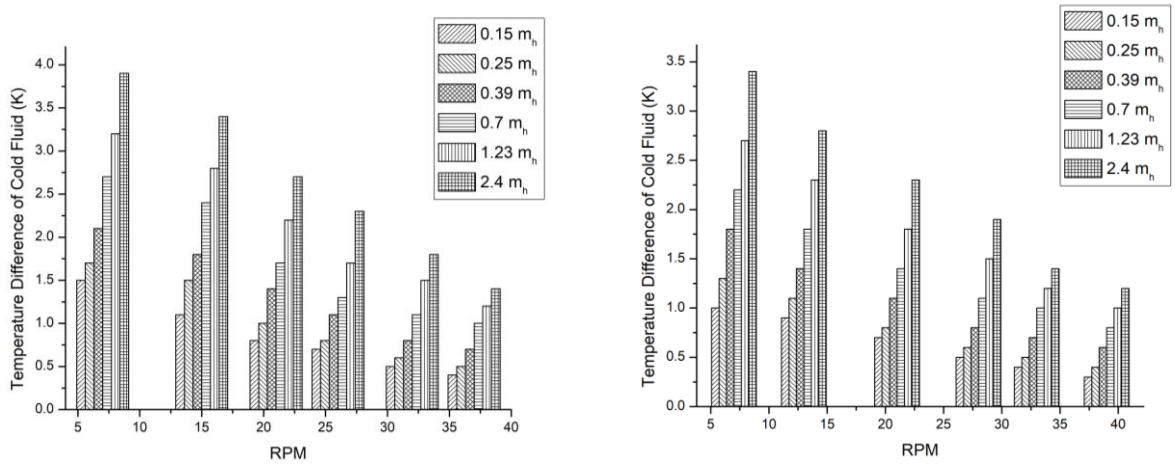
Methodology

The purpose of the present study is to experimentally examine and compare the heat transfer capability of the two configurations of GWVHE, with and without the presence of mixers. For this purpose, an existing experimental setup for testing of GWVHE, was used. One of the configurations, i.e., SFC was designed, developed and tested by Tayyab et al., whereas SWB configuration was designed, developed and tested in the present study [2]. In addition, turbine rotors have also been used as the mixing devices to incorporate the effects of forced vortex in a GVF. These mixers have also been designed, developed and tested by Saleem et al. for the purpose of power generation using a gravitational water vortex. A single-phase water to water heat exchange potential has been evaluated and compared with and without the presence of the mixer.

Results and Analysis

Experimentally obtained values of temperature, temperature distributions and rotational speed of the mixer have been used for the evaluation of thermal exchange performance of GWVHE configurations. In this regard, at first, the effects of flow rate on the heat exchange characteristics of each configurations have been examined in the form of an energy balance (Fig. 1). Moreover, the performance of GWVHE using forced and free vortex has been investigated by comparing the heat exchange between the two fluid streams with and without the presence of a mixer (Fig. 1). Furthermore, the effect of mixer rpm on the heat exchange and the temperature distributions have been evaluated (Fig. 2). Finally, the best GWVHE configuration has been evaluated based on the aforementioned parameters.

Fig. 1 HTR for SWB configuration in first and second SOEs at $T_{h,i}$= 323 K, $T_{c,i}$= 299 K for $\dot{m}_c$= (a) 0.6 kg/s, (b) 1.1 kg/s



(b) (b)

Fig. 2 Effect of mixer rpm on temperature change of cold fluid in SFC configuration at (a) $T_{h,i}$= 323 K, (b) $T_{h,i}$= 313 K

Conclusions

An overview of the results declares that the SWB configuration is more effective in a heat transfer process than the SFC configuration of GWVHE. Moreover, the effect of the presence of mixer is not favorable from the point of heat transfer in a GVF.

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HIGH-TEMPERATURE CORROSION OF Fe-Cr-W STEEL IN OXIDIZING AND SULFIDIZING ATMOSPHERES

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ABSTRACT

Ferritic Fe-Cr-W steel (ASTM T122, with a nominal composition of Fe-12Cr-2W-0.6Mn-0.4Mo0.2V-0.1Si-0.05Nb-0.03B-0.1C in wt%) was corroded for up to 20 h at 1 atm of N_2/3.1%H_2O/2.42%H_2S-mixed gas at 600, 700, and 800 °C and 1 atm of Ar/1%SO_2 at 1000 °C. Characterization techniques like XRD and SEM/EDS were used to study the corroded samples to analyze the microstructure and composition of the scale. The experimental results revealed that the developed scales were thick and fragile. The scale formed into the FeS-outer scale, (FeS, $FeCr_2S_4$)mixed middle scale, and (FeS, $FeCr_2S_4$, oxides)-mixed inner scale as the corrosion progressed into N_2/3.1%H_2O/2.42%H_2S-mixed gas. This showed that corrosion was primarily caused by sulphidation instead of oxidation due to the H_2S gas. The formation of (Fe_2O_3, Fe_3O_4)-mixed outer scale, (Fe_2O_3, Fe_3O_4, $FeCr_2S_4$)-mixed middle scale and (Fe_2O_3, Fe_3O_4, $FeCr_2S_4$)/FeS layered inner scale resulted at 1000 °C under Ar/1%SO_2 gas corrosion. In N_2/3.1%H_2O/2.42%H_2S-mixed gas, the ASTM T122 steel showed a fast corrosion rate as compared to the Ar/1%SO_2 gas environment. However, T122 steel was non-protective and displayed rapid corrosion rates, because FeS was present in both the corrosive gas atmospheres.

Keywords Fe-Cr-W Steel, Oxidation, Sulfidation

Introduction

Tubing, piping, and headers in boilers, gas turbines, petrochemical plants, incinerators, and marine engines are exposed to high-temperature corrosive atmospheres during service at high temperatures [1]. This led to the development of the ASTM T122, which is Fe-12Cr–2W (in wt%) base heat-resistant steel. T122 steel, which has a higher amount of Cr and W and a less amount of Mo than T92 steel, displays high creep rupture strength and good corrosion resistance. For practical applications, it is important to study the high-temperature corrosion behavior of T122 steel in Ar/SO_2 and N_2/H_2O/H_2S-mixed gas, because these gases are frequently encountered during processing in an oil refinery, carbochemistry, petrochemical units, carbon gasification, shipping industry and energy generation in thermal power plants. SO_2 is a highly corrosive gas because it causes the combination of sulfidation and oxidation and deteriorates the metals quickly. It is a typical corrosive gas component of the emitted combustion gas in the form of SO_x, and also mainly released in the industrial atmosphere from fuel burning in any form, boiler combustion, and highpowered ship engines. SO_2 dissociates through the reaction: $SO_2(g) \rightarrow 1/2S_2(g)+O_2(g)$. Water vapor and H_2S gas significantly accelerate the corrosive attack [1-3]. The H_2S gas is produced as the byproduct during processing fossil fuels, dissociates into sulfur and hydrogen, and reacts with the steel according to the reaction; $H_2S+Fe \rightarrow FeS+H_2$. Generally, sulfides are highly nonstoichiometric, and ionic diffusion in sulfides is hence faster than that in the corresponding oxides [4]. Sulfidation is therefore a quite serious problem. Not only sulfur but also hydrogen significantly decreases the corrosion resistance and mechanical properties of the steel through hydrogen embrittlement and hydrogen dissolution in alloys and scales [2,3]. Water vapor dissociates into oxygen and hydrogen. Oxygen forms oxides. Hydrogen released from H_2S and water vapor ingress into the steels interstitially, form hydrogen clusters, and cause hydrogen embrittlement, accelerating the corrosion rates significantly. In this study, the ASTM T122 steel

was corroded at 1000 ºC in Ar/1%SO_2 gas and 600-800 ºC in N_2/H_2O/H_2S-mixed gas to understand its corrosion behavior. The purpose of this study is to investigate the high-temperature corrosion behavior of T122 steel in Ar/1%SO_2 gas and N_2/3.1%H_2O/2.42%H_2S-mixed gas. Particular attention was paid to clarifying the corrosion products, and the scale morphology.

Conclusions

The T122 steel displayed poor corrosion resistance during high-temperature corrosion in both N_2/3.1%H_2O/2.42%H_2S-mixed gas for 20 h and Ar/1%SO_2 gas for 20 h. When corroded in N_2/3.1%H_2O/2.42%H_2S-mixed gas at 600 ºC, the bi-layered scale consisting of sulfides and oxides formed. When corroded at 700 ºC in the same environment, another bi-layered scale consisting of the outer FeS scale and the inner (FeS, $FeCr_2S_4$, oxides)-mixed scale formed. Similarly, when corroded at 800 ºC, a triple-layered scale consisting of the outer FeS scale, the (FeS, $FeCr_2S_4$)mixed middle scale, and the inner (FeS, $FeCr_2S_4$, oxides)-mixed scale formed. However, when corroded in Ar/1%SO_2 gas at 1000 ºC, the three-layered scale formed consisting of the outer (Fe_2O_3, Fe_3O_4)-mixed scale, the middle (Fe_2O_3, Fe_3O_4, $FeCr_2S_4$)-mixed middle scale and the inner (Fe_2O_3, Fe_3O_4, $FeCr_2S_4$)/FeS layered scale. The scales were generally thick, porous, nonadherent, and susceptible to cracking.

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SURVEY OF NZEBS AND MULTIPLE LINEAR REGRESSION ANALYSIS TO INVESTIGATE THE MOST IMPORTANT REGRESSOR VARIABLE FOR NZEBS: A STATISTICAL ANALYSIS

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ABSTRACT

Buildings play a significant role in the establishment of strategies related to sustainable development. Building sector uses a valuable proportion of total energy. Carbon emissions are also greater for this sector worldwide. In recent years, NZEBs (Nearly Zero Energy Buildings) are growing day by day across the world. Many countries have adopted or considering to establish NZEBs as their future prospective. This will help them to alleviate the problem related to the depletion of energy resources and this will be good for the environment as well. There are two strategies involve in NZEBs, first one is that to minimize the energy used in the building by energy efficiency measures and the second one is to use renewable energy resources to meet energy demand for buildings as much as possible. This paper demonstrates the statistical analysis of the data related to NZEBs across the world and the main aim of this paper is to investigate the most important regressor variable for the development of a NZEB. Firstly, the statistical data has been collected and then the best parameters have been extracted from the data then perform multiple linear regression analysis on the selected data to predict the saving improvements in percentage which is the dependent variable in the analysis. Then based on different statistical techniques i.e. residual analysis, leverage values, cook distance, Durbin Watson statistics, identify and discuss the most important regressor variable(s) for the establishment of a NZEB.

Keywords: NZEBs, Regression Analysis, Statistical Analysis.

Introduction

Unfortunately, Pakistan is facing serious energy crises from the last ten years. In Pakistan, electricity supply is about 12,000 MW while electricity demand is 19,000 MW which results a severe power shortage for the country [1]. The overall world energy demand is about 89% and CO2 emissions in the world is about 79% from the last three decades [2]. The gap between supply and demand is increasing which is currently estimated about 2% [3]. There can be many reasons behind these disasters. First reason can be the enrichment of population [4] and the second reason for such severe power shortage can be the Pakistan's heavy reliability on fossil fuels import from recent years [5]. Many areas of northern side are still not getting electricity from grid. The electricity breakdown is 16–18 hours in rural areas and 10–12 hours in urban areas [6]. Three sectors of the country which includes residential, commercial and industrial are severely affected by this shortfall. Nowadays, research related to renewable energy resources has been improved to fulfill the shortfall situation of the country.

Energy consumption for the different sector is not same at all [7], for example, if we look at Pakistan energy sector, energy consumption is very high for the industrial sector, transport sector, and domestic sector. The remaining little energy consumption is for commercial agriculture and other government sectors as shown in
Figure **35** [7].

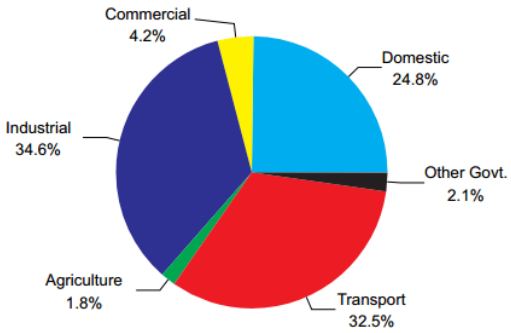

Figure 35: Energy consumption by sector [7]

The geographical location of Pakistan is on a perfect place where it can get a lot of benefit from renewable resources [8]. Pakistan can get benefit of solar, biogas production, biogas from biomass, wind, micro and mini hydal power plants [9].

Around the world, for the energy policy makers, solar PV has been a foundation. The reason behind that the ecological impacts of solar energy are low when contrasted with the traditional energy sources. It is free and basically non-consumable. Well developed nations have been utilizing solar energy for energy generation [9]. And primary energy supply for sources is changing year by year as shown in Figure **36**.

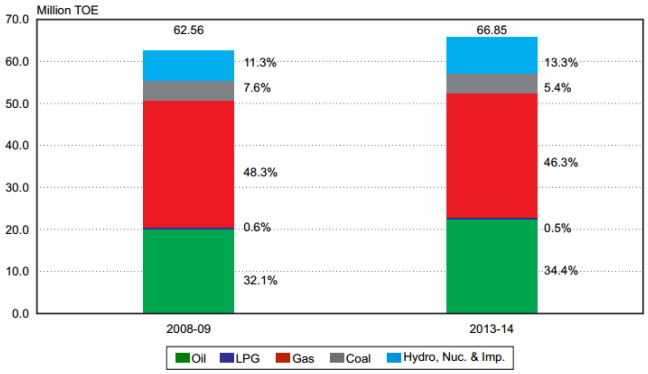

Figure 36: Energy consumption by sector [7]

The economical and cleanest way to decrease energy consumption and the emissions of greenhouse gas is the energy efficiency. The energy consumption for building sector is 40 % of the total primary energy [10] which is larger than other sectors. And the building sector is accountable for15.3 % of greenhouse gas emissions [10].

The largest energy consumption sector is the building sector which consume approximately one-third of final energy consumption globally. The building sector is equally important source of carbon dioxide emissions [10].

Conclusion

The Cp value for the model is the most important entity in the analysis to decide that which model is perfect to fit or not. If Cp value is very close to the number of parameters used in the model, then the model is considered as the best model. For the model consist of all regressor variables, the value of Cp is 5.9999 which is very nearer to the number of parameters which are 6.

To predict saving/improvements X2 and X3 are more important because X3 is strongly and linearly correlated with Y as was shown in matrix scatter plot. And the value of the coefficient B2 and B3 are greater than the values of other coefficients B1, B4 and B5.

So, based on the analysis it can be concluded that, for NZEBs, building category i.e. new or renovated is the most important factor to be considered. And secondly, the renewable contribution ratio is that factor which affects a lot to predict saving/improvements.

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SEAWATER DESALINATION USING VACUUM MEMBRANE DISTILLATION

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ABSTRACT

Seawater desalination process is an emerging technology and has gained attention in the past few years because of the scarcity of fresh water. VMD performance i.e. Temperature Polarization (TP) and permeate flux is based on operational parameters and membrane characteristics and is mostly affected by the membrane characteristics. In the present study, a combined heat and mass transfer model (HMTM) for the VMD has been established and validated with the experimental data of the literature. The effect of some of the influential membrane characteristics like porosity, pore size, membrane tortuosity, number of fibers and thickness of the membrane on the VMD flux was studied. Moreover, the effect of these parameters on the TP phenomenon was also studied. It was observed that by increasing the membrane porosity, number of fibers and mean pore size the VMD flux increases whereas a decrease in the flux occurs with the increase in membrane thickness and membrane tortuosity regardless of the feed velocity and temperature.

Key words: Temperature polarization, VMD flux, Vacuum membrane distillation

Introduction:
Water is a rich natural resource that covers 70% of the total earth's surface. Almost 97% of the total earth's water is seawater which is not drinkable [1]. This issue can be addressed by the desalination of seawater to make it clean and drinkable. Desalination processes are divided into two subcategories i.e. isothermal processes and non-isothermal processes [2]. MD, a non-isothermal process, is the alternative to these techniques used for seawater desalination [3, 4]. In this paper, a combined heat and mass transfer model has been established for the VMD process and the simultaneous effects of the membrane parameters on the TP phenomenon and permeate flux is carried out. The results of the numerical model are verified with the experimental data of the literature.
Methodology:
Poiseuille model is used in case of smaller mean free molecular path than the membrane pore size [5]. While Knudsen model is used when the pore size of the membrane is smaller than the molecular path. Knudsen number, a non-dimensional number is used to identify the nature of flow. In this study, Knudsen model was used to investigate the mass transfer across the membrane. The membrane module used in the present study was MD020CP2N. This membrane module has three layers: membrane layer, the permeate layer which is kept under vacuum and the shell side layer which is responsible for the hot feed solution to flow through it. The calculations were carried out for a feed circulation temperature of 40°C, 50°C, 60°C and 65°C and for two different feed velocities of 0.2 and 0.4 m/sec.
Results and discussion:
Figure 1(a-d) shows some of the numerical results based on the present study. It can be observed from the results that the VMD flux increases with the increase in pore size, feed velocity, feed temperature and decreases with the increase in membrane tortuosity. In case of TP, increasing the mean pore size and membrane porosity would result in a decrease in the TPC while increasing the membrane tortuosity results in a decrease in the TPC.

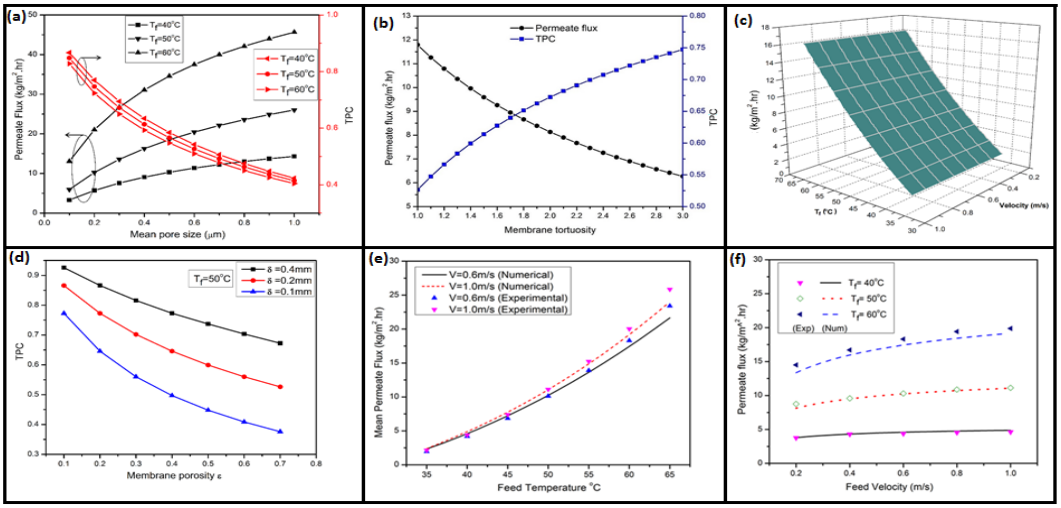

Figure 1: (a): Effect of mean pore size on permeate flux and TP, (b) Effect of membrane tortuosity on permeate flux and TP, (c) Simultaneous effect of feed velocity and feed temperature on permeate flux, (d) Effect of membrane porosity on TP, (e) Comparison of numerical and experimental permeate flux vs feed temperature, (f) Comparison of numerical and experimental permeate flux vs feed velocity.

Conclusions

In this study, numerical simulation was carried out to study VMD process in detail by using an integrated HMTM model. The simultaneous effects of the membrane parameters on the performance of VMD process was studied in detail.

The main conclusions on the basis of this study are as follows:

1. The VMD flux increases with the increase in number of fibers, membrane porosity and pore size whereas it reduces with the increase in thickness of the membrane and the membrane tortuosity regardless of the feed velocity and temperature.
2. The TP phenomenon decreases with the increases in membrane thickness and membrane tortuosity while increases with the increase in membrane porosity and membrane pore size.
3. The increase in membrane pore size is more significant at higher values of feed temperature for enhancing the VMD flux.

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ALTERNATIVE MATERIAL USE OF FAST PYROLYSIS CHAR AND ITS IMPACT ON THE BIOLIQ PROCESS CHAIN

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ABSTRACT

According to research in IKFT (Research Institute) biochar is a significant by-product of bioliq® fast pyrolysis plant concept, amounting up to 28 □ of reaction products. Given its quantity, it would be a good prospect to find an alternative use of biochar on industrial scale. After exploring a number of prospective solutions and applications, activated carbon (AC) has been chosen as the focus of this study. Two methods has been used for the production of AC including physical and chemical activation methods in which steam and KOH has been used, respectively. Some experimental methods including N_2 adsorption, iodine adsorption and scanning electron microscopy (SEM) has been used to analyse physical and chemical characteristics of AC. The results indicated that biochar from wheat straw is promising for this purpose. The effective BET Surface and iodine number were found to be 2900 m^2/g and 2567 mg/g, respectively, in case of chemical activated carbon. The bulk densities of powdered chemical activated carbon and pelleted physical activated carbons are 0.128 t/m^3 and 0.239 t/m^3 respectively. In this current study, the proposed solution is for integration of activation into fast pyrolysis process on industrial scale. The waste thermal energy of flue gas was used to dry biomass and the the usage of waste thermal energy from hot char to produce steam for physical activation process. Physical activation process will be used for production of pelleted activated carbon having great capability to remove metal concentrations and other impurities from drinking water.

Keywords: Activated carbon, BET, Biochar, Demineralization, Chemical activation, Physical activation

Introduction

Biochar is produced from fast pyrolysis in a twin screw reactor along with organic condensate, aqueous condensate and pyrolysis char at a process demonstration unit (PDU). Pyrolysis gas is burnt in a gas burner to supply thermal energy for heat carrier loop and organic condensate which is directly fed to gasifier for gasification but biochar and aqueous condensate are left behind. Currently only 10% of produced biochar is mixed with aqueous condensate to make pump-able bio-syncrude slurry for gasification and 90% of biochar is useless, which is not an economical way to use this biochar on industrial scale [1]. Biochar is used in animal farming, composting, building sector, and textile, cosmetics, paints and energy production without any further up gradation of physical or chemical properties. But few applications need specific improvements in physical and chemical properties of biochar for their respective applications [2] .

Activated carbon is a fine black, odourless and tasteless powder, produced by processing of char having extremely pores structure with large surface area available for adsorption. Because of blockage of the pores by tar [3-4] the internal surface area of char is too low and it does not have developed porous structure. Porosity development is due to activation which results in opening, and widening of inaccessible pores [5].

Physical activation involves high temperature activation using gasifying agents like carbon dioxide and steam in an inert atmosphere to increase the porosity of char. Chemical activation involves high temperature activation using chemical agents like potassium hydroxide, sulphuric acid and zinc chloride under nitrogen atmosphere to increase the porous structure of char.
Due to their microporous structure and chemical nature of their surface with acidic functional groups they have been considered as a potential adsorbent for removal of pollutants and nutrients from industrial and sewage waste water [6]. After reviewing all biochar significant applications, activated carbon seems to be a promising application for future in both gas phase and liquid phase adsorption processes.
Activated carbon is used in both gas phase and liquid phase applications. In gas phase applications, Marsh *et al*. have outlined a few applications which have been widely explored [7]. Activated carbon is also used for cigarette filters, industrial gas masks, chemical warfare agent protection (including clothing and gas masks), effluent gas purification and industrial off-gas purification like (removal of SO_2, H_2S etc.). In liquid phase applications, activated carbon is used for removal of pollutant organic compounds like natural organic compounds (NOM), synthetic organic compounds and by-products of chemical water treatment produce bad odour, taste from water that becomes the source of infection. Activated carbon is also used to treat with effluent wastes from chemical factories, rubber factories, fabric dyeing, fertilizer plants, pulp and paper mills etc. Activated carbon is used for the removal of oil from effluent water in petrochemicals, petroleum refinery and metal extraction. In this current study, activated carbon is used in liquid phase applications especially focussed on drinking water treatment. Clean water availability is a crucial issue in developing countries. In many parts of world, heavy metal concentrations in drinking water are higher than international guideline values. The main threats to human health from heavy metals are associated with exposure to cadmium, lead, mercury and arsenic. Utilization of activated carbon for removal of heavy metals from water will minimize water related health problems.

Conclusions

Employment of wheat straw biochar as a precursor or raw material for production of physical or chemical activated carbon is beneficial on industrial scale. The higher adsorption capacity of chemical activated carbon suggests the process is potentially suitable for industrial scale. In case of chemical activated carbon, impregnation ratio has a large effect on iodine adsorption capacity. Sample (CAC 3) activated at 4:1 impregnation ratio had the best iodine adsorptive properties. Increasing KOH amount used for chemical activation may help in the development of internal microporous cavities, which result in an increased surface area, considered to be most important factor for adsorption. The surface area can be controlled by means of experimental parameters. Iodine adsorption tests show that adsorption capacities conform to the results based on nitrogen adsorption isotherms. According to American water works association, the requirement for water purification BET surface area should be greater than 500 m^2/g and density should not be less than 0.2 t/m^3. These both requirements are fulfilled by physical activated pellets and can used for water purification.
Chemical activated carbon can be used in gas phase applications due to their higher and effective BET surface area.

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STUDY THE EFFECTS OF FLUORIDE ON DENTAL FLUOROSIS IN SECONDARY SCHOOL OF QUETTA REGION

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ABSTRACT

The drinking water quality of Quetta has been deteriorating gradually, due to the introduction of chemical pollutants that affect the human health. Since the high concentration of fluoride in drinking water can cause the dental fluorosis, and was observed in the population of some areas of Quetta, therefore; there is need to analyze the quality of drinking water to address the problem. Physico-chemical analysis of the drinking water sources for the Quetta District was carried out to assess its suitability for drinking purpose. Physical parameter such as Color, Odor, Taste, Temperature, pH-meter, Electrical Conductivity, and Total Dissolved Solids (TDS) with chemical parameters. Total 67 drinking water samples were collected from 67 tube wells of groundwater of Quetta. Out of 67 number of samples, 62% of samples were polluted and only 38% of water samples were fit for drinking purpose. To assess this problem, 910 secondary school children (8-14 years from Government School and Private Schools were examined and 79% were found to be affected by dental fluorosis. A Statistical correlation of fluoride with pH and TDS (total dissolved solids) provides strongly positive and highly significant results. Therefore, it is established that in water the concentration of fluoride is dependent on pH and TDS concentration. On the health of human being, there is a very minor difference in fluorides' concentration that gives beneficial or hazardous effect, therefore a regular monitoring of drinking water sites should be performed. Furthermore, there is a need for remedial measures for the removal of fluoride in drinking water. The results from the survey conducted on different schools showed that most of the children suffering from dental fluorosis use fluoride-containing toothpaste which aggravates the problem of dental fluorosis.

Key words: Fluoride, Dental fluorosis, Quetta, and total dissolved solids

Introduction

Clean water is the basic need of every individual, the daily consumption of water for every person is approximately two (02) liters and that extends to about 12 million m^3/day for the population of the world [1]. The water present in the body of the average human being is two third of water by weight, a human brain is composed of 85% water while muscles contain 77%, and bones contain 33%. Safe and clean drinking water is essential for human physiology. As natural water contains minerals, vital for human and for another living being therefor, it is an important component for the existence of life on earth consequently; it will have a direct effect on public health [2]. Drinking water quality is a comparative term that expresses the composition of water that effects natural processes and human activities [3]. Water quality principles deliver the basis for judging the appropriateness of water for its designated uses and for refining existing conditions. For best development and management of water for the positive uses, present information is needed which is delivered by the water quality monitoring programs (Ali et al, 2004).

Methodology

In this study, an attempt has been made to analyze the suitability of groundwater of Quetta for drinking purpose and the concentration of fluoride with other physicochemical parameters have been statistically correlated. The effects of the higher concentration of fluoride (WHO limit 1.5 mg/L) in drinking water on the health of primary school going children of the sites were examined. For this

purpose, data from different schools of Quetta was collected through a survey, especially those areas where the drinking water has a higher concentration of fluoride.

2.1Site Selection

Quetta valley has been selected for the collection of water samples. The area is completely residential and commercial. The total population of the Quetta District is 2,275,699. A total of sixty-seven drinking water samples were collected from groundwater sources.

2.2 Groundwater (Tube well)

Groundwater is one of the major sources and supplies drinking water to Quetta. From each source, one sample was collected. From every grid, one sample was taken and the distance between two sampling sites was one sample per grid was collected by maintaining the distance of 1 to 5 km^2. Preference was given to permanent public points. Total 67 water samples were collected from Tube wells. The depth of the tube wells varies from 300 to 1000 ft. respectively. Water from Tube well is used for drinking and as well as for land irrigation.

Results and Discussion

Total 67 number of drinking water samples was collected from 67 different sources of Quetta.

3.1 Color, Odor, and Taste

The acquired results of the drinking water samples collected from the groundwater of Quetta were found to be colorless, odorless, and tasteless (Except for two samples). The physical parameters of drinking water quality include color, odor, and taste. The taste of water may be due to the hardness that varies from community to community; though, the concentration of salt in water and saliva should be the same so that it is felt neutral (Asadullah et al, 2013).

SECONDARY SCHOOL CHILDREN AFFECTED WITH DENTAL FLUOROSIS IN DIFFERENT AREAS OF QUETTA.

Fig :1 School: Govt Girls High School Saryab Area: Saryab Road Quetta

To assess the occurrence of dental fluorosis, 910 primary school children (8-14 years from Government School, Private School) were examined and 79% were found to be affected.

Conclusions

On the basis of results obtained from drinking water samples of Quetta, it is estimated that most people use contaminated groundwater. Out of 67 number of samples,62% of samples were polluted and only 38% drinking water samples were fit for drinking purpose. As for as the concentration of fluoride is the concern,43% of the samples were found to be on the risk of dental fluorosis and dental fluorosis. Water samples that have the high value of pH and TDS are due to the concentration of different salts such as, F-, Na^+, SO_4^{2-}, K^+, and Cl^-.

A Statistical and Pearson correlation of fluoride with pH and TDS provides very strongly positive and highly significant results. Therefore, it is detected that in water the concentration of fluoride is dependent on pH and TDS concentration. The salts of Na^+, K^+, and SO_4^{2-} take a very important role in achieving the favorable pH for the dissolution of fluoride-containing compounds in drinking water. Therefore, it is established that rocks present in Quetta valley, are possibly the reason for increasing the concentration of fluoride in groundwater. It is recommended that fluoride-containing toothpaste should not be used if drinking water has the higher concentration of fluoride

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TREATMENT OF RO MEMBRANES REJECT WATER USING DISTILLATION TECHNIQUE

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ABSTRACT

Reverse osmosis membrane reject water is a major environmental problem, and most conventional remediation approaches do not provide acceptable solutions. Distillation treatment typically removes most of the dissolved materials. So, due to its attractive features, this technique was applied in the present study. Membrane reject water of Al-Rahim Textile Industry (ATI) was collected, the distillation procedure was adopted, and a laboratory scales distillator was utilized to separate the distillate from concentrated residue. 1 liter of RO rejected brackish water of 14898 mg/L TDS was collected, and its TDS removal was tested at three temperatures 105, 110, and 120°C. The maximum TDS removal conditions were analyzed in terms of the distillate water quality at different distillation temperatures. The optimum results were obtained at 105°C, and energy consumption was analyzed to treat different volumes of brackish water.

Key words, Distillation, Membrane Reject water treatment, Textile industry wastewater

Introduction

Reverse osmosis (RO) membrane reject/brackish water is a major environmental problem, mostly released from the industry like textile, chemical, and food industries [1], and most conventional remediation approaches do not provide acceptable solutions[2]. Distillation treatment typically removes most of the dissolved materials. In addition, the boiling process kills biological contaminants[3]. Organic compounds that boil at temperatures greater than the boiling point of water (some pesticides) can be effectively removed from the water[4]. According to various authors, more TDS is harmful for living species, human health, and operating machines. There is a need of effective and feasible treatment to overcome such issues. The present study has given the focus on such a technique to optimize maximum TDS removal.

Methodology

The RO membranes brackish water of TDS 14898 mg/L, was collected from Al-Rahim textile industry. The experiment was performed at the pilot scale lab, USPCAS-W MUET Jamshoro. Initially, the Textile industry's brackish water was characterized for TDS, Hardness, and selected metals such as calcium, magnesium, sodium, and chloride. 1 liter of the collected sample was analyzed at 105, 110, and 120°C and calculated Distilling Rate and characterized TDS, Hardness, and selected metals. After achieving more TDS removal at 105°C, the energy consumption was analyzed of different volumes.

Results and Analysis

The collected brackish water was characterized as shown in table 2. The effect of the temperature was studied. At temperatures 105, 110, and 120°C, the 500ml volume evaporated at different times i.e. 3h, 2.5h, and 3h, while the TDS removal was observed 320, 405, and 620 mg/l, respectively. It shows that an increase in the temperature decreases the TDS removal. The process rate also increases by the increasing temperature of 2.7, 3.3, and 4.1 ml/min, respectively. The results show that Maximum removal of TDS at the temperature 105°C. Table 1 shows the results obtained at three different temperatures.

Table 1 The effect of the distillation temperature.

S No	Temperature (°C)	Time (h)	Volume (ml)	Distilling Rate (ml/min)	TDS mg/L	pH
1	105	3	500	2.7	320	6.1
2	110	2.5	500	3.3	405	6.5
3	120	2	500	4.1	620	6.7

Table 2 Water quality analysis of Brackish and Treated/Ditillate water

Parameter	Unit	Brackish water	Treated water
pH		8.12	6.1
EC	us/cm	16272	710
Turbidity	FTU	0.31	0
Sodium	mg/l	4312	49.4
Calcium	mg/l	412	19
Magnesium	mg/l	79	41
Chloride	mg/l	1702	64

For the energy consumption estimation, the formula $Q=C_p*m*\Delta T$ was used, in which the energy requirement of evaporated water can be estimated using the water-specific heat ($4.2*10^{\wedge 3}$ J/(kg*℃)), water volume to be evaporated mass and change in temperature i.e water heating from the normal temperature to the boiling temperature. The initial temperature of the water is around 20℃, and the final temperature is 105℃. So, the temperature difference is 90℃.

Table 3 Energy consumption estimation of different volumes of brackish water

Volume	Unit	Mass (kg)	Energy	
		m=ρV	Joules	BTU
500	ml	0.0005	1890	1.79
1	L	0.001	3780	3.58
5	L	0.005	18900	17.91
1	m3	1	$378*10^{\wedge 4}$	3582.74
10	m^3	10	$378*10^{\wedge 5}$	35827.48
100	m^3	100	$378*10^{\wedge 6}$	358274.87

Conclusion

The present study proved that the Distillation technique has the potential to be effective and economically feasible for the purification of reject/brackish water resulting from the RO membrane. In the lab experiment, it has been shown that the TDS removal was highly dependent on temperature. The highest percentage removal of TDS was found at temperature 105°C. The RO rejected water was distilled and then analyzed before and after distillation, the results were 118 mg/L and 14898 mg/L respectively. The concentration of calcium, sodium, magnesium, and chloride were reduced, which showed that, this process of distillation can be used for RO rejected water.

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AQUAPONIC: GROWING FISH AND PLANT TOGETHER

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ABSTRACT

Aquaponic is a successful developing technique to grow plant and fish together without waste of water, because water is essential to grow for agriculture due to increase of the population. An aquaculture method in which the waste created by farmed fish or other fish, bacteria decomposed the waste from ammonia to nitrite, then these nutrients acts as organic fertilizer for used the plant grown hydroponically. Aquaponic is also called Recirculating Aquaculture System, because this system to circulate water from one tank to another tank and vise versa. In large scale, when we provide the water according to the requirement of plant, it is very suitable to connect the drip irrigation method, this method provide water drop by drop directly into root zoon. This system is not only save the water more efficiently or eco-friendly but also grow the plant and fishes for food with the passage of time without any used of soil. It can be very advantage to use any season, it can be efficient where the water shortage. This advance technique is very help to fulfill the requirement of water according to plant growth, especially in Pakistan due to the overgrowing of population.

Keywords: Fish tank, pump, Plant, drip irrigation method

DOMESTIC APPLICATION OF HYBIRD SOLAR COLLECTOR FOR THE WASTEWATER DESALINATION BY USING PHOTOCATALTIC MATERIAL AN ENERGY CHALLENGE

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ABSTRACT

Today, the clean water intake is the most essential part for the human life and its availability, the people specially living in rural as well as in coastal area, population growth does have negative impact on the availability of pure water. Even for those who have underground water resources, they do not want to intake the uncleaned water. Hybrid solar collector in one of the suitable domestic application for wastewater treatment at low cost and with high productivity. The quest is to purify the wastewater through hybrid solar collector by using photocatalytic material and its availability within the globe specially environment friendly. Many of researchers put their efforts for different types of solar stills and its productivity, this is also one of the energy challenges for domestic wastewater desalination. The theme of this paper represents an intention towards the domestic hybrid solar collector, its working method, thermal efficiency, performance and use of ZnO as photocatalytic material. The most remarkable improvement is for the development and use of such renewable techniques for rural areas which increased by 35% and 45% respectively.

Key words: Solar Hybrid collector1, Desalination 2, photocatalytic material 3

Introduction:
About 71% of globe covered with water, the problems of drinking water are eased to jump more and more on daily basis. We are living in globe, where drinkable water is a major problem, due to different contaminations (salinity, fungi etc.). Available water sources majorly (rivers, lakes, ponds, and ground wells) are polluted by the activities of human, which leads towards major health problems for the human and towards scarcity of water. Several countries facing the problems and do not have proper techniques for the water distribution system for each one, so called portable water system. People are relaying on RO plants. They are constraints to drink the contaminated water, unknowingly and they are suffering from acute water borne diseases. Many of children under the age of 5 years are suffered. Distillation process done by the major renewable energies like solar, wind because of these solar energies is viable, clean, environmentally friendly, economical to the drinkable water sources. There are so many solar devices, which are removing inorganic, bacteriological, organic, and non-volatile contaminations from the sour water. Adopting the practices to bring the solar devices can reduced the TDS up to 28-30 ppm.[2]
Methodology
Fabrication of Hybird Solar Collector
Heating of water using the sunlight as a source; however, the efficiency and reliability depend upon the activation energy from the sun.
Fabrication of hybrid solar collector depends on following components.

1) Tank with storage capacity.
2) Pipes for the circulation of water
3) Structure / support / Portable

The selection would be depending upon the material and the properties of catalytic material like vise TiO2 with ZnO2 [4]

Figure 1.1.1 Hybrid solar Collector and Absorber Plate.

Hybird soalr collector:
This is special type of solar heat exchanger, which transforms the solar radiations into energy, which will help to remove the contaminants from wastewater, due to effect of catalyst we used as photocatalytic material (TiO2) and ZnO.

Thermal Conductivity Ranges of Photocatalytic Materils

S.NO	MATERIAL NAME	THERMAL CONDUCTIVITY	UNITS
01	TiO2	4.8	w/mK
02	Zinc oxide	46-147	w/mK
03	Copper	400	w/mK
04	Aluminum	250	w/mK
05	Iron	80	w/mK
06	Steel	43	w/mK

Table No: 01

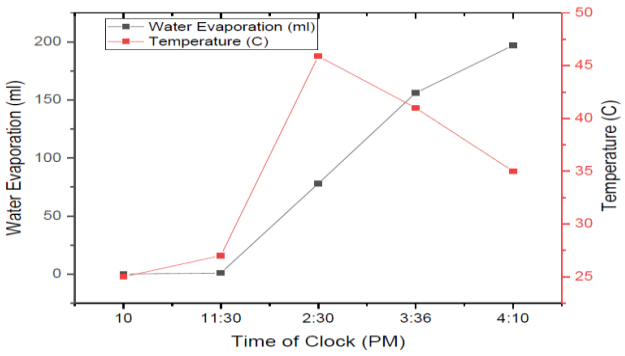

Figure 1.1.2

Experiemetal Analysis, Results
We are located near by the industrial zone. It is near the Arabian Sea. All the waste that was generated from industries including oil and gas, Textile, Cement, and Leather etc. was discharged into the sea due to which it was contaminated with lots of pollutants.
Table 2: Location of sample
Amount of Calcium, Magnesium and Total Dissolved Solids (TDS) were calculated in all the three samples at Dawood University of Engineering & technology, Karachi.

Following Results were found. Calculations were done in mg/l

S.NO	Location
Sample 1	Oil field
Sample 2	Qaida bad
Sample 3	Larkana

Table 3: Results of Samples

S.NO	Calcium	Magnesium	TDS
Sample 1	80	48	600
Sample 2	60	30	400
Sample 3	45	43	400

Conclusion

This project aims towards the current problems of domestic drinking water, as the population is going to increased day by day, we must be ready and face the challenges. The current growth of world is so rapid to grip the challenges towards drinking water supply and demand and the energy efforts poses to fresh water. We consider contaminated water as a waste, but this would be the valuable resource. The potential for fresh water is the worldwide application towards the portable technology. The challenge for wastewater treatment includes the cost, treatment technique, and toxicity. Treatment cost depends on the physical and chemical characterizations of water produced by oil and gas fields.
Future Recoomendations:
I: The project intentions, towards the possible and valuable solutions towards the domestic drinking water and the commercialization of the project in oil & gas industries facing curious problem of produced and dispose of wastewater. use of TiO2 as a catalyst wider application, which is currently under study in oil and gas industries for the removal of contaminations. ZnO2 is second most catalyst, and aluminum is best heat conductor, which was also used in this project as the increase in the demand's solar collector.

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A NEW HITCH BY SURGICAL MASKS ON ENVIRONMENT DUE TO COVID-19 PANDEMIC

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ABSTRACT

Already world is facing different environmental problems including deforestation, acid rain, waste production, loss of biodiversity, marine debris, extreme weather effects and disposal of waste. Due to outbreak of Coronavirus pandemic, need of surgical masks has mounted so production has been increased in both developing and developed countries. Only China is producing more than 100 million units of surgical masks on per day. Surgical masks are normally made from polypropylene and these are disposed-off after limited use. Single use of face masks is creating significant environmental problems and damaging both ecosystem and marine life. Discarded these masks are creating environmental pollution and these masks are not biodegradable taking around 25 to 30 years to be decomposed completely. A large number of surgical masks' production produces unimaginable quantity of waste for several years disturbing-rather destroying land, ocean and marine life ecosystem. Such a huge quantity of these products with little or no attention by environmental protection agencies results pollution to an extent requiring decades for healthy and hygienic environment to be restored. Challenges are just on their way for scientists, environmentalist and governments, and demand prior planning apropos environment sustainability and healthy world for generation coming after us.

Keywords: COVID-19, decomposition, single use, ecosystem, sustainability

PAKISTAN HEALTHCARE INFRASTRUCTURE AND COVID-19, A CASE FOR ISOLATION AND QUARANTINE FACILITIES OPTIMIZATION IN CONTEXT OF PAKISTAN

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ABSTRACT

COVID-19, one of the largest pandemic hit the world by the end of 2019 and took the globe by a storm. With almost 750,000 effected and above 35,000 deaths, it is declared by WHO a major global health crisis in March 2020. Pakistan, a developing South Asian country of 6th largest population in world having fragile and poor healthcare infrastructure also got hit badly with above 1600 affected and more than 20 deaths till time of writing in March, 2020. With such a large health burden at stake & closing of all major socio-economic activities with having very limited quarantine and isolation facilities, there is a dire need to explore the gap of existing healthcare infrastructure to cope with current circumstances and how it could be improved. In order to explore the current context with reference to the COVID-19 health burden, existing infrastructure and facilities were explored through literature review and documented against the set criteria and standards by CDC and WHO with respect to Quarantine and Isolation facilities. It was concluded through comparative analysis and exploration of the current line of actions by the governing bodies, that existing infrastructure fails to fulfill the need of the current pandemic situation and transformation of existing healthcare facilities and other allied buildings like hostels and educational institutions would not help in development of Quarantine and Isolation facilities. Infact they will create higher level risks for contamination and management of the disaster at hand, since these do not fulfill the set criterion for Isolation and Quarantine facilities with functional and spatial aspects. A two stream approach is proposed to handle the current situation with focus on using existing facilities at one hand with limited usage for quarantine and isolation while developing new facilities using pre-fabricated construction to enable quick delivery of such infrastructure to manage the COVID-19 in Pakistan. Proposed design interventions are shared.

Key words: COVID-19, Healthcare design, Infection control & prevention, Isolation Ward, Pakistan, Quarantine.

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SYNTHESIS OF A TCF-BASED FLUORESCENT PROBE FOR WATER AND SOIL ANALYSIS APPLICATIONS

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ABSTRACT

Fluorescent probes became a powerful tool for researchers to selectively detect variety of substances in living cells, in water and soil samples due to their simplicity and sensitivity, aiding researchers to monitor concentration of different contaminations, and ions to understand their effects on life, and environment.
As part of our research Tricynofuran (TCF) based fluorescent probe was designed and synthesized. This Fluorescent probe was synthesized successfully from reactant 2-(3-cyno-4,5,5-trimethylfuran-2(5H)-ylidene)malononitrile and reactant 2-hydroxy-5-methoxybenzaldehyde.The fluorescent probe obtained (simply say as 7a) after synthesize was characterized. In addition, Fluorescence tests of the TCF based Fluorescent probe were carried out with several analytes, results are given in the paper. Meanwhile, this 7a fluorescent probe would be investigated as sensors in the future for the more real-world applications for the analysis of water and soil.

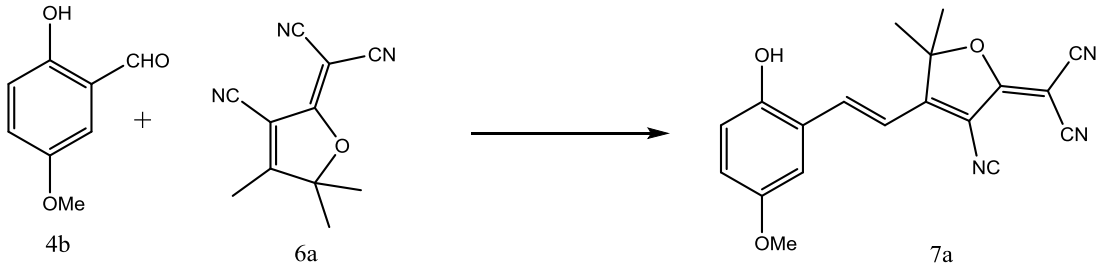
Key words: Fluorescent probe, water analysis, soil analysis

Introduction

With the fast growth of the economy, the common existence of numerous environmentally associated contaminants has become more and more serious.[1] The spreading of such contaminating agents are the primary source of environmental pollution of all major spheres. Especially, groundwater and Soil has been badly contaminated by a variety of industrial contaminants, which damage human health. Thus, it is required to develop a technique with simple and selective performance for analysis of contaminants in environmental water and soil. Currently, several techniques have been applied to analysis of pollutants including atomic absorption spectroscopy, inductively coupled plasma mass spectrometry and others [1]. While these analytical techniques can precisely detect pollutants in environmental water and soil, they even have few drawbacks like complex sample pretreatment, expensive instruments, and complex instrument operation. Therefore, scientists have launched to develop a variety of fluorescent techniques with innovative tools for prompt and accessible detection of pollutants. Mainly, fluorescence probe allows online monitoring of single or multiple pollutants. For instance, Tan's group produced a dual-response quinoline-based fluorescent probe for analysis of Cu^{2+} and Fe^{3+} [2]; Wang group made acid-based fluorescent probe for the detection of Fe^{3+} and Hg^{2+} [3], Muthukumar devised a chemosensor for the detection of Al^{3+} and Cr^{3+} [4].

Methodology

Preparation of fluorescent probe



4b 6a 7a

Fig. 1 Synthesize of TCF-based Fluorescent probe

Under Ar protection, A mixture of compound 4b (1mg, 1 mmol), and Compound 6a (200mg,1 mmol) was dissolved in 10-15 ml EtOH.[5] Then add a drop of acetic acid and two drops of piperidine. The

reaction mixture was refluxed and stirred for 2h at 80℃. After completion, the reaction mixture was evaporated under vacuum. Then using column chromatography on silica gel, purify the crude product (P.E/EA, 1:1, vol/vol) to give desired product 7a (350mg) as a reddish solid. Compound 7a was confirmed by HNMR, CNMR and Mass Spectrum.

Preparation of Solutions for fluorescence tests

Excitation of 7a was carried out at 290nm, slit was 4nm. Different analytes solutions were prepared. In every tubes 40µl of solution was taken with concentration of 7a compound was 0.1µM and concentration of different analyte ions was 0.1m M and solvent was mixture of H_2O: THF in the ratio 6:4.

Results and Discussions

Fluorescent probe was utilized to analyze the solutions of several compounds including NaF, NaBr, NaHS, $NaHSO_4$, $NaHCO_3$, Na_2SO_3, H_2O_2, HO_4P^{2-}, NaClO, Fe^{2+}, and Cu^{2+}. Yet 7a did not cause clear observable fluorescence increase or decrease in the solutions.

Conclusion

Fluorescent probe synthesized successfully and used on different solutions of following compounds including NaF, NaBr, NaHS, $NaHSO_4$, $NaHCO_3$, Na_2SO_3, H_2O_2, HO_4P^{2-}, NaClO, Fe^{2+}, and Cu^{2+}. When Fluorescent probe (7a) was applied to solutions there was no clear observable fluorescence increase or decrease detected. Hence these contaminants like NaF, NaBr, NaHS, $NaHSO_4$, $NaHCO_3$, Na_2SO_3, H_2O_2, HO_4P^{2-}, NaClO, Fe^{2+}, and Cu^{2} cannot be detected by 7a probe. Furthermore, after this 7a probe will be used to detect other contaminants as well to find the proper usage of 7a probe.

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IN-FIELD SUGARCANE TRASH MANAGEMENT STRATEGIES TO CONTROL ENVIRONMENTAL POLLUTION: A SHORT REVIEW

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ABSTRACT

In the conventional practice, the sugarcane trash, after harvesting, is usually burnt in the field which ultimately leads to loss of nutrients, degrades soil fertility and the environment. This paper presents a short review on the trash management approaches and strategies used in field to effective utilization of crop residue and thus help to control the environmental pollutions. The crop residue incorporation in the soil not only increases the soil fertility but also a technique to prevents the environmental pollutions. The mechanical handling and incorporation will help to enhance crop yield and overall farmer banifit.

Key words: Trash, conventional, operative, Environment

Introduction

Sugarcane is the major source of income for Pakistan and plays important role in the agricultural and industrial sectors of Pakistan. Sugarcane is the second-largest cash crop of Pakistan [1]. Sugarcane is harvested, both manually and mechanically, worldwide. Sugarcane leaves, which are becoming more available in the fields due to mechanical harvesting. The burning of sugarcane trash is a common practice among farmers because of the lack of labor and the shorter duration of the next crop [2]. In Pakistan, the main problems arise after the harvesting of sugarcane, the trash left on the ground. After manual harvesting, it is very difficult for the farmers to handle the trash in the field, so the remaining sugarcane trash burnt in the field. Many disadvantages occur during the burning of sugarcane trash in the field. The major effect of trash combustion on environmental pollution. Sugarcane trash burning emits large amounts of carbon, nitrogen, and particulate matter (PM). Sugarcane fires also have significant effects on the composition and acidity of rainwater because of the emissions of aerosol and trace gases which are very effective for human health [3]. For saving the environment from pollution and improve soil fertility using a sugarcane trash shredder, in the field worldwide. That machine cuts sugarcane leaves (120 to 150 cm long) into small pieces and environment friendly. The purpose of this study to find out the impact of trash management strategies on the environment.

Trash Management strategies

Conventional strategies

A few years ago, sugarcane farmers facing the problem of trash management of the crop. So, they adopt the conventional method for trash removing from the field and burnt the whole trash in the field. The trash contains very effective nutrient for soil fertility. During trash combustion very hazardous gases carbon, nitrogen, and particulate matter (PM) emit in the form of smoke which causes injury to human health. Burning canes liberate a considerable amount of CO_2 and other GHGs. The estimated direct CO_2 emission from cane burning was 10,410 kg/ha. An additional 1,791 kg CO_2/ha was estimated from the other gases (CH_4 = 467 kg CO_2, CO = 1,241 kg CO_2, and N_2O=830 kg CO_2). This summed up to 12,204 kg CO_2/ha which translates to about 37% of the total greenhouse gas emission in cane production on the farm[4]. Small size particles, penetrate deep into the lungs and reach the lower respiratory system, nitrogen and carbon gases also affect the respiratory system [3].

Figure 1. Conventional trash

Residue retention/mulching

Compared with burning, the organic matter content in the soil was considerably increased compared to the waste retention. Waste retention also increases the size of the microbial biomass, as well as the respiratory rate and ammonia rate.

Mechanical handling strategies

In sugarcane farming, the detrashing technology is the major step towards improving soil fertility and save the environment from hazardous gases that emit into the atmosphere with the conventional burning method. For detrashing, the sugarcane trash uses the sugarcane stubble shover and sugarcane trash shredder (single, and double) row as shown in figure (2). Trash shredder can be used for in-situ shredding of sugarcane leaves in the field. It minimizes the bulky trash to be managed at harvest time (about 12-20 t/ha). With detrashing, fewer trashes (60%) remain after harvest. This could pave the way to a complete stop of burning the trashes. The detrashed leaves activate the microbes to start decomposition and reduce fertilizer use [4].

(a) (b) (c)

Figure 2. a) Sugarcane stubble shaver b) Sugarcane trash shredder c) Graphical representation on trash shredder impact on sugarcane trash

One of the trash shredder studies gives us its importance in environmental pollution control. The length of trash varied from 43.18 cm to 185.42 cm. The average length was found to be 113.6 cm. The length of the trash after the shredding operation varied from 3.2 to 9.7 cm and the average length was found out to be 5.51 cm as shown in figure (3).

Adoption Problems

Trash Shredding technology is very familiar nowadays, but farmers are not adopted due to its high cost and high power required for operating this machinery.

Conclusion

From the study it is concluded that mulching and mechanical shredding in the field is cost savings, improves soil properties, increases yield especially, decreases the overall energy input, and carbon emission in sugarcane production and during trash management.

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SPATIAL DISTRIBUTION OF CARBON MONOXIDE IN KARACHI, PAKISTAN

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ABSTRACT

Karachi is an expanding metropolitan city where urbanization settlements are increasing at rapid rate. There is a voluminous increase in motor vehicles as an impact of increasing population centers which causes deterioration of air quality. Carbon monoxide (CO), one of the major pollutants emitted by vehicular emission which is also an extensive threat to the human health. This study has been conducted on Street level/roadside carbon monoxide assessment has been conducted in Karachi. We have collected CO using Portable USB-CO data loggers. The data samples been gathered from Street Levels and Over Head Bridges of 25 sites were monitored during the working days. A total of 360 observations were made for each site during the rush hours at two different heights. Major part of the study was conducted in summer season. Meteorological data for the particular sampling period was also taken and vehicles were counted manually. GIS data analysis and Mapping techniques were helpful. Correlation of coefficient was employed to evaluate the CO concentration between different heights, meteorological parameters and with traffic density. One hour mean CO value were ranged from 9.54±2.1 ppm to 1.16±0.3 ppm. 1-hour average ambient CO guideline of 26 ppm. The correlation results indicate significant emissions from traffic-related sources and much larger influence of wind speed on CO concentration at 15 meters. Upon comparative analysis, it is observed that the CO concentration is being trapped more in the streets within buildings than the open roads. The street level carbon monoxide concentration was found within World Health Organization. However, further research is needed to get the accurate examination of air quality of the city.

Key words: Spatial analysis, carbon monoxide, Exposure, Traffic emissions, Karachi

Introduction

In recent times, several Asian countries have accomplished substantial economic growth proceeding to increased urbanization, automation and energy consumption. Due to this, air quality is badly effected and become a major environmental issue because of lack of effective control actions. Globally, 865,000 premature deaths occur due to urban air pollution and out of this 60% deaths take place in Asia. [1]. In urban areas transportation motions have been recognized as a point source of prime source or air pollution [2] with consequential detrimental effects on human health [3]. The vehicle micro environment should be defined as individuals spend a consequential component of their time in this open environment, where vulnerability to contaminants are regularly profoundly raised in contrast to elsewhere, where people may increase the considerable contribution to their daily entire exposure and by virtue of the expanding link between exposure to traffic and negative impacts on human health results [4]. Rapidity of urbanization has eventually originated a number of environmental issues which include improper sewage system, poor infrastructure and heavy traffic. Furthermore, rapid industrialization specifically in underdeveloped countries is cause of deterioration of environmental factors hence increasing more harmful contaminants to the atmosphere [5].Therefore, the current study was carried out to monitor the concentration of CO on busy streets of Karachi by manipulating the data with the use of GIS techniques.

Methodology

Carbon monoxide monitoring data logger was used for sample collection on busy streets of Karachi during the rush hours (5pm-6pm). Twenty five different sampling sites were selected on the availability of pedestrian bridges, as the concentration of CO was to be analyzed on two different heights (2m & 15m).

Results and Analysis

The results shows a high concentration of CO at peak time of the day (5pm-6pm). Figure 1 (a&b) clearly depicted the mean concentration of CO at two different heights (2m& 15m) of sampling stations. it is clearly seen that 2 meter mean CO value for all the sampling sites are higher than the mean CO value at 15 meter for the respective site The comparison between two different heights expressed that value of CO usually reduced with the rise in height.

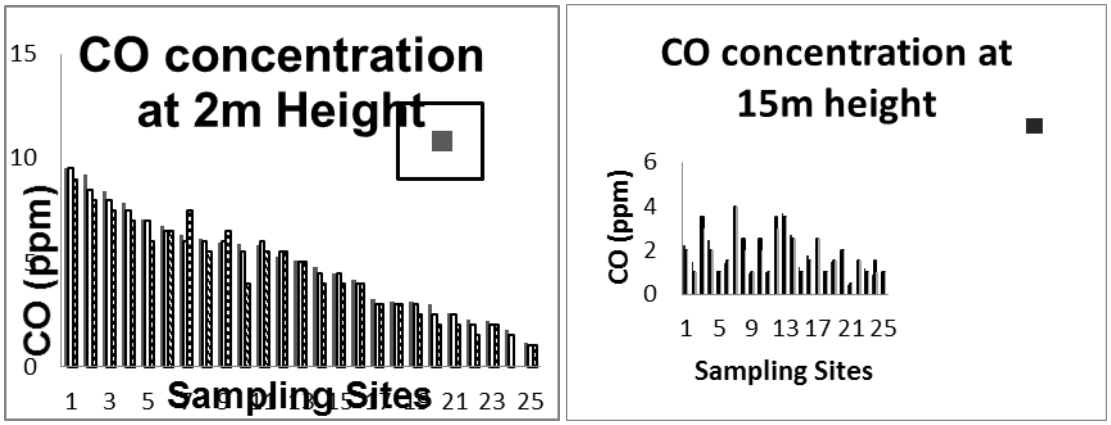

Figure 1: a) Comparison of Mean, Median and Mode concentration of CO at 2 meter height b) Mean Median and Mode of CO concentration at 15 meter measuring height

Conclusions

The monitoring of CO in this study was found to be above ambient air quality standards. The current road system in Karachi cannot meet to the demands of exponential increased in the number of vehicles and the problem is being provoked by an old vehicle and low efficiency of fuel. The current study revealed that there should be focused on ambient air quality standards that need to be publicized by government.

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COMPARING THE EVALUATION OF AUTOMATED SHADING AGAINST FIXED SHADING DEVICES ON ENERGY PERFORMANCE OF COMMERCIAL BUILDINGS: A STUDY CONDUCTED IN THE CLIMATE OF LAHORE

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ABSTRACT

The commercial buildings are using huge amount of energy to heat, cool and light the space and to maintain thermal comfort. One of the reason for this high energy consumption is the façade design of these buildings. Window is one of the significant component of building façade as it provide high air leakage and least insulation point in the façade. In order to solve this problem, world needs buildings which require lesser energy to maintain the ideal conditions and are energy efficient. In hot climate like that of Lahore, excessive amount of heat gain occurs due to increased WWR and glazed facades. Energy efficient / high performance facades, therefore, do not have entire glazing. Rather, windows of such facades must be designed carefully to increase the insulating capacity and decrease air leakage simultaneously. Shading is a passive strategy which increase the resistivity of window and can make it energy efficient. And shading control patterns increase the efficiency of such windows and facades. This research is carried out to understand the efficiency of moveable /automated shading device over conventional fixed shading device on energy performance of a window opening. The simulation is conducted for the climate conditions and geographical values of Lahore with a semi-arid climate. The results of the simulation showed that the installation of moveable shading devices always reduce the energy consumption in the buildings more as compared to the conventional fixed shading and is always advantageous. The benefits of the moveable / automated shade is evident on all orientations.

Key words: Energy Consumption, Automated Shading Devices, Energy Performance, Semi-Arid climate

Introduction

The world is changing very fast. There is a change in lifestyle of people all over the world. This change in lifestyle along with the increasing population is causing an increase in energy consumption in various sectors of life. [1] Building sector is note able in this respect as it is responsible for 40% of energy consumption and 19% of GHG gas emissions.[2] A considerable contribution in this excessive energy consumption has been made by commercial buildings due to entire glazed facades which have become a trend all over the world. The building envelope is a barrier and must acts a modifier between outdoor and indoor climate. [3] There is a need to design façade which must respond to outdoor climatic conditions. Window is an important element of façade design as it is a weak thermal link in the façade. Window needs to be carefully designed as it is responsible for the heat gain as well as heat loss.[4] Solar control can provide an optimal solution to counter excessive heat gain and heat loss through windows. Shading is a way to add solar control value and to increase the resistivity of windows. All kinds of shading devices can help but automated shading has some extra benefits over the conventional fixed shading. This research is conducted in the semi arid climate of Lahore in order to investigate the role and benefits of shading systems in commercial facades specifically focusing on automated shading sytems.

Methodology
The study is conducted through computer simulation and façade is modelled in a software named as comfen. The name "Comfen" is derived from commercial fenestration and is well suited for the research. As the target is the commercial building and the issues related to the energy consumption through glazed surfaces. The scenarios are created with managing different parameters of window design. Some of the parameters like WWR and glazing material have remained constant and the type of shading systems vary in each scenario.
Results and Analysis
The designed scenarios are simulated on cardinal orientations and results are discussed in terms of energy use breakdown, annual energy consumption and glare control.

Conclusions

The results show that the automated exterior shading performed better as compared to conventional fixed shading systems. The efficacy of automated shading observed to be highest on east and west orientations

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GREEN ROOF SUSTAINABILITY

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ABSTRACT

Key words: Building Modeling Technology (BIM), Energy Reduction, Carbon Emission, Sustainable Green Retrofit

Introduction
The building sector is considered one of the main energy consumption sectors, the trend of sustainable green roof buildings using BIM (Building Information Modeling) technology is the focus of many countries. Any building retrofitting is challenging, and residential/commercial old buildings offer no exception. They are increasingly in the need of retrofitting due to their age [1].
Methodology:
Efficient energy retrofitting of existing building is used to mitigate the impact on surrounding environment due to the excess use of energy. We developed a framework for benchmarking energy retrofit system in different zones of the country by integrating BIM and green roof [1-2].
Results and Analysis:
We presented an overview on sustainable green retrofit to identify key lessons from selected retrofitted projects. The most energy efficient renovation measures can be achieved by retrofitting of external walls only either the building is residential or commercial. To make buildings sustainable, the life cycle and energy efficiency were improved and buildings can last long [3]. Therefore, a green retrofit of existing buildings was found more useful rather than implementing it on new construction because, the older the building is, the more carbon emissions it will generate. The proposed non-destructive methodology assisted in providing an estimate of possible energy reduction, and the likelihood of achieving standard and sustainable conditions. The analysis of overall energy consumption was investigated through developed benchmarking tools such as Autodesk Ecotect, Autodesk Green Building Studio and BIM application in the retrofitting process. An improved comfort zone was discovered from BIM and solar gains were also reduced (from 80% to 20%) for the buildings.
Conclusion
The integration of BIM and green roof will make the building sustainable and will show how minimum retrofitting can cause huge reduction in energy consumption. The results of the investigated framework showed that the examined buildings can reduce its total energy consumption by adopting some simple measures. Such BIM integrations can enhance the development of retrofitting plans effectively to improve the building's service life.

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DESIGN DEVELOPMENT AND CHARACTERIZATION OF ORIENTED ELECTRICAL STEEL

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ABSTRACT

Electrical steels nowadays are replacing the copper and are considered to be more energy efficient because of low electrical losses and long life. In this present work an electrical steel was developed on laboratory scale. The chemical composition of the experimental steel was C-0.23%, Si-2.32%, Mn-0.76%, Cr-0.149%. The steel was melted in induction furnace and cast into ingots. The samples were normalized at 850°C for 1 hour and air cooled. The Eddy current was used to measure the conductivity, temperature coefficient of resistance and dielectric strength. These tests were performed before and after the further treatments. Rolling was performed at 800°C t make the steel grains oriented in a particular direction. Thermo-mechanical treatments were performed on the steel and it was found that conductivity, temperature co-efficient and dielectric strength were improved in the experimental steel.

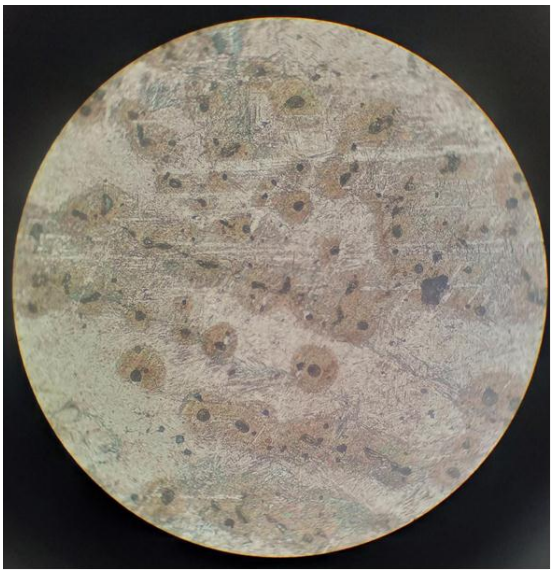
Key words Electrical steel, conductivity, die electric strength, oriented.

Introduction

Copper is supposed to be more conductive material hence is used in various electrical applications such as motor winding, electrical transformers, power lines etc. [1, 2]. Production and cost of copper is considered to be more expensive factor and also the heat and current losses are more than sufficient. The major drawback of the copper is considered to be life of copper and also it cannot be used where the high temperature is required. The melting point of copper is approximately 1100°C this make it not suitable at high temperature environmental conditions [3]. Electrical steels nowadays getting attraction by various researchers and scientist for replacing copper because steels are more cheaper than copper and also easily available cost effective material than copper itself. [4]. In the present research work a laboratory based model electrical steel was developed and characterized with various testing equipment's and it was found that electrical conductivity and other related properties [5]. It was concluded that electrical steel was successfully developed and characterized as per international standards and it was found that electrical properties are enhanced by applying rolling and thermo mechanical processing.

Methodology

The steel was melted in induction furnace and cast into ingots. The samples were normalized at 850°C for 1 hour and air cooled. The Eddy current was used to measure the conductivity, temperature coefficient of resistance and dielectric strength. These tests were performed before and after the further treatments. Rolling was performed at 800°C t make the steel grains oriented in a particular direction. Thermo-mechanical treatments were performed on the steel.



Silicon steel of 1.5% etched in picral .200x

Conclusions

In the present research work a laboratory based model electrical steel was developed and characterized with various testing equipment's and it was found that electrical conductivity and other related properties [5]. It was concluded that electrical steel was successfully developed and characterized as per international standards and it was found that electrical properties are enhanced by applying rolling and thermo mechanical processing. it was found that conductivity, temperature co-efficient and dielectric strength were improved in the experimental steel.

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DESIGN DEVELOPMENT AND CHARACTERIZATION OF HIGH IMPACT ENERGY KEVELLAR COMPOSITE

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ABSTRACT

As the technology grows the role of Advance Materials and their development grows rapidly in this decade. The Kevlar polymer composites are increasingly being considered as an enhancement to and/or substitute for infrastructure components or systems. This study also helps to develop such methods used to manufacture the composites. In this study, effect of different matrix combinations on blunt trauma and energy absorbed by Kevlar composite are studied. Composite samples were prepared with epoxy and different percentages of Kevlar + epoxy + fiber, that were be experimentally tested against high impact energy. SEM, Tensile test and impact test were performed and it was found that this composite can bear high energy impact behavior as indicated by experimental tests.

Key words Electrical steel, conductivity, die electric strength, oriented.

Introduction

Kevlar based composites are used in such applications are there is the risk of a bullet shot. This study presents a review of into the impact performance of Kevlar based composite materials, which includes fiber-reinforced laminates, fiber metal laminates, and sandwich composites with FRP face-sheets. The dynamic loading experienced by composite materials under surface contact, near-field and far-field shots events is described. The mechanisms by which fiber-polymer laminates, fiber metal laminates and sandwich composites absorb the shock wave energy generated by any high velocity object have been studied experimentally. In this study, effect of different matrix combinations on blunt trauma and energy absorbed by KGFRP laminates are studied. KGFRP composite samples will be prepared with epoxy and different percentages of rubber + epoxy +fiber, that will be experimentally tested against high impact. It find its application in automotive and aerospace applications as well.[1-3]. In the present research work a laboratory based model electrical steel was developed and characterized with various testing equipment's and it was found that electrical conductivity and other related properties [4-5].

Methodology

Kevlar is mostly-used as a friction material in the automotive industry and a combustion protection material in the aerospace industry. Kevlar has unique properties, such as high tensile strength, high toughness. It has chemical stability at high temperatures in aromatic polyamides. Composite Material was developed in the following as in the chart:

Step 1:

Kevlar sheet purchased from chemical market then blend with synthesized sheet Rubber and Kevlar Composite in Moulding Machine at 160°C ± 10 °C for 15 ± 5min. then cooled at room temperature**.**

Step 2:

Using epoxy to laminate the graphene (powder) on flex fiber then different test like optical microscopy, SEM images and XRD technique will be performed.

Step 3:

These flex fiber graphene materials are sandwiched in Kevlar rubber sheet with the lamination of epoxy, then hold it for 24 – 36 hr tightly

Figure 1. Development of Composite sheet.

Results and Discussion

Antishock resistant Kevlar composite was successfully developed in the laboratory scale. For making the composite sheet Kevlar, flakes fibers and coconut fibers were used. Epoxy resin as added as binding agent in the composite sheet.

Conclusions

In this study, effect of different matrix combinations on blunt trauma and energy absorbed by Kevlar composite are studied. Composite samples were prepared with epoxy and different percentages of Kevlar + epoxy +fiber, that were be experimentally tested against high impact energy. SEM, Tensile test and impact test were performed and it was found that this composite can bear high energy impact behavior as indicated by experimental tests [6-13].

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SYNTHESIS OF ZINC OXIDE NANOPARTICLES (ALTERNATE TO COSTLY PGMS IN HER)

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ABSTRACT

Nano materials (1-100 nm) have gained more contemplation in today's technological world with the novel properties and transitional behavior. Among the promising metallic nanomaterials; ZnO is one of the nanomaterial which has a vast area of applications including photoconductivity, antibacterial activities, high radiation absorption, optical transparency, Sun-screens, Painting-agents and beside all of these, strong attraction is given to the usage of ZnO NPs as a Nanocatalyst material in the Electrolytic production of Hydrogen in place of costly PGMs. In this work ZnO NPs have been successfully synthesized having hexagonal wurtzite phase in the range of 4-12 nm with the varied concentration and pH parameters of the precursors through the simplest, cheapest and feasible Sol-Gel method. This work is of great interest to synthesize ZnO nanoparticles at a very cheap rate and to take forward these nanoparticles in the much convenient & cost efficient production of Hydrogen through the catalytic study of these particles.

Key words: ZnO NPs, PGMs, Sol-Gel Method, Hydrogen Production

Introduction

ZnO nanoparticles, due to their good biocompatibility and low cost, show promising potential in bio imaging and drug delivery [1] The ZnO Nano crystals show a sharp UV emission band and a broad green emission band [2] One reason for ZnO being such an attractive and versatile material is due to the fact that its physical and chemical properties are directly linked to its morphology and particle size with the effect of some solvent medium [3] Beside the unique characteristics of Zinc Oxide Nanoparticles (ZnO NPs) including photoconductivity, antibacterial activities, high radiation absorption, optical transparency, and wide band gap they are brought in work to be used as a catalyst in the Green Synthesis of Hydrogen. As Hydrogen production from fossil fuels is hence an unsuited way towards the global demands that is why the green synthesis of Hydrogen has taken more attention. This is done through the electrolysis process having an electrolyser such as Nickel or Platinum based ones but by far these are high in cost (less efficient in case of Ni) therefore, strong attention is given to ZnO NPs as they appeared to have high catalytic properties to be used in Hydrogen Evolution Reaction (HER)[4]. Herein, we have synthesized the ZnO NPs on a very cheapest and simplest process Sol-Gel with major focus given to the precursor's concentration and pH so to take forward the electro-catalytic behavior of ZnO NPs which is a remarkable alternate as a Nano catalyst to the costly Platinum Group Metals (PGM) in Hydrogen Evolution Reaction (HER).

Methodology

ZnO nanoparticles are synthesized through various synthetic techniques (Hydrothermal, Solvothermal, Precipitation method and etc) but herein Sol-Gel (Chemical) method has been selected out of NanoTech Bottom up approach for the production of ZnO nanoparticles because of its low cost effectiveness, feasibility and better efficiency.

- Zinc acetate dehydrate {Zn (CH3CO2)2.2H2O} → precursor of Zinc
- Sodium Hydroxide (NaOH) →precursor, Variation In pH

- Ethanol (C2H5OH) →Solvent For Dissolving Zn (CH3CO2)2.2H2O
- Deionized water (H2O) →Solvent for dissolving NaOH

FIGURE #03 [24Hrs Stirring]

FIGURE #04 [Washing Solution Of Distilled Water + Ethanol]

FIGURE #05 [Filtration For Col Of White Precipitates]

FIGURE #06 [Collected Principates]

FIGURE #07 [Water Bath]

FIGURE #08 [Obtained Powder after D

FIGURE #09 [Collected Sample after Drying]

FIGURE #10 [Crucible Transfer Into The Furnace]

FIGURE #11 [Collected Sample After Calcined]

1. Three solutions of NaOH with concentrations 1M, 2M & 3M in distilled water were prepared. Four solutions with concentration
   0.4 M were prepared in a way that 20mmol (4.39gm) zinc acetate {Zn (CH3CO2)2.2H2O} was dissolved in 50ml ethanol.
   pH of 8, 11, 11.12 & 11.41 were attained respectively with the 1M,2M & 3M NaOH solutions.
2. Solutions were kept for 24 hours of continuous stirring by Magnetic Hot Plate Stirrer
3. For washing the prepared gel, 10% ethanol (50ml ethanol+450ml DI Water) solution was prepared. The gel was mixed in 10% ethanol and stirred for about 15 minutes.
4. The washed solution was filtered by Filter Paper
5. The Filtered gel was heated overnight at 80°C for drying using Digital water bath.
6. Powder obtained having pH 8, 11, & 11.12 then calcined at
   600°C for 90 minutes in Muffle Furnace

FIGURE #01 [2M Solution Of NaOH]

FIGURE #02 [pH Meter Electrode Placement and Showing pH 8]

Results and Analysis

XRD (X-Ray Diffraction)

The X-Ray diffraction peaks confirms that the prepared powder consists of particles in Nano scale range. We determined position, width, intensity and full-width at half-maximum (FWHM) data from this X-Ray diffraction patterns. The comparison has keenly indexed the X-Ray diffraction peaks (located at 31.84°, 34.52°, 36.33°, 47.63°, 56.71°, 62.96°,
68.13°, and 69.18°) as hexagonal wurtzite phase of Zinc oxide
[2] and further the purity (free of impurities) of Zinc oxide nanoparticles are also confirmed by this pattern as it does not contain any characteristics X-Ray diffraction peaks other than Zinc Oxide (ZnO) peaks. We calculated the synthesized ZnO nanoparticles diameter using Debye-Scherrer formula ($d = 0.89\lambda/\beta \cos\theta$) [5]

The calculated average particle size of three samples using Scherrer's formula of samples A, B and C is 11.73 nm, 4.19 nm & 9.77 nm respectively.

DLS PARTICLE SIZE ANALYSER:

The particle size distribution (PSD) of uncalcined Sample 4 having pH 11.41 is shown in (Figure# 13). The particle size distribution (PSD) of Zinc Oxide nanoparticles ranges from 0.49µm to 118.82µm as shown in graph. The average particle size is 27.2 µm as obtained by the Dx (50) value of given row data.

Conclusions

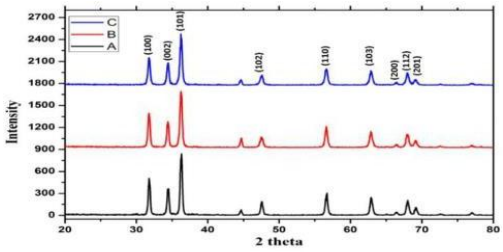

FIGURE #12 [XRD Result Sample A(pH 8), Sample B(pH 11) & Sample C (pH 11.12)]

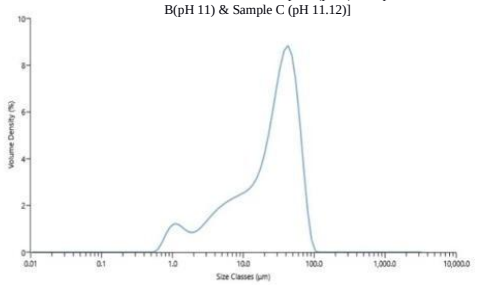

FIGURE #12 [XRD Result Sample A(pH 8), Sample B(pH 11) & Sample C (pH 11.12)]

ZnO NPs have been successfully synthesized with the varied concentration and pH parameters of the precursors through the simplest, cheapest and feasible Sol-Gel method having hexagonal wurtzite phase in the range of 4-12 nm. This study is of great importance both fundamentally and practically since it introduces a new simple and cost-effective method for developing Nano catalysts and testing them as cathode materials for water splitting devices for the production of hydrogen. Researchers can make use of this work to incorporate ZnO Nano catalysts as an alternate to the PGMs in the electrolytic production of Hydrogen in cost efficient and much convenient way.

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NUMERICAL INVESTIGATION OF SAVONIUS TYPE VERTICAL AXIS WIND TURBINE FOR MULTAN METRO STATIONS

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ABSTRACT

Wind energy is most common renewable energy resource has a great potential for large scale as well as small scale power generation system. Vertical Axis Wind Turbine (VAWT) used as small scale power generation system and the performance of VAWT is greatly impacted by different working conditions. In this paper, numerical modeling of savonius type VAWT was proposed to evaluate the performance and flow characteristics over the turbine rotor using CFD FLUENT®. Numerical analysis was performed at wind flow velocity of 8.5 miles per hour with different twisting angles of rotor blades and tip speed ratio. The outcomes showed that the highest values of power and torque coefficient are 27.5% and 48.5% at TSR 0.9 and 0.6, respectively. Furthermore, the performance was also affected due to the hot and cold environment with a highest and lowest value of power coefficient at temperature of 15°C and 45°C, respectively. Therefore, the consideration of hot and cold weather would be essential for the design improvement and design optimization of savonius VAWT for Multan Metro Stations.

Key words: Savonius type VAWT, CFD FLUENT, and POWER COEFFCIENT

Introduction

Nowadays, the availability of energy due to the burning of fossil fuels like oil, coal and natural gas and the environmental issue are the main issues for the engineers and researchers [1]. Renewable energy has a tremendous source of energy and is one of most important energy resources as it is clean and friendly environment [2]. On the other hand, wind turbines play an important role to produce electric power especially for those areas where wind flow velocity is higher. The average wind velocity of the Multan city is about 8.5 miles per hour at the elevation of 10 meters. The graphical representation of average of mean hourly wind speed with 25th to 27th and 10th to 9th percentile bands is shown in Figure 1. Furthermore, the highest elevation of Multan Metro Station is about 129 meters. Therefore, the wind potential at the elevated Multan Metro Stations is greater and the installation of savonius type VAWT is best for the production of electric power. The main purpose of this study is to develop a numerical model to examine the turbine performance of savonius VAWT for production of electrical power of Multan Metro Stations. In order to examine the flow the characteristics over the turbine rotor of VAWT, Computational Fluid Dynamics (CFD) FLUENT was used.

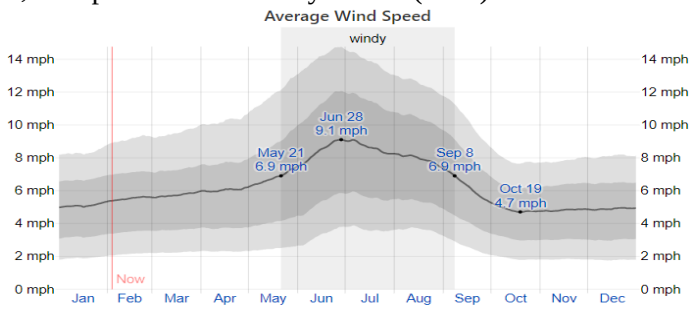


Figure 37: The average of mean hourly wind speed with 25th to 27th and 10th to 9th percentile bands

Methodology

The present research work is majorly based on the numerical analysis using CFD FLEUNT. In order to solve the governing equation in numerical method, Finite Volume Method (FVM) has been applied. Furthermore, SIMPLE algorithm was used to develop the connection between the pressure and velocity in the numerical analysis. In order to solve the governing equations such as turbulent kinetic energy, pressure, momentum and dissipation, 2nd order upwind scheme was used in CFD FLUENT. In addition, for numerical simulation K-ω SST viscous model was also used. Furthermore, inflow air velocity of 8.5 miles per hours was used and density of air considered as 1.25 kg/m^3 at temperature of 15°C. Two-Dimensional computational domain of VAWT is shown in Figure 2.

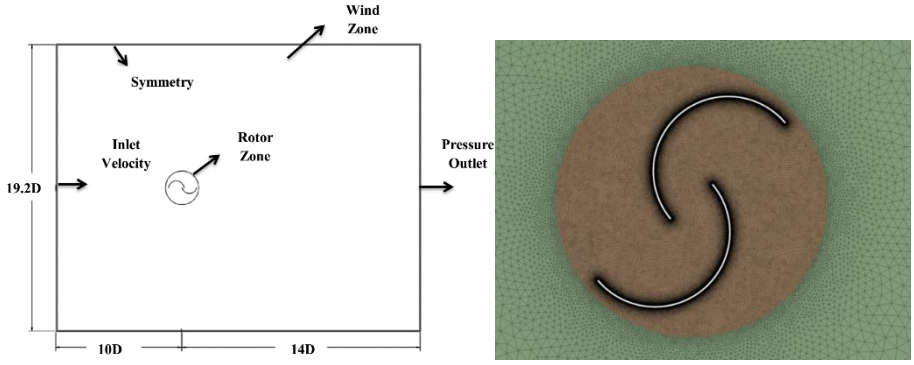
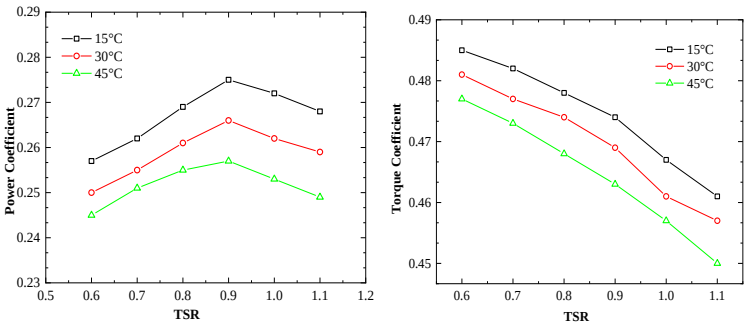


Figure 38: (a) Two-Dimensional Domain for CFD analysis (b) Meshing around the Rotor Blade

Results and Analysis

Numerical investigations of the VAWT were performed at a flow velocity of 8 m/s at different rotor blade angles and TSR values for the Multan Metro Stations. Numerical analysis was performed using CFD FLEUNT to evaluate the efficiency of the VAWT. The main performance parameters for the investigation of VAWT are coefficient of power and coefficient of torque and power generation etc. The power and torque coefficients for different TSR and temperatures are represented in Figure 3. Figure 3 show that the maximum value of coefficient of power was observed 0.257 at the value of TSR of 0.9. Similarly, the maximum value of coefficient of torque of 0.485 was observed at the same TSR of 0.9. It was also examined that the maximum performance of turbine was observed at a temperature of 15°C while the generated power output decreased with the rise of air inlet temperature shown in Figure 3.

(a) **(b)**



3.

Figure 39: Variation of the coefficient of power and coefficient of torque with different TSR at different temperatures of hot inflow air

Conclusions

It is concluded that the highest value of coefficient of power and coefficient of torque are observed 27.5% and 48.5% at the value of TSR of 0.9 and 0.6 respectively. It is also examined and concluded that the performance of the savonius VAWT was also affected by the hot and cold weather conditions.

The highest and lowest coefficient of power values are observed at the air flow temperatures of 15°C and 45°C respectively.

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EXPERIMENTAL THERMAL PERFORMANCE OF DOUBLE-PASS SOLAR AIR HEATER USING PHASE CHANGE MATERIAL

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ABSTRACT

In the present research work, the performance of double-pass Solar Air Heater (SAH) for two different geometrical configurations (V corrugated and Flat Plate) with phase change material and without Phase Change Material (PCM) has been analyzed using experimentally. The purpose of this work is to fabricate and test a double-pass SAH with phase change material under the climate condition of Multan city to extract solar energy and utilize it during night time. The experimental method was proposed to examine the performance of double-pass SAH at different inflow mass flow rates varying from 0.03 kg/s to 0.05 kg/s. The results presented that the temperature difference of 31°C with a mass flow rate of 0.03 kg/s is observed maximum. It was also observed that by using PCMs, the overall performance of double pass SAH is higher as compare to conventional without using PCMs. The appropriate thermal performance and useful heat gain were achieved at mass flow of 0.03 kg/s.

Key words: Solar air heater, Phase change material, Heat transfer

Introduction

The amount of energy that comes from the sun in the form of light and heat is known as solar thermal energy and is further converted into electrical energy. There are several applications of using solar thermal energy, but the utmost potential of solar thermal solar energy is to deliver a warm air for drying purpose in the agriculture field and heating of domestic as well as commercial buildings to retain a comfortable environment. The earth receives about 174.000 terawatts (TW) of energy that comes from sun light in the form of radiation energy at the upper level of atmosphere [1]. About 31% is re-directed back again to space and respite of all is enthralled by cloud, land masses etc. World population exists in areas where solar radiation level is about 150 to 300 W/m^2 [2]. Solar air heaters generally utilize solar thermal radiation and convert these radiations to the heat energy in the air which is used for various drying purposes.

The major components of SAH consist of;

- absorber plate which absorbs the sun light in the form of thermal energy,
- air flowing channels
- Insulating materials wrapped at bottom and lateral sides of collector.
- Transparent cover of collector.

A significant research has already been conducted on solar energy conversion and utilization. Ali et al. [3] performed experiment investigation on a double-pass SAH with and without PCMs and used Al and Cu rods as thermal enhancer and concluded that after sunset, SAH with storage medium provide extra output for 1.5 and 2 hours. The main purpose of this research work is to evaluate the double-pass SAH experimentally for two different geometrical configurations with and without phase change material at different inflow mass flow rates ranges from 0.03 kg/s to 0.05 kg/s.

Methodology

The present research work is based on experimental analysis of double-pass SAH. The overall methodology is summarized in Figure 1. The literature review enlightened previously developed models and helped finding research gap. Secondly, the experimental analysis was performed followed

by finding optimum parameters. Research findings showed that SAH with phase change materials can be utilized in industry.

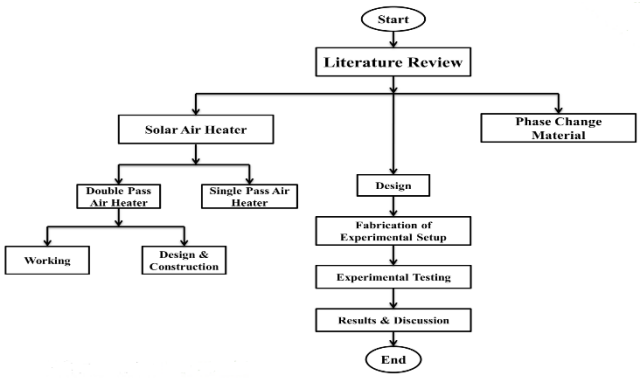

Figure 40: Research Methodology flow chart

Results and Analysis

The experimental study is performed at two different geometrical configurations (Flat Plate & V-corrugate Plate) with and without phase change material. Paraffin wax with concentration of 0.7 % copper oxide (Nanoparticle) was filled in circular aluminum finned tubes as a phase change material in upper pass. The experiments were performed at each geometrical configuration and at three different mass flow rates (0.03 kg/s, 0.04 kg/s & 0.05 kg/s). The experimental data was recorded for each configuration without phase change material from 8:00 AM to 6:00 PM and 8:00 AM to 8:00 PM with phase change material. Figures 2 represent the variation in solar radiations intensity for all geometrical configurations. Similarly, Figure 3 represents the air outlet temperature for all configurations of double-pass SAH at flow rate 0.03kg/s.

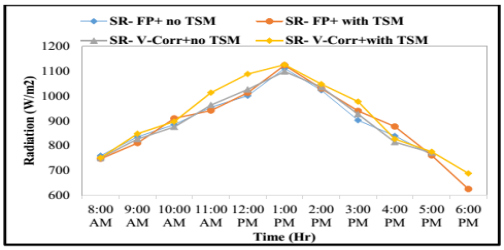

Figure 41: Solar Radiation of all Configurations,

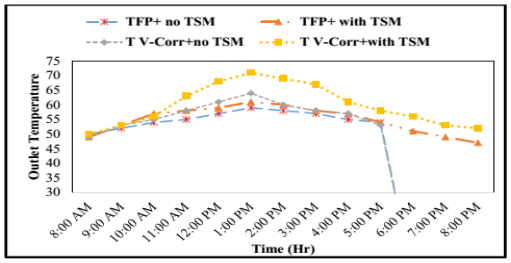

Figure 42: Outlet Temperature of all configurations at 0.03 kg/s

Conclusions

Heat gain of double-pass SAH with two geometric configurations (Flat Plate & V-corrugate Plate) was experimentally investigated at different inflow mass flow rates ranges from 0.03 kg/s to 0.05 kg/s with and without phase change materials. Maximum heat gain was obtained from SAH with V-corrugate plate configuration at inflow mass flow rate of 0.03 kg/s with phase change material.

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COMBUSTION EFFICIENCY ANALYSIS OF INTERNAL COMBUSTION ENGINE USING FUEL PRE-INJECTION WITH INTAKE AIR

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ABSTRACT

Fuel economy is a big challenge for Internal Combustion engines (ICEs) with high RPM and power. People have used many ways to achieve high efficiency like hybrid fuel, high compression ratio, turbocharger use, etc. The standard approach to increase efficiency has high-temperature air, the turbocharging or pre-heated air achieves this, and this tried the same to accomplish in our research by the reaction of fuel with intake air. This small amount of fuel was supplied in the suction line by keeping the rest of the mechanism the same. The effect of this change was monitored in terms of the mechanical efficiency of the engine.

Keywords: Efficiency analysis, fuel pre-injection, an internal combustion engine

Introduction

An internal combustion engine is a heat engine in which fuel combustion of chemical energy results in high temperature and pressure gases in the cylinder. Combustion plays a crucial role in engines because it provides the energy to operate effectively, depending on the type of fuel and the engine's working conditions. These contribute to the power, performance, and emissions of the engine[1].

The compression ignition (CI) engine is mainly controlled by spray-controlled diffusion combustion, while ignition engines are characterized by pre-mixed combustion. Due to its higher thermal efficiency, the CI engine is finding applications in traffic, industry, marine and other sectors. There is a trade-off between NOX and soot emissions as higher emissions decrease diesel engine efficiency [2]. In the design and optimization of engines, researchers and engine makers simultaneously aim to reduce NOx and soot emissions. Few suggested in-cylinder combustion techniques to reduce NOX and soot emissions without sacrificing engine effectiveness; partially Pre-mixed Combustion (PPC) and Reactivity Controlled Compression Ignition (RCCI) were used by some researchers[3]. These low-temperature combustion theories (LTC) minimize local combustion temperatures and correlation to reduce NOX and soot formation [4].

Besides, searching for new technologies, which depends on the enhancement and improvement of the engine brake power, has a great interest for many scientists. Many systems were modified or redesigned in this direction, such as the intake system and the exhaust system, to improve the diesel engine brake power[5]. This research was carried out to enhance the efficiency of a diesel engine using pre-mix air-fuel that will result in self oxidation of air with fuel, leading to pre-heating of suction line air. This pre-heating caused better combustion. Thus, the design modifications of the intake and exhaust systems were used to help the engine run in smooth conditions.

Methodology

The single-cylinder four-stroke compression ignition engine was used for experimentation; for the experiment, the engine was a bit modified in its suction line to inject mixed air with diesel. The modification was made in the suction line using a sprayer nozzle through which fuel droplets were injected in the suction line. This was done to achieve the high performance of the engine. A sprayer nozzle was used to make the fine mist of diesel in a plastic container injected in the engine's suction line with intake air. This fine mist caused self-oxidation of air which increased the temperature of the intake air. This warm intake air resulted in good combustion with improved performance and reduced COx and unburnt hydrocarbons.

Results and Analysis

The experimentation was performed to analyze the compression ignition engine's combustion efficiency by using pre-injection of fuel with air. Pre-injection of fuel in the suction line caused self-

oxidized of air, and the air becomes pre-heated. Effect of load and exhaust temperature as well as COx were analyzed and were plotted. After successful experimentation, it was observed that when the engine's load is increased, then exhaust temperature also increased. It means the engine running at a high load will have more heat losses than low load conditions. After pre-injection of fuel, pre-heating was observed, and we got fewer heat losses compared to without pre-heating curve. It can be observed from the below graphical representation of load vs. exhaust temperature shown in Figure.1(a)

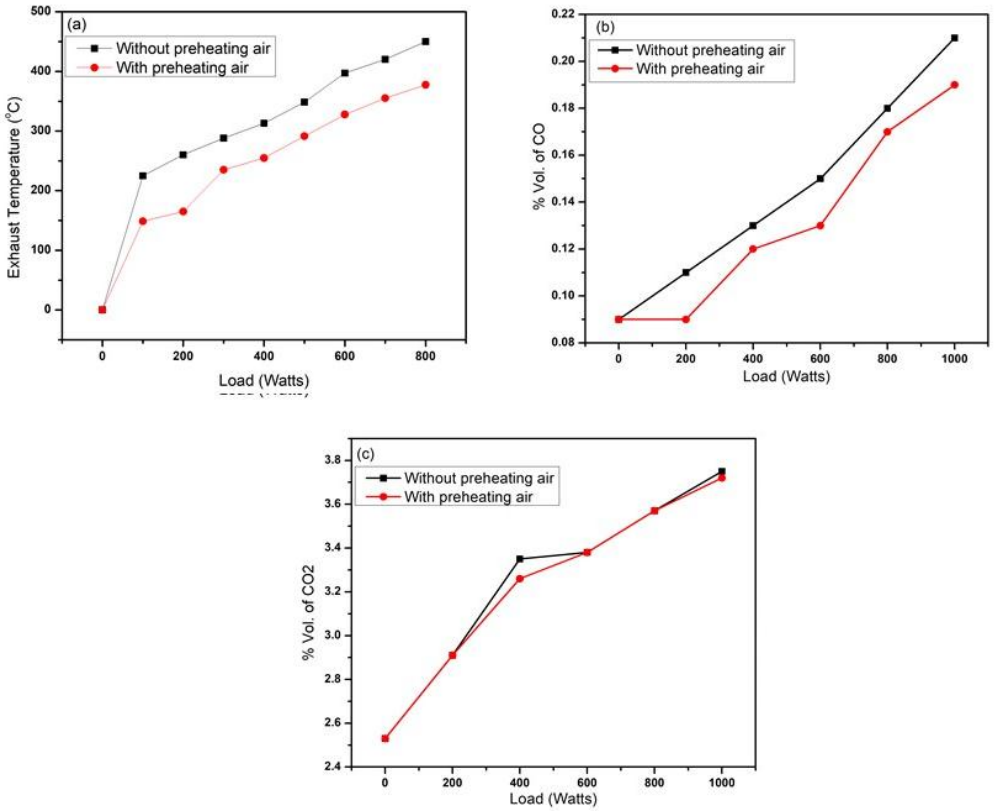

Figure 43; (a) Plot of Exhaust gases Vs load (b) Effect of inlet air preheating on CO Emission (c) Effect of inlet air preheating on CO_2

Moreover, the analysis of exhaust gases was done by checking different volume percentages of CO2. And CO with varying loads. Figure *1(b)* indicates that CO emissions of 2000 watts without air preheating are 0.11 percent volume. Yet CO emissions decreased to 0.09 percent vol*ume* after air preheating. After preheating, the air charging temperature is 47*0*C for 200 watts. CO emissions also decrease after inlet air preheating for other loads. It was observed that CO2 content in the exhaust gas remains unaltered with an increase in intake air temperature, as shown in Figure 1(c).

Conclusions

At different loading conditions, better efficiency was observed by pre-injection of fuel with air in the suction line. Also, COx emissions were decreased after premixing/preheating, and better efficiency was observed. Moreover, Lower premixed intakes gave better results for less loading, while Intermediate premixed intake resulted in inefficient combustion at higher loads. With preheated intake air, premixing of fuel with air, efficiency was increased up to 10-15% than without premixing conditions.

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REMEDIAL MEASURES FOR ENERGY CRISIS IN PAKISTAN AND THE PATHWAY ADOPTED BY DEVELOPED COUNTRIES AS A WAY FORWARD

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ABSTRACT

Pakistan is currently way behind its renewable target and the Paris commitments. Now, more than 80% of the energy supplies of Pakistan are derived from two natural resources that are Oil and Gas. But the energy crisis of Pakistan has deep roots and cannot be solved only by improving the supply side. This paper deals with the route that was adopted by Pakistan's energy sector that leads us to this incessant energy crisis. It shows that the slow pace of our economic activities resulted in prolonged gas and electricity shortfalls, which affected almost every sector of the country, causing Pakistan a significant share of its GDP in recent years. Although capacity has been improved in past years, the routes of the problem are way too deep. There are unfathomable problems, majorly with our energy policies. Moreover, this paper also discusses the route that was adopted by developing countries to emerge from these energy crises, thus providing a way out to Pakistan. This research led to some reform priorities that must be taken by the state to put itself back on track. Bureaucracy to efficiency, regulation to competition, and a transition from opportunistic transactions to sustainable strategy have been identified as the major reform priorities on which the country must focus.

Key words: Energy crisis, Energy Modeling, Energy economics

Introduction

Energy sector of Pakistan has always been a major hurdle for economy of the country. Energy sector has every other department linked with it and any major deficiency or drawback causes a detrimental effect [1]. The foremost reason of Pakistan's energy crisis is the high dependence on thermal energy resources. Around 45% of Pakistan's energy demand is fulfilled from thermal sources and since they come with a high import cost [2]. Previously energy shortfall and the resulting cost effect has significantly affected many sectors resulting in closing of many small scale industries.

Now to counter these effects, most countries have adopted a sustainable transition pathway that leads towards better energy outlook [3]. This study analyses the path that most countries have adopted to overcome energy crisis.

Methodology

The methodological approach uses both quantitative and qualitative analysis for energy assessment. A common survey was conducted among different stakeholders in the energy departments and their views were modelled through NVIVO for getting a detailed analysis. Based on the reference file results, a common and linked framework was established that can help in policy formulation process.

Results

Results obtained from the analysis depicted that decentralization, energy diversity, key economic indicators are the most critical aspects that control the energy portfolio of country. Pakistan needs to divert its energy sources by adopting renewables and penetrating new energy sources into the system. This will not only reduce dependency from the fossil fuels, it will further reduce the cost of overcapacity and upcoming financial threats.

Conclusion

Through help of qualitative and quantitative analysis, this study has identified the critical parameters that can be promoted to diversify the energy supplies of Pakistan. An extensive review and survey was conducted to identify the key steps taken by other developed countries in similar direction. Based on the results, a policy framework has been proposed that will enable clean energy transition in the country.

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THERMAL CONDUCTIVITY INVESTIGATION OF PCM USING DIFFERENT KINDS OF MICELLS.

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Abstract

Thermal storage materials using phase change materials (PCM) have attracted the world researchers due to better temperature range for thermal energy storage. However lower thermal conductivity limits the usage of PCM as heat storage medium. The purpose of the research is to increase thermal conductivity of PCM using different surfactants acting as micelle. PCM was mixed with different weightages (2%, 4% and 6%) of Dodecyl trimethylammonium bromide (DTAB), cetyltrimethylammonium bromide (CTAB). The results shows that peak temperature for pure paraffin wax was obtained as 61.5℃ For DTAB sample results obtained are 62.5℃ for 2%,63℃ for 4% and 64℃ for 6%. In case of CTAB the results 68℃ for 2%, 70℃ for 4% and 72℃ for 6%. Thus, Composite PCM with 6% weightage of CTAB provides best result as compare to other samples.

Key words: PCM, Surfactants, Thermal Conductivity

Introduction

Due to harsh climate change and growing population, world energy requirement is increasing day by day. The concept of sustainable energy is getting more popularity because of environment friendly nature [1]. Solar energy is considered as largest source of sustainable energy. Latent heat storage materials, named as phase change materials, are used to store energy. There are of two types: Inorganic and Organic PCMs. Organic PCMs containing fatty acids and alkanes are best known for thermal energy systems due to nontoxic nature, chemical stability and low cost. Paraffin has high thermal storage, but low thermal conductivity limits its applications [2].

Various methods have been used to increase the thermal conductivity of PCMs. This includes applications of various metal forms, nano particles and fins. Cui et al [3] increased the thermal conductivity of PCM by using carbon nanofibers (CNF) and carbon nano tube (CNT). The experimental findings revealed that the thermal conductivity of soy wax was increased by adding 10 percent of CNF and CNT to 0.469 and 0.403 W/m K by weight. By mixing eutectic ternary carbonate salt (thermal conductivity 1.33 W/m K) with magnesium particles (100-200 mesh, thermal conductivity was increased to 156 W/m K. Tian et al. [4] prepared the composite phase change material (CPCM). Results found that thermal conductivity in CPCM increased by about 19.55% by adding 0.1% of magnesium particles.

Harish et al. examined the impact of graphene nanoplatelets (GnP) on the thermal conductivity of the substrate for lauric acid-based phase changes. Results revealed that the addition of 1% of nanoplatelet graphene to lauric acid increased its thermal conductivity by 230%.[5]. The major issue with all these methodologies was poor distribution of nano particles, segregation, leakage incase of nano encapsulation and vaporization.

To overcome all of these issues' surfactants were used as nano particles which forms self-assembly named as micelle. These micelle acts as conducting medium in paraffin wax thus causing the better thermal conductivity.

Methodology

Dodecyl trimethylammonium bromide (DTAB), cetyltrimethylammonium bromide (CTAB). were chosen as nano particles. Particles were dispersed in water and temperature of the solution was maintained at melting temperature of paraffin wax(58-60C) Paraffin wax in the molten form was added in the nano particle dispersed water solution drop by drop. Solution was homogenized by stirring and sonication process for 4 hours. PCM droplets were encapsulated due to hydrophobic and hydrophilic nature of surfactants. This capsulated entity is named as micelle acting as conducting medium in Paraffin wax.

Results and Discussion

Paraffin wax sample with 2%,4% and 6% weightages of CTAB were undergone heating and cooling cycles for 90 minutes and results are shown in the Figure1.A, B,C

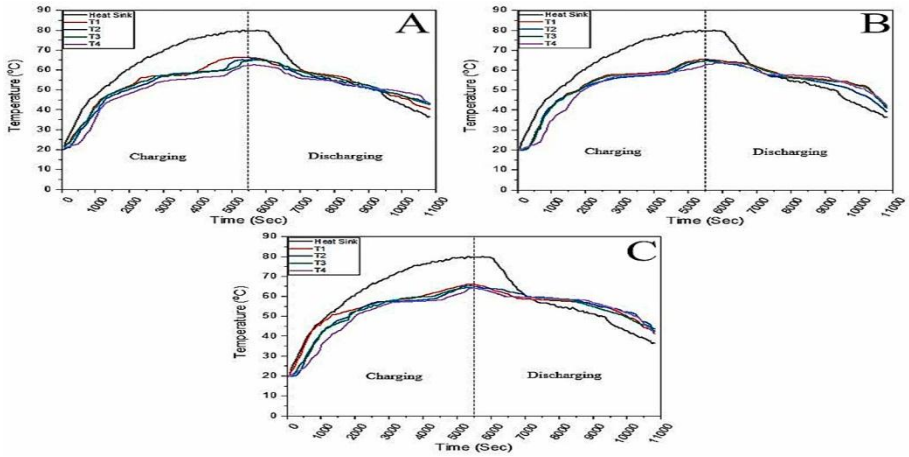

Figure 44. Charging & discharging behavior of PCM having (A) 2 wt.%, (B) 4 wt% & (C) 6 wt.% of CTAB.

Similarly, the results for DTAB are given below in the figure2.

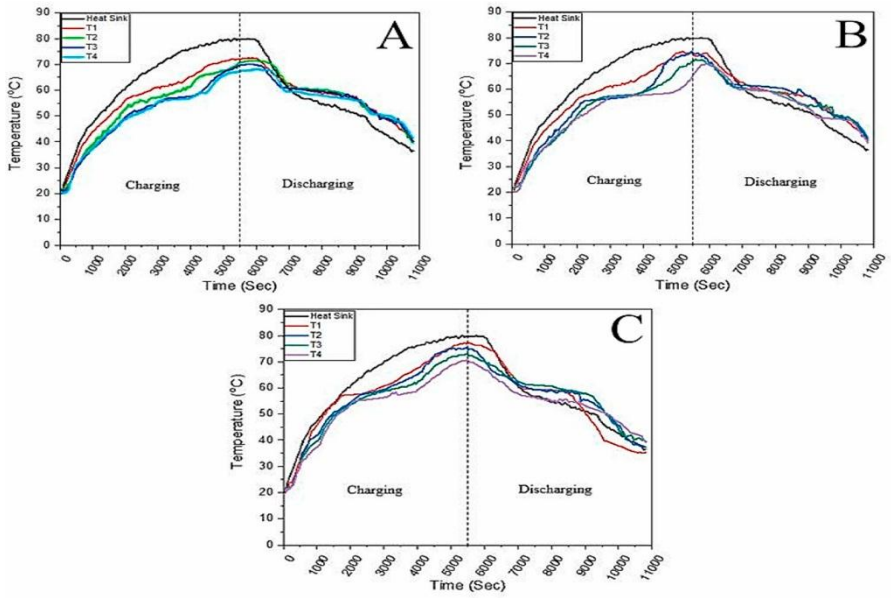

Figure 45. Charging & discharging behavior of PCM having (A) 2 wt.%, (B) 4 wt% & (C) 6 wt.% of DTAB.

From Figure1 we can see that peak temperature of PCM was increased after addition of surfactant-based micelles. The highest temperature was observed at T4 which is 64 which means rapid heat transfer in PCM (shown in Figure1C). Similarly we can observe in figure2, the highest temperature 68 was obtained in the case of 6% weightages of DTAB.

Conclusions

Different weightages of surfactants form micelles (self-assembly of surfactants) which acts as conducting medium in the PCM. We have observed better result in the case of 6% weightages of both CTAB and DTAB because higher weightage forms a stable self-assembly which strongly helps in better thermal conductivity of PCM.

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MULTIGENERATION SYSTEM WITH DOUBLE EFFECT ABSORPTION AND REHEAT RANKINE CYCLE USING WASTE AS A RENEWABLE SOURCE.

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ABSTRACT

A new multigeneration system is proposed in this paper which uses municipal solid waste material as its main source of energy. This new system provides seven outputs namely electricity, cooling, heating, hot water, fresh water, hydrogen and oxygen and uses double effect absorption cycle along with reheat Rankine cycle as its main working cycles. The system is analyzed using energy and exergy analysis.

The system is analyzed using EES with the assumption of ambient atmospheric pressure and temperature at 101kPa and 298K respectively. The efficiency of reheat Rankine cycle and COP of double affect absorption cycle is observed as (44%) and (0.92) respectively.

Key words*:* *multigeneration system, double effect absorption, energy, desalination, molten salt*

Introduction

With an increase in population, waste production in every part of the world multiplied. Managing this waste is one of the main concerns of every country as the solution to this problem lies in either burning it or dumping in the ocean, both of which lead to environmental pollution and various health hazards. Therefore, a method known as Solid Waste Treatment is adopted by many countries to convert the waste into more productive process.

Up till now the world has relied on burning of fossil fuels to produce power for all sorts of purposes. The production of electricity, heating, the fuel used in our cars, all have been using fossil fuels as our main sources of energy while they give an excellent output there is a downside to their supply. The fossil fuels are a limited energy source as the world is running out of its supply. Therefore, a constant struggle has been made to find alternate renewable energy sources for our needs [1]. Hence, this process aims to not only reduce the amount of waste but to produce power from it while keeping the pollution to a minimum.

Methodology

Some of the main equations used in system's calculation are:

$$\dot{Q}\ gen\ I,\ in = \dot{m}\ 23 * h23 + \dot{m}\ 20 * h20 - \dot{m}\ 19 * h19$$

$$\dot{Q}_{HXI} = \dot{m}_2 * (h_2 - h_3)$$

Table 1: Calculated Values of the Multi-generation System

Moisture Content	<45%
Organic Volatile matter	>40%
Fixed Carbon	<15%
Total inert	<30%
Calorific value	>1200KJ

$\dot{W}_{HP,\,out} = \dot{m}_1 * (h_1 - h_2)$

Table 2: Parameters considered for waste material

Calculated Values for MSBC	
Temperature after boiler	750^0C
Temperature after HX I	596.3^0C
Calculated Values fo r RC	
Power produced by HPT	429.3 kJ/s
Calculated Values for Ele ctrolyser	
Outlet mass of Hydrogen	0.6824 kg/s

Few notable values of this multigeneration system are shown in tables below:

Results and Discussions

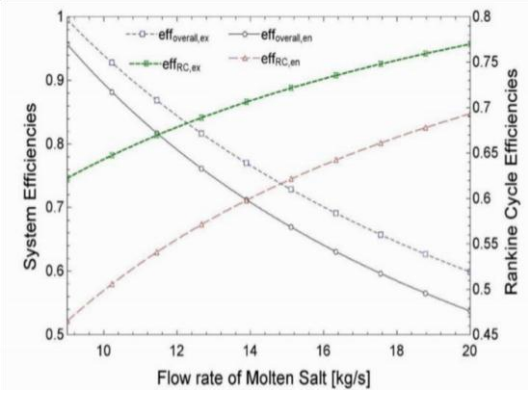

Figure 1: Effect of Molten Salt Flow rate on Efficiencies

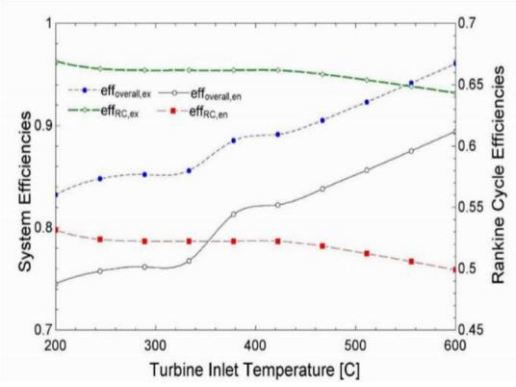

Figure 2: Effect of turbine inlet temperature on efficiency

Fig.1. explains the effect of Molten Salt flow rate on System and Rankine Cycle efficiencies. It depicts that with rise in flow rate of molten salt the efficiencies of system drop while that of RC increases. The increase in flow rate from 13.89 kg/s to 17.56 kg/s results in 71.25% to 59.64% of system's energetic efficiency and 59.81% to 66.12% of RC energetic efficiency.

Fig. 2. describes the effect of Turbine Inlet temperature on energetic and exergetic efficiencies of system and Rankine Cycle. By increasing the turbine Inlet temperature, the energetic and exergetic efficiencies of the system increase while the energetic and exergetic efficiencies of Rankine Cycle slightly decrease as shown in the graph

Conclusion

This Multigeneration system can produce electricity, fresh water, heating, hot water and cooling for residential homes as well as for commercial purposes. The result of the study shows that COP for individual systems and efficiencies are 44% and 0.92.

The efficiencies of the complete system along with RC and double effect refrigeration cycle suggests that the system proposed is in accordance with the renewable energy initiatives being implemented by the global community and is an important system for the future with 89.46% as overall efficiency.

An important aspect of this system is that it only uses municipal solid waste as the fuel and water as the working fluid to produce power. This on one hand helps in managing the increasing population waste and on the other hand assists in meeting increasing energy demands from sustainable resources.

Considering the high results and especially the system's overall efficiency further research in the proposed system will be fruitful.

Subscript

COP	coefficient of performance Heat	HPT	High Pressure Turbine
HX	Exchanger	MSBC	Molten Salt Based Cycle

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FUZZY SVPWM BASED INVERTER FOR A GRID-INTEGRATED PHOTOVOLTAIC SYSTEM WITH IMPROVED FUZZY PSO BASED MPPT ALGORITHM

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ABSTRACT

The global energy crisis has intensified market penetration of distributed generations (DGs). Due to environmental affability, DGs like solar is the most practicable option to fulfill the energy demand. This research study presents the fuzzy space vector pulse width modulation (FSVPWM) based current control scheme for a single-stage utility-scale three-phase voltage source inverter without a DC-DC converter. Fuzzy particle swarm optimization ((FPSO) based maximum power point (MPP) tracking algorithm has been employed. A 250 KW PV array is designed by keeping in mind the need for small to medium size single-story industrial corridors. This FSVPWM controller compensates current better than the PI controller and provides better DC link voltage utilization. A MATLAB/SIMULINK platform is utilized for research and the proposed system is tested under various conditions.

Keywords: FSVPWM, FPSO, MPPT, Fuzzy Logic Control, P&O

Introduction

Nowadays renewable energy resources are playing a vital role in electric power generation. Because of various incentives introduced by the government of different countries, advancement in technology, reduction of cost of power electronic devices, and lower maintenance, the use of solar PV systems is increasing. The integration of such systems into a utility grid is quite a complex task. Synchronization is necessary to ensure i) high efficiency ii) grid stability iii) injection of quality sinusoidal power into a grid, etc.[1]. The main objective of a grid-connected photovoltaic (PV) system is to enhance the reliability and efficiency of both converter and solar PV panels. For that purpose, a single-stage voltage source inverter system is the best choice. The MPP tracking control scheme is the most important part of the PV system due to the non-linear power and current characteristics of the PV module. Currently, most of the commercial Grid-connected PV systems employed conventional MPPT algorithms such as P&O and IC, due to which tracking efficiency is compromised [2]. Previously PSO algorithms are used with duty cycle chosen as PSO particles for two-stage PV systems. This paper presents an improved Fuzzy PSO algorithm based on a linearly decreasing scheme for inertia weight [3]. Here PV module voltage is considered as PSO agents and the MPPT algorithm gives the optimal DC reference voltage for DC regulator which employs fuzzy logic controller instead of PI to achieve faster convergence speed, high tracking performance, low computational burden, and ability to find MPP under changing conditions.

SVPWM is quite successful for inverter control of grid integration of micro-hybrid grid if the system is linear. In this technique, PI control is commonly implemented as a current compensator. However, due to its requirement of a specific linear mathematical model, the PI controller has become unsuccessful to perform effective control under the grid-connected mode, load step changes, nonlinear behavior, and variation of parameters. Therefore, we need a fuzzy logic controller (FLC) because there is no need for mathematical modeling of the system and it is based on a linguistic approach. Hence, the problems linked with the SVPWM technique can be tackled easily using FLC [4]. It employs non-linear and adaptive control under stable and dynamical conditions hence improves the power quality. The natural uncertainties of plant and control variables are modeled by fuzzy set theory. The effectiveness of the proposed model is compared with conventional and it is found that improved fuzzy PSO tracks MPPT with faster speed and better accuracy and FSVPWM provides better power quality under steady and dynamic conditions[5].

Methodology

The research consists of two parts. Firstly, a fuzzy SVPWM based inverter controller for grid integrated system is designed. Secondly, an improved fuzzy PSO based MPP tracking algorithm is designed to get the maximum available power from the photo-voltaic system. Here we have used a single-stage VSI by using current-controlled topology, so there will be no need for a DC-to-DC converter for MPP tracking. The MPP tracking algorithm is directly integrated into the inverter. The terminal currents and terminal voltages of the PV array are measured and passed through the MPPT algorithm and its output will give the reference DC voltage for the DC link voltage controller. Photo Voltaic (PV) array voltages are chosen as PSO particle positions and reference voltage to DC-link voltage controller is determined by computational results of fuzzy PSO MPP tracking algorithm. The DC-link voltage controller's output gives reference current for the inverter controller.

Results and Analysis

The modeling of PV array, FSVPWM inverter controller, and fuzzy PSO based MPPT algorithm are implemented. The initial irradiance and voltage reference is given to the voltage controller is 200W/m^2 and 400V respectively. FPSO starts tracking with three initial particles which are 65%, 80%, 85% of PV array open-circuit voltage respectively. V_{MPP} is 481.3V at 45^o temperature and 100W/m^2 irradiance level and the maximum dc mean power is 241.5kW. The behavior of the DC link voltage is analyzed in the steady-state and the transient state. The load is applied with incremental changes to evaluate the dynamic behavior of space vector PWM based current regulators. The FSVPWM based current regulator has given a decent dynamic response to step load changes. The grid current THD for the FSVPWM current regulator is measured and compared to the conventional SVPWM regulator. Under varying operating conditions, the three-phase FSVPWM based inverter-controller injected pure sin wave current to the utility grid. At step load changes, the simulation results of grid voltage and current in a transient state validate its high performance. This controller along with improved fuzzy PSO provides more tracked efficiency and a tracking time of 0.4s is achieved with 400V initial reference voltage which is a significant improvement. The FSVPWM provides better DC-link control in contrast to traditional space vector PWM. Moreover, a significant reduction in switching losses, accurate control over the injection of quality sinusoidal power to the system, and reduction in non-linearity is achieved.

Conclusions

The efficiency, convergence, and performance of the Fuzzy PSO based MPPT algorithm is verified under fixed and variable irradiance levels by comparing it with conventional PSO, IC, P&O. Optimal power extraction with almost zero oscillation at MPPT is achieved by FPSO. A fast response (tracking time = 0.4s) is achieved. The behavior of the DC link voltage is analyzed in the steady-state and the transient state. The load is applied with incremental changes to evaluate the dynamic behavior of space vector PWM based current regulator. The controller dynamic response to step load changes is decent. The grid current THD for the FSVPWM current regulator is measured and compared to the conventional SVPWM regulator. The FSVPWM has provided better DC-link control, lower switching losses, accurate control over the injection of quality sinusoidal power to the system, reduction in non-linearity, and lower harmonics.

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RECENT ADVANCEMENTS IN THE PHOTO ANODIC-CATHODIC CHARGE TRANSPORT LAYERS INFLUENCING THE STABILITY AND PERFORMANCE OF PEROVSKITE SOLAR CELLS

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ABSTRACT

Perovskite solar cells (PSCs) with organic-inorganic lead halides based composition are emerging as interesting materials for the conversion of the solar energy. PSCs are characterized for their auspicious performance which can be attributed to their higher absorptive confidents and longer lengths of diffusion in case of the charge carriers. Also, they are processable at lower temperatures with ambipolar characteristics. PSCs have gained an amazing power conversion efficiency of 25% in a short period of time. Efforts are in progress for further improvement in the efficiency by means of advancements in engineering different components of PSCs. In this regard, the main target of the photovoltaic community is to not only improve the performance of PSCs in terms of efficiency but also stability. Charge transport layers have an influential impact on the overall functionality of the PSCs. Great deal of review articles have highlighted the role of these charge transport layers in PSCs. However, current poster has specifically analyzed the data from last years (2019 and 2020) and present the recent advancements. The poster summarizes the role of organic and inorganic materials in impacting the efficiency of the PSCs.

Key words: Charge transport, Conversion efficiency, Environment, Energy, Photovoltaics

Introduction

Solar energy has been converted to electrical energy by using different types of photovoltaic devices for considerable duration. There has been a considerable reduction in the price ranges of these devices showing economic viability and consideration of the solar energy as a reliable source for improving human life. Solar cells are one of the most significant photovoltaic devices which have received considerable attention for reduction in the commercial price dropping up to a level of 75% for last decade. Therefore, solar cells signify the most important competitor in the photovoltaic based market for harnessing of the solar energy [1]. In the modern era, perovskite solar cells having organic inorganic halide composition have been gaining interest of the photovoltaic community by the virtue of remarkable dielectric characteristics. Active absorber perovskite layer is known for the emission of the electrons and holes upon reception of solar light [2]. Perovskite based technologies have been employing abundant substances in the absorber layer, however, the complete champion PV device to be used in commercial set up must comprise of the auxiliary layers having a distinct functionality. For instance, these layers are specialized for the collection and conduction of the electron and holes generated at absorber site in addition to their function as a carrier of different charges in mobilizing them towards the external circuit for further utilization. Most often, PSCs have organic layer for the performance of these functions. However, the challenges of higher costs and alleviated stabilities causes the gradual conversion of the organic moiety into inorganic layers comprising of different elements e.g. nickel or copper. PSC device architecture is incomplete without the presence of the transparent electrodes *e.g.* indium tin oxide (ITO) and fluorine doped tin oxide (FTO). Chemical passivation done via utilization of larger quantities of PbI_2 in the solution containing nonstoichiometric precursor for an augmented PCE of PSC device. It consequently gave rise to a profound reduction in the defect density in comparison to the reference cell containing stoichiometric

precursor solution. Inside mixed perovskite containing films, there is defect at the deeper level formed due to Br atoms as revealed by deep-level transient spectroscopy analysis. A sharp shifting trend is also exhibited by the films upon aging in the air. The transformation of defect state has been attributed to the methylammonium molecules lost from perovskite layer, subsequently giving rise to an alleviated short circuit currents, dilapidation of PCE and stability of PSCs for longer durations.

Charge transport layers are an integral component of the perovskite solar cells, which influences the performance in an appreciable manner. Large number of review articles have been published to date regarding role of electron transport layer (ETL) and hole transport layers (HTLs) in transforming perovskite solar cells [3]. However, current poster has specifically focused the most recent advancements done in the employment of the ETL and HTL by considering researches done in 2019 – 2020. Current poster has also added an account of the utilization of different materials in terms of advantages and disadvantages.

Methodology

Present poster is based on the analysis of the most recent literature regarding role of HTL and ETL in improving the performance of perovskite solar cells. The poster has been constructed by the literature content analysis by considering research items inclusive of research articles, reviews, book chapters, perspectives and short communications obtained from different electronic databases *i.e.* Google scholar, Web of Science, ProQuest, Embase, Cochrane. Considering the relevance of the topic with the conference and space limitations, current poster is limited to knowledge extracted from only 100 articles.

Results and Analysis

Perovskite solar cells have rapidly progressed from 3.8 to 25% in a short span of time expressing the auspicious candidacy of these solar cells for future applications for transforming solar energy into electrical energy. Large number of materials have been used for transportation of charges *i.e.* electrons or holes in the perovskite solar cells architecture. However, in case of all materials, it was observed that perfect alignment of the layers should be done for the achievement of the remarkable functionality in terms of the energetics and movement of the charges. Such alignment ensures the minimization of aggregation of the charges. Therefore, the existence of charge transport layers is significant for providence of the pathway to electrons and holes.

Conclusions

Great variety of materials have been used for development into electron and hole transport layer. Materials used in this regard have also been modified by engineering. Engineering based transformations are associated with the reduced permittivity ensuring good functionality perovskite solar cells. Novel charge transport layers based on different materials exhibit favorable characteristics such as non-reactivity towards photosensitivity, good thermal stability and electronic mobility.

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ENERGY- USE EFFICIENCY OF TEXTILE DYE-BATH EFFLUENTS WITH ADVANCE TREATMENT FOR DEVELOPMENT OF CLEAN AND SUSTAINABLE ENERGY SYSTEM

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ABSTRACT:

The optimization of industrial processes for the treatment of textile wastewater by using advanced treatment processes is significant for achieving maximum sustainability around the globe. This study is aimed at determining energy efficiency of water consumption by estimating and managing average water-use with respect to process requirement. In this regard, a fabric-dyeing industry was surveyed, which incorporated modern physical treatment to treat textile effluents before has discharged them to the water stream. The industry utilizes a physical treatment system that comprises of an Electrocoagulation System (ECS), a Dissolved Air Floatation (DAF) System, Sand-Filter, a Lamella Separator, Moving Bed Bio-Film Reactor (MBBR), Cartridge Filters, a larger Reversed Osmosis system followed by mini RO system. The energy consumption by each system was calculated, based upon the data collected. The quality of water after each treatment was also determined at the laboratory to measure its water treatment efficiency. The water quality parameters of final treated water were determined as; temperature (14ºC), pH (7.75), Electrical Conductivity (146.9µS), TDS (13.7mg/l), Turbidity (0ntu), Salinity (0.1ppt.), and COD (11mg/l) and compared with NEQS. However, the energy consumption of the entire plant was estimated at 80-90kW, with ECS consuming 70-80kW of total power. The plant treats 25000-30000 L water per hour, with an operational cost of Rs. 30-35/m3 water treated. Such energy consumption with high costs makes the plant energy inefficient and unsustainable considering the GHG emissions from power consumption. This study paves the way to design industrial water treatment systems that are energy-efficient, emit less greenhouse gas emissions, and prevent water pollution.

Keywords: Energy Efficiency; Advanced treatment; Textile Effluent; Clean Energy System; Cost-Efficiency

Introduction:
Textile sector is considered as the most significant pillar to strengthen the Pakistan's economy. It is estimated that average water-use efficiency in the textile dye industry is about 70 to 400 l/kg of the fabric and effluent production in medium-scale industry contains 180 to 430 l/kg of the fabric, organic pollutants, dyes, color, detergents, salinity and non-degradable materials [1]. The major issue from textile dye is wastewater discharge in the environment. Thus, this study will facilitate to conserve the fresh water resources, recycling and reuse the industrial dye-bath effluents and also introduce efficient reuse strategies towards sustainability with minimizing efforts of organic loading in final treatment process.
Methodology:
The energy efficiency of advanced waste water treatment was found out after initial survey of the textile industry. An environmental expert at the industry was consulted to explain the treatment process. Waste water samples from each component of the treatment plant were collected. The samples were tested in laboratory to determine the water quality parameters achieved by each component of the process. Finally, the energy efficiency, flow rate, and treatment efficiency was calculated.
Results and Analysis:
The water quality parameters of final treated water were determined as; temperature (14ºC), pH (7.75), Electrical Conductivity (146.9µS), TDS (13.7mg/l), Turbidity (0ntu), Salinity (0.1ppt.), and COD (11mg/l) and compared with NEQS. However, the energy consumption of the entire plant was

estimated at 80-90kW, with ECS consuming 70-80kW of total power. The plant treats 25000-30000 L water per hour, with an operational cost of Rs. 30-35/m^3 water treated.

Conclusion:

The results showed that the advance treatment system for the treatment of textile waste water had lower energy efficiency although the process was quality-efficient. Thus, there is a need of advanced and efficient treatment process. Achieving sustainability in terms of clean and affordable energy in this sector will lead to better achievement of the Sustainable Development Goals (SDGs). This will facilitate to provide potable water for the surrounding community to meet the future clean water availability concerns.

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AN EFFICIENT ZnO/SnO_2 BASED HYBRID ELECTRODE MATERIAL FOR ENHANCED SUPERCAPACITOR PERFORMANCE

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ABSTRACT

Supercapacitors have recently emerged as an excellent device for energy harvesting and storage issues in the vast number of novel mobile equipment. ZnO/SnO_2 based hybrid system is presented as supercapacitor electrode material owing to its enhanced energy capacitance. This work aims to investigate the combined effect of zinc oxide and tin oxide as a supercapacitor electrode. A hybrid supercapacitor device (ZnO/SnO_2@NF//AC@NF) was organized asymmetrically through 3 M KOH electrolytes. Fabricated hybrid supercapacitor physical properties and performance were analyzed by high-resolution transmission electron microscopy (HR-TEM), scanning electron microscopy (SEM), X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), Galvanostatic charge-discharge (GCD) measurements, and cyclic voltammetry (CV). It can be seen that fabricated ZnO/SnO_2 hybrid electrode demonstrated a specific capacitance (C_S) of 2307 F/g at 20 mV/s with 78.8% columbic efficiency for 7000 cycles. Moreover, the hybrid supercapacitor device reached maximum specific energy and power of 47.28 Wh/kg and 10.4 kW/kg, respectively.

Keywords: electrodes, supercapacitors, zinc oxide

Introduction

As a result of the remarkable rise in environmental pollution and the depleting fossil fuel worldwide, the lookout for unique, green, and renewable energy alternatives has been intensified. Particularly, flexible energy storage and conversion devices that perform as power sources for portable electronics are in exigency. Most common energy devices employed today are supercapacitors and lithium-ion batteries [1]. One of the primary energy storage devices, batteries, have played a significant role in ensuring the growing energy demands. However, lithium-ion batteries have shown several limitations, such as relatively poor power density, limited lithium resources, and safety concerns [2].

However, supercapacitors have exhibited several salient capabilities consisting of a wide range of operating temperatures, exceptional power densities, long life cycle, and environmentally benign [3].

Several transition metal oxides (SnO_2, NiO, Co_3O_4, and RuO_2) have emerged as potential electrode material owing to their high specific capacitance. Recently, SnO_2 has been widely used as an electrode material for energy storage systems due to its non-toxicity, easy availability, and low cost.

Methodology

A single-step hydrothermal method was employed to synthesis ZnO/SnO_2 based hybrid nanoflakes on nickel foam (NF). SnO_2 and ZnO were also synthesized using similar processing conditions for comparison. A hybrid supercapacitor device was fabricated using ZnO/SnO_2@NF and AC@NF as a positive and negative electrode, respectively.

Results and analysis

SEM analysis revealed the honeycomb-like structure of as-prepared ZnO/SnO_2 hybrid nanoflakes consisting of several cavities and ridges. It was observed from XRD analysis that prepared ZnO/SnO_2 nanoflakes comprised hexagonal phases. Moreover, HR-TEM revealed lattice spacing of 0.33 nm and 0.28 nm for SnO_2 and ZnO, respectively.

Conclusions

ZnO/SnO_2 nanoflakes has been fabricated by a single-step hydrothermal approach. Electrochemical results showed a maximum C_S of 2307 F/g at a current density of 1 A/g. A capacitance retention of 92% is viewed for 7000 continuous charge-discharge cycles. A hybrid asymmetric supercapacitor device constructed by the material synthesized in this study revealed that the maximum specific capacitance of 92 F/g at a specific current of 2 A/g with an energy density of 47.28 Wh/kg. These results indicates that the ZnO/SnO2 nanoflakes enhances the electrochemical performance of supercapacitor.

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THICK COATINGS BY ELECTROPHORECTIC DEPOSITION ON METALLIC SUBSTRATE FOR THE APPLICATIONS OF ENERGY MATERIALS

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ABSTRACT

The research reports the electrophoretic deposition of (EPD) from a solution of lead-free ceramic on flexible, cost-effective, electrically integrate able metallic substrate i-e Nickel. The deposition of $(Ba_{0.85}Ca_{0.15})(Zr_{0.1}Ti_{0.9})O_3$ thick coating having applications in microelectromechanical systems (MEMS), energy harvesting, thin-layered sensors, actuators and widely used in microelectronic industries

Key words: Electrophoretic Deposition; Sensors; Actuators; Microelectronics; Integrateable

Introduction
Smart materials are of great importance as they need to store energy and are focused to make from lead-free materials which are used in energy storage devices and are versatile. The applications like transducers, sensors, energy harvesting, actuators, ultrasonic. As the properties of BCZT bulk ceramics are studied and they are application dependent so to make it best and lower dense it can be coated on some metal (Ag, Au, Pt, Ni, Cu, etc.) substrate by some media and the layers are stacked one over each other and they are used in same applications as the metals will have a strength which will help the ceramics in many ways [1, 2].
Methodology
The traditional solid-state route was adopted for the preparation of precursors, making a stable suspension in methanol. The coating was done by EPD technique having a time of 90-150 sec varying voltages of 100 and 150 V sintered at 1115℃. The coating thickness was measured ~ 54µm.
Results and Analysis
Thick Coatings with better bonding to the substrate were sintered at 1115℃ for 30 min. X-ray diffraction confirmed the perovskite structure of the BCZT thick film on Ni substrate. Scanning Electron Microsorographs revealed the densified structure of the thick coating. Atomic Force Microscopic results tell the surface roughness of the coatings and an Optical microscope is used to measure the coating thickness ~ 54µm. The electrical properties were analyzed by Impedance Spectroscopy confirmed that there are two active semi-circular regions one for grain and the other for grain boundary.

Conclusions

This work will lead the lead-free thick coatings on metallic substrates using an eco-friendly method like EPD and having the required properties as in bulk lead-free materials. Further these application-based materials in microelectromechanical systems, energy harvesting, sensors, and actuators.

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FLEXIBLE PIEZO-NANOGENERATOR BASED SENSOR FOR ENERGY HARVESTING

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ABSTRACT

For practical applications like structural health monitoring sensors and biological microelectromechanical systems, functional ceramics play a pivotal role in providing real-time signals. Piezo nanogenerator manufactured using BFO-BT nanoparticles by solid-state method gives maximum 15 V output and current in mA.

Keywords: Flexible devices; Piezo nanogenerator; Energy harvesting, Capacitor charging

Introduction
Sustainable materials and processes with environmentally friendly nature are the current research drive in functional ceramics. In this regard, flexible thick layers add diversity in monitoring practical devices like sensors, actuators, and capacitors for energy storage applicators.
Methodology
Binary solid solution of lead-free bismuth ferrite barium titanate ceramics was synthesized by a conventional solid-state method. An extensive high energy ball milling process was used to obtain the submicron or nanometre range of ceramics particles.
Results and Analysis
To obtain flexible piezoelectric nanogenerator (PNG), nanoparticles were dispersed in silicon-based organic polymer, polydimethylsiloxane (PDMS). Polarization of BFO-BT nanoparticles dispersed in PDMS assisted to align its nanodomains and generate electric response signals upon mechanical load. Characterization shows voltage generation of 10-15 V on hand tapping.

Conclusions

It can be concluded that piezo-nanogenerator manufactured using BFO-BT nanoparticles by solid state method gives maximum 15 volts output and current in milli amperes. By tapping PNG, electric charges stored in capacitor and 2 LEDs blink when circuit is closed.

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ASSESSMENT OF BIOMASS TO HYDROGEN ENERGY POTENTIAL IN PAKISTAN UTILIZING THE PRODUCT SPACE MODEL

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ABSTRACT

This study aims to assess optimum hydrogen production pathways from various biomass sources. Product space model will be utilized for this purpose. Hydrogen is regarded as clean fuel for the future. For Pakistan, one of the promising sources for hydrogen production is biomass, which is widely available, clean and renewable. Environmental friendly and economically feasible pathway mixes will be optimized, for biomass to hydrogen conversion, such as pyrolysis and gasification. The estimated Biomass potential of Pakistan is 50,000 GW h/year (Farooqui, 2014).

Key words: Hydrogen energy, Biomass, Product space model

Introduction

Currently, Pakistan is facing serious energy crisis that is hindering economic development. Also the current energy mix of Pakistan is highly dependent on fossil fuel resources. Regarding the global warming situation, we need to develop more and more renewable energy resources which are environmental friendly. Biomass is a clean and renewable energy source which is widely available in Pakistan. Various biomass sources are available in Pakistan such as agricultural residue, municipal solid waste, agro-industrial residue and animal manure. Biomass Agriculture is the second largest sector of Pakistan's economy. The estimated agricultural residue was calculated to be 81 million tons per annum (Ghafoor *et al.*, 2016). Other than that, urban areas of Pakistan produce more than 64,000 tons of municipal solid waste daily (Aziz, 2013), the major portion of which consists of organic waste.

Methodology

Literature review will be carried out from online sources. Data will be collected from waste management sources and agriculture department. Data will be entered in Product space model. Optimum feedstock mixes and best optimal pathways for biomass to hydrogen conversion will be determined.

Conclusion

The results of this study will act as a baseline to formulate policies and action plans in the country for hydrogen-based energy technologies. This will also reduce the burden on waste management facilities in Pakistan. The dependence on fossil fuels for energy generation will also decrease with significant reductions in the greenhouse gas emissions and global warming.

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EXPLORING TECHNICAL & MANAGERIAL CHALLENGES AFFECTING THE PROFITABILITY OF GAS DISTRIBUTION COMPANIES IN PAKISTAN

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ABSTRACT

Energy Sector has great significance for any Nation's Economic Development and Growth. Therefore its importance can never be over-emphasized. It is very clear that Pakistan's Energy Sector has not been able to deliver to the nation with sufficient and sustainable energy supply, be it electric, oil, coal or gas both for domestic and commercial uses. Natural Gas Distribution companies play very significant role in the national energy sector. This study intends to explore technical and managerial challenges faced by gas distribution companies in Pakistan which affect their profitability. A country from developing world like Pakistan has more challenges which are faced by these gas distribution companies besides having large room for sustainable improvement. In Pakistan only two gas companies are public utility providers i.e. SNGPL & SSGCL. Among these two companies major gas volume handling is carried out SNGPL having 5.6 Million consumers approx. and therefore it has been selected for this case study. There are some factors which increase profitability and others which are responsible for profitability erosion. However gas distribution companies have a random and firefighting approach to cope these challenges in their business plans and don't have a sustainable approach to manage those challenges for optimization of profitability in a stable manner. Survey research design was developed, validity test was verified by experts, and reliability was checked. SPSS version 23.0 was used for statistical analysis. A number of analyses were performed on the data including normality testing, correlations and regression analysis. Some challenges are more significant than others. It was observed that companies are not focusing on these challenges in a systematic manner to optimize the profitability. A random short term approach of firefighting to cope these challenges have been adapted by companies during every fiscal year rather than quantifying the challenges and making a strategy to cope them in an organized manner to maximize profitability. The results of this study prove to be beneficial for gas distribution companies in Pakistan and help them to make a systematic long term approach to cope these technical and managerial challenges while optimizing their profitability in a more stable manner. This would facilitate the national energy sector in larger interest.

Key words: Technical & Managerial Challenges, Unaccounted for Gas (UFG)-Control, Profitability, Gas Distribution companies, development, Asset capitalization, SNGPL

Introduction

Energy Sector is very significant for the national development and economic growth. Energy is required, to run the industry, fuel commercial business and as utility for residential/domestic usage. Economic development of those countries is remarkable which have stable energy management and infra-structure. Natural gas plays one of the major roles in the energy sector of Pakistan constituting 50 % of primary energy mix. Natural gas distribution in Pakistan is mainly dealt by two Sui companies i.e. SNGPL & SSGCL. SNGPL is the largest natural gas distributor in Pakistan. Total 5.65 Million consumers including industrial, commercial and domestic are fueled by Sui Northern Gas Pipeline Limited (SNGPL Annual Report 2017). Handling such a large consumer count is very challenging, while operating on the network length of 1, 19,652 km (Transmission mains: 8637 Kms & Distribution mains and services: 1, 11,015 kms). SNGPL and SSGC both companies have to face technical and managerial challenges during their field of operations.

SNGPL being the largest gas distribution company of the country has been selected for this case study. However the results can be extended to the other since both the companies are regulated by OGRA and their business nomenclatures are almost same with slight differences. SNGPL's profitability and financial health is very crucial for the natural gas industry in Pakistan. Profitability of

the company is compromised by gas volumetric losses contributed by multiple factors in the form of unaccounted for gas losses i.e. UFG Losses and it is enhanced by the development, asset capitalization, earning of Engineering Construction Projects and other sources of income for company. However the technical and managerial challenges faced by company have not been analyzed for incorporation in their business plan from the perspective of profitability.

These technical and managerial challenges which are faced by company do impact company profitability and the relative impact of each factor should be analyzed to plan an optimized profitability. SNGPL is the largest gas distribution company. The financial health of the company should be robust so that it may launch new projects and diversify its business to create new sources of income and minimize the liabilities. However there is a firefighting approach of the company to control losses and random approach of the company towards sources of income. Thus profitability of the company or net profit earning is outcome of firefighting based efforts and random business events / coincidences. This study is intended to explore those technical and managerial challenges affecting the profitability of SNGPL and analyze their impact on business

SNGPL is the largest gas utility provider company in Pakistan. However annual reports of the company over consecutive fiscal years have revealed that company's profitability is erratic and random. In the last ten years company's annual profit/ (loss) after taxation is very erratic like in 2008 profit was Rs. 2497 Million (approx), in 2009 profit was Rs. 930 Million (approx), in 2010 profit was Rs. 2554 Million (approx.), in 2011 profit was Rs. 1125 Million (approx.), in 2012 profit was Rs. 3044 Million (approx.), in 2013 there was loss of Rs. (9749) Million (approx.), in 2014 there was loss of Rs. (3964) Million (approx.), in 2015 loss was Rs. (2494) Million (approx.), in 2016 there was again profit of Rs. 124 Million (approx.) and at closing of fiscal year 2016-17 in June 2017 there was a big profit of Rs. 8614 Million (approx.). The results clearly indicate that the profitability of the company is very erratic and random. The profitability of the company i.e. efficiency of the business can be improved, from erratic to much stable and gradually increasing trend by investigating and analyzing the technical and managerial challenges affecting the profitability.

Conclusions

If profitability equation arising from regression analysis has more liabilities than earning hands i.e. sources of income, the profitability would remain erratic. It infers that companies which are not developing their all probable sources of income or revenue generation aspects and rely on the single aspect for revenue generation besides having more liabilities would suffer erratic profitability. Those projects which could generate revenue for the company but not linked with profitability or business plan have negligible significance for the company profit. Those companies which would rely more on mere fighting their liabilities than boosting new sources of income would have to suffer the dilemma of erratic profitability. Gas distribution companies of Pakistan are being treated as utility providers and do suffer external influences as well, need to develop sources of other operating income i.e. engineering construction project services (ECP services) etc. to develop a new source of income and diversify the reliance on single aspect. These companies should seriously consider having a stable business plan which could manage the impact of variation in one aspect (liability or source of revenue) through other aspect of business. This would stabilize the financial health of these companies in Pakistan. Presently a haphazard approach to deal with profitability equation has been adopted and there is no product diversification by these companies as far as profitability and efficiency is concerned. Therefore services offered by these gas distribution companies should be diversified to stabilize the variation impact arising from these independent variables on the dependent variable of profitability. Effectiveness of existing primary business process should be developed as a tool for increasing the profitability of these gas companies. SNGPL in specific and Gas Companies should develop their owned tangible assets like lands and properties with revenue generation perspective to add up as earning hand.

DEVELOPMENT OF SUSTAINABLE BIOMASS SUPPLY CHAIN IN PAKISTAN

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ABSTRACT

Biomass is a promising green energy resource in Pakistan. The increasing trend in the population and challenged energy crisis of the country urged to explore biomass potential. There are various biomass sources in the Pakistan, including industrial, forest, agricultural (crop residues, animal dung), and Municipal Solid Waste (MSW) biomass. Pakistan is an agricultural country where agriculture makes 22% contribution to GDP, and 35% of the total labor force is employed in this sector. Among all biomass sources, crop residues show the highest potential for bioenergy in Pakistan because of their round-year availability. MSW is another noteworthy energy resource in Pakistan as its generation rates in the country's major cities is extremely high. The Pakistan's government aims to improve the country's energy mix by increasing the share of renewable energy from 1.1% to 5% by 2030. Biomass can play a significant role as a renewable resource for the country to practically sound this shift. Being a developing country, Pakistan is facing various environmental challenges but the need is to consider the possible mitigation routes to mitigate the environmental negativity. Biomass is an appealing alternative energy resource for Pakistan to reduce the dependence on coal, oil, and gas for electricity generation and domestic purposes and to cut environmental emissions. By using GIS technique, biomass sources have been tracked to develop a sustainable biomass supply chain. For the development of the sustainable biomass supply chain, the need is to address and solve the challenges associated with collecting, processing, conversion, storage, and biomass transportation.

Key words: Biomass, Pakistan, GIS

Introduction

Pakistan is a developing country where energy situation is significantly challenged. The supply and demand gap of electricity is a major concern of energy sector. Energy consumption is high but the energy resources are not reliable enough to ensure the continuous supply on the longer run. The production of biomass from various sources has progressive role if its potential is explored. Pakistan is facing burden of climate change so the need is to shift the energy mix of the country majorly on green energy. Biomass can make surprising contribution to the energy mix of the country as renewable energy resource. The development of sustainable biomass supply chain consists of various segments including conversion, storage and biomass transportation. In Pakistan, the need is to solve the associated hurdles by following the certain supply chain model. By the help of GIS technique, various biomass sources can be located in the country and their energy content can be analyzed.

Methodology

The method used in the study to locate biomass sources in Pakistan is GIS. Agricultural, forest and MSW biomass has been identified at various locations. Secondly, a biomass supply chain model has been developed in the light of present literature to provide the required comprehensive model for ensuring sustainable biomass supply chain in Pakistan.

Results and Analysis

The conducted study showed that biomass is an appealing renewable energy resource in Pakistan as it is abundant and cheap green energy resource. Analysis shows that among all biomass resources, agricultural biomass can make significant contribution as its round-year energy content is highest. As the resultant statement it is to mention that the hurdles associated with the logistics must be solved to ensure sustainable biomass supply chain in Pakistan.

Conclusions

Pakistan is an agricultural country where abundance of agricultural biomass is notable. Besides agricultural biomass, MSW and forest biomass are another green energy resources in Pakistan. GIS appears to be a useful tool to locate biomass sources at various locations of country. For the development of sustainable biomass supply chain in Pakistan, the proposed supply chain model needs to be followed. Biomass energy must be hailed as the most suitable renewable energy resource for Pakistan and it must be valued in government policies.

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SIMULATION OF SOIL WATER DYNAMICS UNDER DIFFERENT MANAGEMENT PRACTICES IN MAIZE-WHEAT ROTATION

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ABSTRACT

Field experiments were conducted on a loam soil for two years to simulate soil water dynamics using different irrigation (60, 80, 100% of field capacity) and mulching practices (plastic and straw) in a maize-wheat rotation. Irrigations were applied to fill the soil moisture deficit at pre-decided field capacity levels with intervals of 7 days for maize and 15 days for wheat. soil volumetric water contents in 0-160 cm depth at 20 cm intervals in soil profiles were measured in each depth at every 7 days using TDR in each plot. WHCNS (Water Heat Carbon Nitrogen Simulator) model was calibrated by the measured data set. The model parameters were adjusted using 'trial and error' method until the simulated values agreed well with measured data. The WHCNS model was acceptable in simulating soil water in the study area as simulated soil water content were all in good agreement with the measured data.

Key words: Field capacity, Mulch, WHCNS model

Introduction

Variation in soil properties and environmental conditions make the processes of soil water dynamics and N cycling complex in soil-crop systems. These complex systems under spatial and temporal variability are analyzed successfully using the model approach. The main objective of designing the Soil-crop models is to find the answers of specific questions and to simulate processes [1]. A soil-crop model helps to simulate soil water and nitrogen dynamics and growth of crop under different comprehensive management practices e.g. integrating mulches with irrigation and nitrogen fertilization is not available. Crop growth, turnover of organic matter and N dynamics are simulated using soil and crop models for the optimization of N and water management practices [2]. Based on a previous studies WHCNS (Water, Heat, Carbon, Nitrogen Simulator) model was developed to simulate soil water dynamics, nitrogen transport and crop growth under integrated management practices [3]. With careful insight model validated during this study can be applied in other regions as well.

Methodology

Two field experiments were conducted at Research Farm of Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad, Punjab, Pakistan for two years using maize-wheat rotation. For maize-wheat crops there were three irrigation levels (I_1 = 60% FC, I_2 = 80% FC and I_3 = 100% FC) and two mulching materials (plastic film (M_1) and rice straw mulch (M_2)). No mulch was added in control treatment. A randomized block (RCB) design with split-plot arrangement using three replications was used. At critical growth stages, irrigations were scheduled in individual treatments. Canal water / tube well water was the source of irrigation water depending upon the availability. Moisture contents and bulk density were determined at 15 cm intervals up to 45 cm depth one day before each irrigation. Soil samples were taken with the help of augar, weighed immediately and oven dried at 105ºC for 24 hours. The soil moisture was measured using the gravimetric method. The total applied water was the sum of the calculated deficit water in the corresponding layers. A 90 cm cutthroat flume with 20 cm wide throat was installed at the entry point of the water to measure the amount of irrigation water applied.

Soil water movement, soil NO_3^--N and NH_4^+-N were simulated with the use of WHCNS model. The calibration of model parameters was done by selecting a treatment without water and nutrient stress according to previous studies. The agreement between the predicted and observed data was assessed by the use of three statistical indices: (1) Root mean square error (RMSE), (2) Nash–Sutcliffe

modeling efficiency (E) and (3) Agreement index (d). An acceptable simulation should have E > 0.36 and d > 0.7 [4].

Results and Analysis

Higher values of soil water contents were observed after application of irrigation. Measured and simulated soil water contents and nitrate concentrations at all depths were in well agreement with measured results. Statistical indices of soil water contents at various depths for all validation treatments are presented in Table 1. The RMSE values of soil water contents at various depths ranged from 0.01 to 0.04. E values ranged from 0.61 to 0.84 and d values ranged from 0.85-0.93. The values of statistical indices indicates that model performed well in predicting soil water content. A significant relationship was observed between measured and simulated values for both studies. The values of correlation coefficients for soil water contents was 0.87 (Fig. 1).

Table 1: Model performance criteria

Soil layers (cm)	RMSE	NSE (E)	IA (d)
20	0.02	0.84	0.92
40	0.01	0.71	0.9
60	0.01	0.82	0.93
80	0.03	0.74	0.93
100	0.01	0.8	0.92
120	0.03	0.65	0.89
140	0.02	0.73	0.91
160	0.04	0.61	0.85

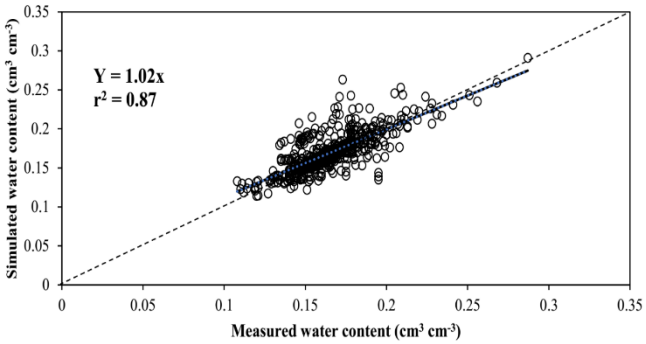

Fig. 1: Relationship between measures and simulated values

Conclusions

The WHCNS model could be used to simulate soil water and nitrogen in the study area as simulated soil water content and soil nitrate concentration were all in good agreement with the measured data. In future scenario analysis of different management practices needs to be conducted to obtain the best management practices among different irrigation and fertilizers practices.

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REMOVAL OF METOPROLOL AND PROPRANOLOL FROM ENVIRONMENTAL WATERS BY ADVANCED OXIDATION PROCESSES

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ABSTRACT

β-blockers are the most commonly detected pharmaceuticals in wastewater. The stability of metoprolol (MET) and propranolol (PRO), as typical representatives of this group of compounds, were analyzed in environmental waters. Environmental waters were sampled in Temerin, Jegrička puddle, and at Old Mountain, the spring water source Topli Do. The physical and chemical characteristics of the waters were determined. Also, the stability of investigated pharmaceuticals in mentioned waters showed that direct photolysis wasn't an efficient way for their removal. The presence of ZnO in water solution had a strong influence on the process. Also, photocatalytic removal of both compounds was more efficient in environmental waters, comparing to the ultrapure water (UPW). Significant mineralization of parent compounds and the mixture of their intermediates formed during the process of photocatalytic degradation was achieved after 90 min of irradiation, whereby the following results were obtained: UPW 71%, Jegrička 88%, and Topli Do 85%.

Key words: Environmental waters, Pharmaceuticals, Photocatalytic degradation

Introduction

The presence of pharmaceutical products in aquatic environments is increasing over the years. Chronic exposure to these pollutants, even at low concentrations, could have negative effects on aquatic organisms and human health [1]. Among these pollutants are β-blockers (adrenergic receptor antagonists), as frequently prescribed pharmaceuticals for the treatment of cardiovascular diseases, and disorders such as hypertension, angina, and cardiac arrhythmias [2]. Different methods are developed to remove or degrade metoprolol (MET) and propranolol (PRO) from water, including adsorption, advanced oxidation processes (AOPs), etc. AOPs are attractive methods comparing to others, given the simplicity of performance and low cost [3]. Photolysis is considered as an adequate ecological approach for the removal of MET and PRO because it has a chemical-free nature, but the process isn't efficient. Photocatalysis is a widely used process, where the acceleration of a reaction occurs when a semiconductor interacts with the light and produces reactive oxidizing species (for example $^{\bullet}OH$, $O_2^{\bullet-}$) and reactive e^-–h^+ pairs. In literature, TiO_2 and ZnO are presented as highly efficient semiconductors for the degradation of MET and PRO from water [4,5]. This study aimed to perform a detailed comparative analysis of photolysis and photocatalytic degradation kinetics of the mixture of MET and PRO in different environmental waters, under simulated solar irradiation (SSI). The mineralization approach was used to see the effectiveness of the photocatalytic process, and to estimate the degree of degradation of MET and PRO to CO_2, H_2O, and inorganic ions.

Methodology

After sampling, environmental waters (in September 2020 in Temerin and Old Mountain) were sterilized by filtration. Total and carbonate hardness, iron and chloride contents, conductivity, COD, and pH values were determined. Ultra Fast Liquid Chromatography with Diode Array Detection was used to monitor the kinetics of MET and PRO degradation.

Results and Analysis

Experiments of photolytic and photocatalytic degradation of MET and PRO in the mixture were performed in different types of waters under SSI. It was found that after 90 min of SSI, degradation of

MET and PRO wasn't significant (Fig. 1). These results were expected based on the absorption spectra of MET and PRO (wavelengths of maximum absorption at 223 and 215 nm, respectively). Significant degradation of MET and PRO was observed in the presence of ZnO in all investigated waters (Fig. 1). The degree of MET removal was increasing in order: UPW < Topli Do < Jegrička. In the case of PRO degradation was almost over 15% higher in environmental waters compared to the UPW. After photocatalytic degradation of the mixture of MET and PRO, the chemical oxygen demand was 71% UPW, 88% Jegrička puddle, and 85% Topli Do water.

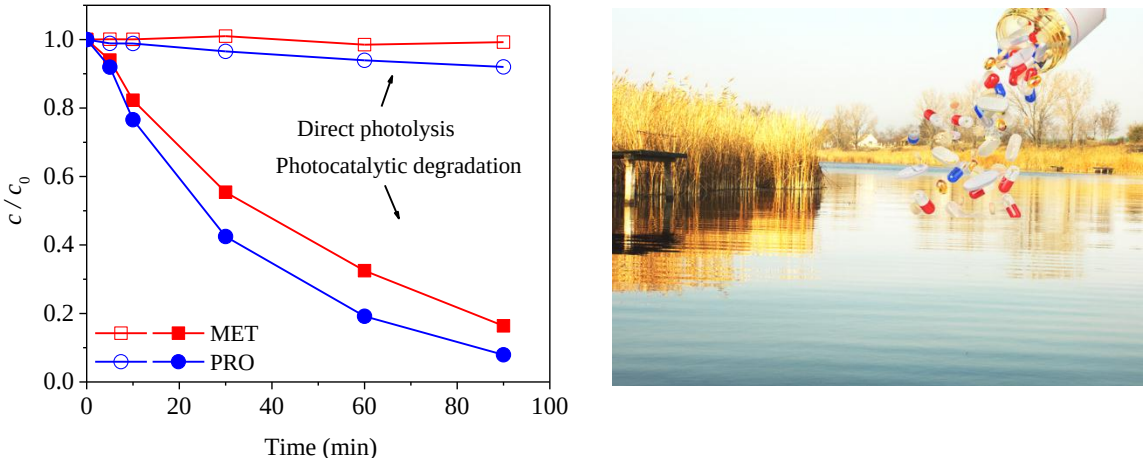

Figure 1. Direct photolysis and photocatalytic degradation of MET and PRO in the absence/presence of ZnO under SSI (left) in Jegrička puddle (right)

Conclusions

Based on our results, we can report that the content of water is important for the degradation of the investigated compounds in the mixture. Physico-chemical characterization of waters enabled us to explain how the presence of different ions affects the degradation of MET and PRO. Further, the experiments proposed an effective way for mineralization of organic pollutants and their degradation products which could be more toxic than parent compounds.

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INFLUENCE OF WATER COMPOSITION FROM THE CITIES LOZNICA AND VRBAS ON THE EFFICIENCY OF PHOTOCATALYTIC DEGRADATION OF SELECTED β-BLOCKERS IN MIXTURE

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ABSTRACT

Nowadays, environmental pollution is very serious and increasing attention is dedicated to the presence of pharmaceuticals that accumulate in the environment. Metoprolol (MET) and propranolol (PRO) belong to the group of β-blockers often found in wastewater. Photocatalytic degradation of MET and PRO in a mixture was examined in different natural waters, in aqueous suspensions of ZnO under simulated solar irradiation (SSI). Samples of water were taken in Loznica (spring water, the local name "Iron water") and Vrbas (Danube-Tisa-Danube canal, DTD). Results of degradation in natural waters were compared with ultrapure water (UPW). The kinetics of photocatalytic degradation was monitored using UFLC–DAD. Also, the physical and chemical characteristics of the water samples were determined. Results of direct photolysis and photocatalytic degradation were compared. Mineralization in the case of direct photolysis wasn't significant, while significantly higher mineralization was observed in the case of photocatalysis.

Key words: β-blockers, ZnO, Natural water

Introduction

Many pharmaceutical compounds have been detected in various concentrations in soil, wastewater, surface water, and even drinking water [1]. These compounds in drinking water clearly show that conventional wastewater treatment processes don't remove a wide range of pollutants. β-blockers are generally recognized as pollutants, and they are present in the environmental water due to their frequent use in hospitals and households [2]. Metoprolol (MET) and propranolol (PRO) are a class of frequently prescribed drugs for hypertension, which are used for cardiovascular treatment and cardiac arrhythmias. There are several ways to remove β-blockers from the water in the literature, but photocatalysis is considered an ecological approach [3]. This study aimed to perform a detailed comparative study of the kinetics of photolysis and photocatalysis of MET and PRO under simulated solar irradiation (SSI) in different water types: ultrapure (UPW), spring water, and canal water. Commercial catalyst ZnO, as an effective catalyst for degradation of MET and PRO, was used.

Methodology

The natural water samples were taken in September 2020 in the cities of Loznica and Vrbas. After sampling natural water, to avoid microbial degradation, natural water was sterilized by filtration, and all glassware was sterilized by autoclaving for 30 min at 140 °C. The following water characteristics were determined: total and carbonate hardness, iron (Table 1) and chloride contents, conductivity, COD, and pH values.

Kinetics of MET and PRO were monitored with Ultra Fast Liquid Chromatography with Diode Array Detection. The reproducibility of repeated runs was around 3−10%.

Table 1. Iron concentration in analyzed waters

Sample	**γ (Fe^{3+}) (mg/dm^3)**
UPW	0.05
DTD	0.11
"Iron water"	0.11

Results and Analysis

Experiments of direct photolysis in UPW, "Iron water", and DTD under SSI were performed. Results showed high stability of MET and PRO in all investigated waters. Further, photocatalytic degradation of MET and PRO in aqueous ZnO suspension was examined. Degradation of MET and PRO in UPW was 74 and 78%, respectively, after 90 min under SSI. Simultaneously, natural water removal of investigated compounds was higher than 90% for both compounds (Fig. 1). Results of mineralization showed high efficiency of removal of intermediates that are formed during the degradation procedure. In UPW, mineralization of mixture was 71%, while in "Iron water" and DTD mineralization was 90% and 87%, respectively.

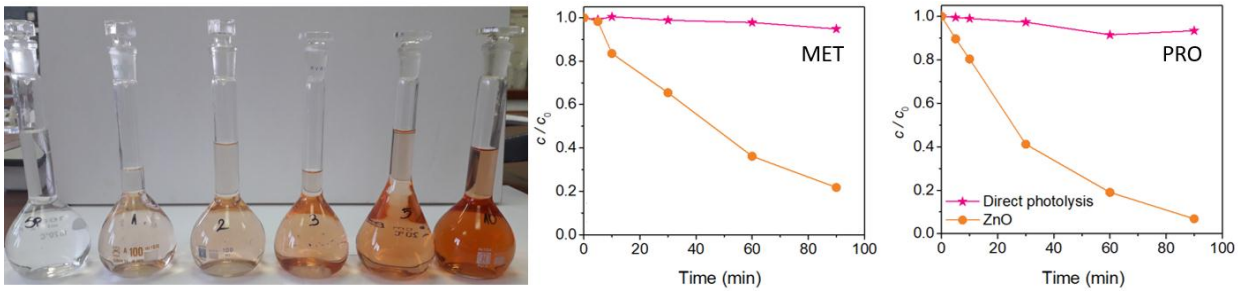

Figure 1. Standard solutions of iron prepared for the construction of the calibration curve (left). The efficiency of photolytic and photocatalytic degradation of MET and PRO in "Iron water" under SSR (right)

Conclusions

Based on the results, it can be concluded that the composition of water significantly affects the photocatalytic degradation of MET and PRO. Also, ZnO showed as a suitable catalyst for efficient mineralization of parent compounds and intermediates formed during the processes.

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ASSESSMENT OF WATER QUALITY USED BY POULTRY BUTCHERS FOR THE PRESENCE OF E. COLI, SALMONELLA AND SHIGELLA AND DETERMINATION OF ANTIBIOTIC RESISTANCE

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ABSTRACT

The quality of water used for hand washing and cleaning slaughtering tools by poultry butchers were assessed for the presence of hygiene indicator bacteria. Total 39 water samples were collected from the buckets and containers of poultry slaughtering settings in Hyderabad and Jamshoro district of Pakistan. Three-hygiene indicator bacteria were focused, i.e. *E. coli, Salmonella and Shigella* and for the detection of their presence, spread plate method was used. Bacteria were identified on culture plates on the basis of their morphological characteristics and colonies were counted by using colony counter. *Salmonella* colonies were further tested for their antibiotics susceptibility against four commonly used antibiotics. It has been found out that in collected water samples, prevalence rate of *Shigella, E. coli and salmonella* was 78%, 64% and 71%. The CFU/ml were in the range of zero to >2000/ml. The results of antibiotic test revealed that all of the isolated were resistant to Ampicillin, 50% to Erythromycin, 8% to Gentamycin and 16% to Ceftazidime.

Key words: Poultry, Water quality, Hygiene, and Microbes

Introduction

Slaughtering facilities are the link between the approved and safe meat, and meat products and the customer [1]. Therefore, the proper hygienic practices used for meat handling in these facilities regulate the health of the meat consumer [2]. Among the food-borne disease outbreaks 40% are the result of direct hand cross contamination. It often occurs; when slaughterhouse workers does not wash their hands properly and equipment properly or if the quality of water used is poor [3]. Hence, this study is conducted to analyze the quality of water used for slaughtering workers for washing their hands and slaughtering tools for the presence of hygiene indicator bacteria [4]. Moreover, assuming the recent outbreak of extremely drug resistant XDR Typhi, the antibiotic resistance of *Salmonella* is also determine.

Methodology

The study was conducted from February 2020 to September 2020. Total 39 water samples were collected from poultry slaughtering facilities of Hyderabad (13) and Jamshoro (26). Samples were analyzed for the presence of *salmonella, shigella and E. coli* by using spread plate method on salmonella-shigella (SS) agar plates. Bacterial colonies were identified based on their color difference and colony-forming units were counted in ml. Black colonies were further sub-cultured on another SS-Agar plate and were confirmed by two biochemical tests, i.e. TSI-Agar test and Urease test. Positive isolates were then tested for their antibiotic susceptibility by using disc diffusion method. Antibiotics used in this regard are Ampicillin, Erythromycin, Gentamycin and Ceftazidime.

Results and Analysis

Out of 39 water samples 25 (64.28%) samples were positive for *Salmonella*, 30 (78.57%) for *Shigella* and 27 (71.42%) for *E. coli.*

Out of 39 water samples, 17 water samples were having >12000 CFU/ml and only 8 samples showed zero CFU/ml (Figure 1)

All of the isolates showed resistance to Ampicillin, resistance to Gentamycin was found as 8%, while resistance to Erythromycin and Ceftazidime was found as 50% and 16% respectively (Figure 2).

Conclusion

The poultry butcher shops of Hyderabad and Jamshoro district are using poor quality water with high rate of diseases causing pathogens. Antibiotic resistance *Salmonella* is circulating in the water used by poultry butchers for washing their hands and cleaning their slaughtering tools (Knife etc). The high resistance profile of *Salmonella* isolates to these antibiotics can be explained by the high level of use of these antibiotics in veterinary due to their relatively low price and availability to the local population. To improve the quality of water there is need to create the awareness among the poultry butchers to adopt the hygiene and sanitation standards to increase the safety of meat.

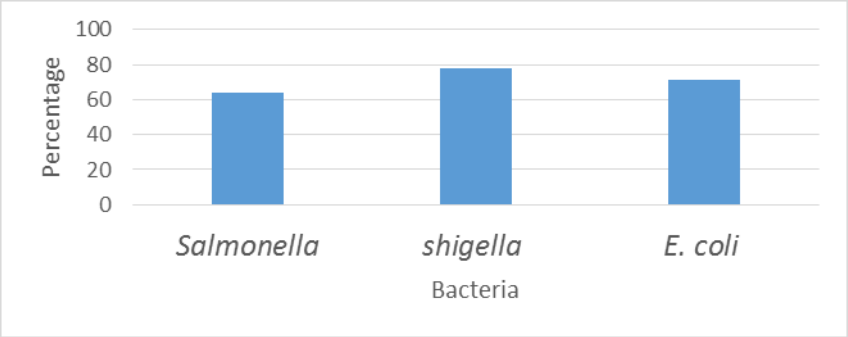

Figure 1: Number of positive samples for *Salmonella, Shigella* and *E. coli*

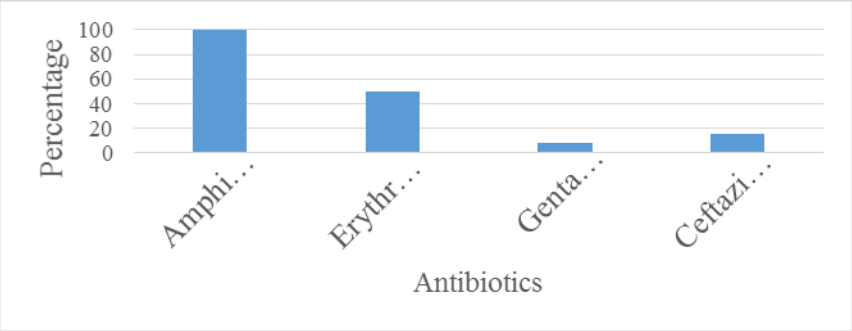

Figure 46: Disc diffusion test results

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THIOSULFATE-OXIDIZING BACTERIA (TOB) BIOASSAY FOR DETECTION OF HEAVY METALS IN WATER, LAB-SCALE STUDY

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ABSTRACT

Mainly, continual discharge of toxicants by industrial and domestic effluent in concentrated amount are accountable for contamination of water and also threaten for living beings. Use of bioassay as detecting tool increases due to its reliability and rapid detection of heavy metals toxicity in an aquatic environment. The Vial-type bioreactor was fabricated for determining the heavy metals in water by utilizing the Thiosulfate-Oxidizing bacteria (TOB) bioassay. The reactor function was based on the oxidation of thiosulfate by chemo-lithotrophic pathway. In product, sulfuric acid (to produce SO_4^{2-} and H^+ ions) was formed. The detecting parameters were pH and EC (uS/cm) which associate with amount of hydrogen ion and sulfate ion. The batch test was designed to evaluate Zinc toxicity at 30 ^{0}C with agitation of 150 rpm. The reactors were contained thiosulfate, inoculum (which was collected from Master Cultured Reactor by utilizing the aerobically treated bioreactor sludge) and Zinc (0 – 10 ppm). The bacterial activity was ceased with concentration of Zinc. The percent of inhibition was 10 – 90 % (0.25 – 10 ppm of Zinc) respectively with EC_{50} of 0.75 mg/L for 24 h by hillslope EC_{50} equation. So, TOB bioassay can serve as effective method for toxicant detection in water.

Key words: Bioassay, Toxicant, Thiosulfate-Oxidizing bacteria (TOB), EC_{50}.

Introduction

Continuous expulsion of toxicants in water through industries deplete its quality. Its exposures also increase the potential risk for the living beings (bioaccumulation) [5]. Variety of toxicants were detected by using bioassay and its effects on organisms. It is more suitable method than other laborious analytical methods [1, 3]. In bioassay, chemo-lithotrophic Thiosulfate-Oxidizing bacteria (TOB) was utilized as bioindicator. The determination based on oxidation of thiosulfate in the presence of oxygen. Sulfuric acid as product gives sulfate and hydrogen ion which showed by EC and pH of media.

Methodology

For consistent supply, TOB was cultured in Master Culture Reactor (MCR) by using 10 mL of aerobic bioreactor sludge at fed-batch mode. The providing conditions were thiosulfate solution with 250 mL/min aeration at 30^{0}C. Zinc batch reactors were designed in glass vials of 25mL, contained thiosulfate (50 ppm), inoculum and Zinc of 0, 0.25, 0.5, 0.75, 1, 2.5, 5, 10 ppm. These were incubated at 30 ^{0}C with 150 rpm for 24 h. The parameters were EC and pH. Inhibition percent was obtained by EC.

Results and Discussions

MCR was stabilized within 60 days. Bacterial activity in MCR was showed as: pH was noted as neutral to acidic (pH 7 to 2.5) and EC was maximum with each feeding cycle. Thiosulfate was added to MCR with 4 days interval, pH was kept at 6.5 before addition to avoid precipitation. In toxicity test inhibition in bacterial activity related to contact time and quantity of Zinc. Inhibition of TOB activity acted as end-point. In reactors (0 – 10 ppm of Zinc) pH change was acidic to neutral and EC change was stopped with Zinc dose, as in fig:1. Oxidation of TOB was obstructed with Zinc cause decreasing in hydrogen and sulfate ion formation [2, 4].

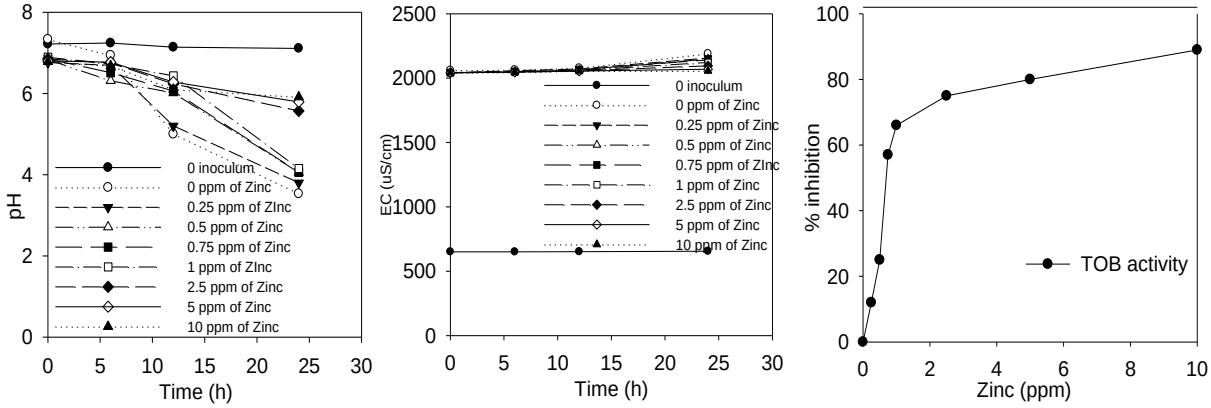

Fig: 1. pH, EC and % inhibition of Zinc toxicity test

Conclusions

TOB bioassay is effective for the evaluation of Zinc toxicity in water than other evaluated EC_{50} values. The TOB inhibition percent in the presence of Zinc (0.25- 10 ppm) was 10 - 90% with EC_{50} of 0.75 ppm. TOB bioassay is more effective than other bioindicators because it works at lower pH.

Acknowledgement. The work was sponsored by USPCAS-W, MUET Jamshoro.

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SYNTHESIS OF N-MODIFIED TiO_2 NANO-POWDERS FOR EFFICIENT PHOTOCATALYSIS OF RHODAMINE B DYE UNDER NATURAL SUN IRRADIATION

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ABSTRACT

In this work, Nitrogen modified TiO_2 nanoparticles were successfully synthesized via fast acid catalyzed sol-gel route with ammonia solution as a primary nitrogen precursor. The effect of amount of nitrogen was investigated by further incorporating secondary nitrogen in prepared sample with urea precursor by adopting wet impregnation approach. Pure TiO_2 nanoparticles were also synthesized for comparison. Prepared photo-catalysts were characterized by FTIR, XRD and DRS Spectroscopic analysis. Laboratory test experiments on Rhodamine B (RhB) decomposition under artificial visible light (20W White LED) revealed the highest photocatalytic activity of catalyst doubly doped with ammonia solution and urea whereas pure TiO_2 showed poor activity under visible light illumination. The effect of operational parameters such as catalyst dose, solution pH and substrate concentration on photocatalytic efficiency was also evaluated to obtain optimal conditions. Photocatalysis of RhB under natural sunlight with doubly-doped photo-catalyst (T5N2) showed remarkable photocatalytic performance of 99.9% after 1 hour illumination.

Keywords: Solar Photocatalysis, TiO_2 Nano-powders, Nitrogen Dopant, Fast Sol-Gel Synthesis, Urea Precursor

Introduction:

Synthetic Dyes are organic compounds extensively used in textile industry to impart vibrant colors to the commodities, however, during wet coloring stage, a significant amount of these dyes does not bind to fabric and thus released to the environment as waste posing serious environmental concern[1] Semiconductor-based heterogeneous photocatalytic mineralization has gained importance since few decades as a promising technology powered by free and renewable solar energy for water detox application. In this regard Titanium Dioxide (TiO_2) is considered as "golden" photocatalyst due to its remarkable features of chemical, biological and photo-stability, non-toxicity and low cost. However, the main hindrance in the way of pure TiO_2 application under natural sunlight is its large bandgap. Nitrogen (N) is considered as low cost, promising and efficient dopant in terms of reducing bandgap and enhancing photoactivity[2] The current study deals with the synthesis of nitrogen modified TiO_2 Nano-powders by adopting alcohol free fast Sol-Gel process with ammonium hydroxide as a primary nitrogen precursor. The adopted procedure follows direct hydrolysis of Titanium precursor at room temperature, facilitated by Acetic Acid, allowing the completion of Sol-Gel reactions within short time. Afterwards the amount of nitrogen impurity was enhanced by wet impregnation with urea precursor. For comparative study, pure TiO_2 nanoparticles were also synthesized. The activity of prepared nanoparticles was investigated by photocatalysis of Rhodamine B dye under artificial 20W white LED lamp and natural sunlight for practical application.

Methodology

For Photocatalyst preparation, a simple fast Sol Gel route as reported in reference[3] has been adopted with some modifications. 40ml of Titanium isopropoxide (TTIP) was added directly into distilled water and the suspension was immediately stirred on magnetic stirrer. After 30min, Glacial Acetic acid was added such that the molar ratio of TTIP: Distilled H_2O: Acetic Acid was maintained as 1:172:12. The colloidal suspension was left under continuous stirring for 3hr after which NH_4OH (33%) solution was added to raise the pH of solution to 11. Precipitates formed were washed and dried in air oven at 100°C till dried powders were obtained which were calcined at 400°C for 1h. The sample was labeled as T5N1.

To check the effect of amount of nitrogen on activity of photocatalyst secondary nitrogen dopant (urea) was incorporated into as-prepared catalyst (T5N1) via wet impregnation route. For this, 2g of T5N1 was added in 50ml of distilled water to make homogenous colloidal suspension to which Urea

solution (keeping urea to TiO_2 molar ratio 1:1) was added and the mixture was agitated for 1h at room temperature. The temperature was then raised to 68°C and mixture was kept under stirring for further 30 min after followed by solvent evaporation in open beaker at 100°C. Obtained paste was dried and the powders were baked at 350°C for 1h. The sample was named as T5N2. For comparative study, pure TiO_2 nanoparticles were also synthesized via similar sol gel method as adopted for T5N1 sample except NaOH was used instead of NH_4OH for precipitation. Fabricated nanoparticles pure and doped were subjected to FTIR spectroscopy with Cary-630 spectrophotometer. X-Ray diffraction (XRD) has been conducted with D2 Phaser diffractometer and diffuse reflectance spectroscopy (DRS) was performed for determination of band gap energies by Jasco-V770. Photocatalytic experiments were performed in a batch slurry reactor under artificial 20W portable LED white lamp. After regular intervals aliquots were withdrawn from suspension and decolorization of dye was monitored by measuring absorbance of solution with Perkin Elmer (Lambda 25) UV-Vis Spectrophotometer at λ_{max} of 554nm. For experiments under natural sunlight, photocatalytic assembly was placed directly under the sun with optimum load of photocatalyst powders at the Institute of Chemical Engineering and Technology, University of the Punjab Lahore, Pakistan.

Results and Discussion

The FTIR peaks obtained at 3225 cm^{-1} and 1630 cm^{-1} revealed the presence of adsorbed water/OH functional groups on all prepared photocatalysts. The small peaks at 1449 cm^{-1} and 3334 cm^{-1} were obtained on T5N2 sample showing the presence of nitrogen. XRD analysis confirmed the formation of pure anatase phase in all samples with crystal size in 5-7nm range. Bandgap energies obtained by DRS were 3.35, 3.08 and 2.99eV for pure TiO_2, T5N1 and T5N2 respectively.

Pure TiO_2 showed very low activity under artificial light with 17.45% decolorization of RhB (10mgL^{-1}) whereas the activity was significantly enhance in N-doped samples such as 83.12% and 96.93% photodegradation was achieved with T5N1 and T5N2 respectively. The best degradation efficiency was observed at pH=3 and catalyst load of 1.5g/l. Under natural sunlight T5N2 showed 99.9% degradation efficiency whereas the activity was only 19% with pure TiO_2. However both pure and doped photocatalysts showed slightly higher activity under natural sunlight compared to artificial light source.

Conclusions

Nitrogen modified TiO_2 nanoparticles were successfully synthesized by adopting fast acetic acid assisted Sol-Gel method with ammonia solution as primary nitrogen precursor (T5N1 sample). The amount of nitrogen was increased by wet-impregnation route with urea as secondary nitrogen dopant (T5N2 sample). Significant bandgap reduction with nitrogen insertion in Nano-powders was confirmed by Diffuse Reflectance spectroscopy. Under 20W Artificial White LED with T5N2 Nano-powders, degradation of Rhodamine B was 96.93% after 1 hour whereas experiments under Natural Sunlight showed higher photocatalytic efficiency as compared to artificial light with 99.9% decomposition of dye within same time duration. The adopted semiconductor based technology for environmental remediation has demonstrated to be efficient and effective enough to be further investigated and practiced on real time wastewater system.

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SPATIO-TEMPORAL VARIATION IN GROUNDWATER QUALITY OF LAHORE CITY

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ABSTRACT

Major source across the world for drinking purpose is groundwater. However, due to an increase in human activity, the quality of groundwater is changing. In Lahore, Pakistan groundwater is suspected to be polluted. Both the depth (up to 15m in various parts) and quality of groundwater is deteriorating. Therefore, there is a need of assessment of groundwater contamination so that proper management can be performed for mitigation of contamination. The present study aimed at trend analysis of groundwater quality spatio-temporally. Mann Kendall (MK) was used for trend analysis which is a rank based non-parametric test. Three water quality parameters (Electrical conductivity, sodium absorption ratio and residual sodium carbonate) were analyzed during 2003-2013. The results indicate that electrical conductivity (EC) and sodium absorption ratio (SAR) showed significant trend spatio-temporally during the period 2003-2013. However, residual sodium carbonate (RSC) showed no trend during the period 2007-2007 while a significant trend has been observed for 2007-2013. The outcomes of this research work can be utilized to mitigate the groundwater contamination for sustainability.

Key words: Groundwater contamination, Mann Kendal test, Water Quality

Introduction

Water is an essential component for sustaining the life on earth. Due to the increase in population, the demand for water is increasing year to year **[1].** Major source across the world for drinking purpose is groundwater which helps and plays a vital role to maintain the ecological value of many areas. However, due to an increase in human activity, the quality and quantity of groundwater are changing **[2].**

Moving of people from rural to urban areas is known as urbanization. The main reason for urbanization in big cities is increasing job opportunities and several industries. Proper infrastructure is needed for water supply to meet this rapid increase in urbanization. Due to the increase in urban areas the numbers of industries also increase which are the major source of groundwater contamination. Multiple resources i.e., natural, domestic, and industrial and complex pollutants including arsenic, heavy metals, organic compounds etc. are responsible for groundwater contamination. Various activities and all life forms on earth are influenced by. Due to variation in precipitation, recharging rates of groundwater and the availability of resources of water will increase the pumping of groundwater. Salinity in the aquifers increases due to the rise of sea level and its interaction with the groundwater. The Contamination of groundwater may adversely affect both humans and wildlife.

In Lahore, Pakistan groundwater is suspected to be polluted. Both the depth (upto 15m in various parts) and quality of groundwater is deteriorating due to the increase in urbanization and industrialization. Lahore is the capital of Punjab province and the second largest city in Pakistan. It is located on the map with its proximity to Kasur district in the South and Sheikhupura in the North-west. The Urban area of Lahore has expanded almost double in the last 12 to 15 years. There is a need of impact assessment of groundwater contamination so that proper management can be performed for mitigation of contamination and for sustainability. The present study aimed at trend analysis of groundwater quality spatio-temporally. Mann Kendall (MK) was used for trend analysis which is a rank based non-parametric test. It can be used for the detection of variations in hydrometeorological timeseries data. The MK statistics, S is given as

$$S = \sum_{k=1}^{n-1} \sum_{j=k+1}^{n} \text{sgn}(Y_j - Y_k)$$

$$\text{sgn}(Y_j - Y_k) = \begin{cases} if\,(Y_j - Y_k) < 0; & then \quad -1 \\ if\,(Y_j - Y_k) = 0; & then \quad 0 \\ if\,(Y_j - Y_k) > 0; & then \quad 1 \end{cases}$$

Where,

Y_k= Time series value over time K
Y_j-= time series data values over time J

Three water quality parameters were analyzed i.e., Electrical Conductivity (EC), Sodium Absorption Ratio (SAR) and Residual Sodium Carbonate (RSC) fort the period of 2003-2013.

Conclusions

Groundwater quality of Lahore, Pakistan is deteriorating. The results indicates that Electrical Conductivity (EC) and Sodium Absorption Ratio (SAR) showed significant trend spatio-temporally during the period 2003-2013. However, Residual Sodium Carbonate (RSC) showed no trend during the period 2007-2007 while a significant trend has been observed for 2007-2013 as shown in Table 1. The outcomes of this research work can be utilized to mitigate the groundwater contamination for sustainable development. SAR and RSC indicate that there is a possible sodium and alkalinity hazard in groundwater. Proper management is the need of the hour to maintain the quality of groundwater for sustainability.

Table1. Water Quality results of Lahore City

Water Quality Results of Lahore City			
Parameter	**C.I**	**Samples**	**Status**
EC	<1000	50	Fit
	1001-1300	70	Marginally Fit
	>1300	45	Unfit
SAR	<5	32	Fit
	5-8.5	78	Marginally Fit
	>8.5	93	Unfit

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STATISTICAL MODELLING OF DROUGHT AND GROUNDWATER QUALITY NEXUS

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ABSTRACT

Drought is generally categories as metrological drought, hydrological drought, agricultural drought, and socio-economic drought. The metrological drought is considered a deficiency in rainfall over a prolonged period and could cause serious negative impacts on irrigated agriculture, catchment runoff, river flow, lake level, and ultimately the quality of water. In general drought and immediate recovery periods, could affect water quality. Hence in the current study, key water quality parameters i.e. electrical conductivity (EC), Sodium Adsorption Ratio (SAR), and Residual Sodium Carbonate (RSC) have been selected and standard precipitation index (SPI) was used to compute the metrological drought at two stations i.e. Sargodha and Juharabad. Furthermore, to understand the relationship between the drought and water quality, Statistical modeling has been carried out based on the estimated drought index (SPI) and water quality parameter. Based on findings, it resulted that during the study period, the select study area observed 164 drought events with maximum severity of -1.62 and a maximum duration of 8 months. Moreover, a weak correlation was observed between the corresponding SPI and water quality parameters. However, a better correlation ($R^2 \geq 0.45$) was found in the case of lagged series. As disruption of catchment inputs and influence of interposes (i.e. biological uptake of nutrients, denitrification, and settling) could increase during prolong drought and its recovery period, hence it was expected that the lagged water quality series could have a better relationship with SPI. The overall assessment resulted that the value of EC, SAR, and RSC have better agreement with prolonged metrological drought and hence, concluded that prolonged metrological drought has a significant impact on variation in water quality

Key words: standard precipitation index, ground water quality, statistical modeling

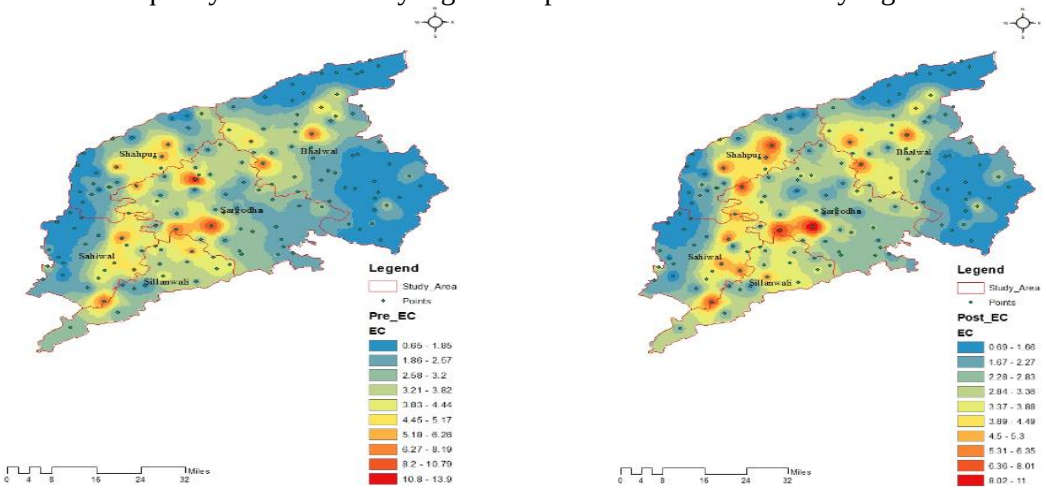
Introduction

Drought means the normally happening phenomenon that exists when precipitation has been effectively below the normal recorded level; causing hydrological uneven characters that combatively influence land resource production systems. Environmental change bringing about progressively extreme and continuous dry seasons could cause impressively to bring downstream and subsequently have impacts on surface water quality, primarily expanding constituent focuses and noteworthy contrasts. Water quality can be deteriorated by anthropogenic impacts, for example, land-use changes. The deficiency of precipitation during the drought harms, impact on the quality of the surface water, a decrease of the water supply, the aggravation of dissipation, the drop of the water table and the shrink of river and lake basin and the increase of the concentration 10 of nutrition components (for example nitrogen, phosphorus, etc.), the devastating of the hydrodynamic conditions. The water resources and their management are highly affecting the growth of changes in population, associated food, changes in temperature, and alteration of precipitation patterns [1]. The agrarian sector and state economy are directly affected by the drought. People that are influenced by the drought, started to move towards cities for the sake of employment. Dry season disturbs the horticultural production, and the balance between demand and supply of agricultural products will be affected and eventually expands inflation [2]. In the dry season, the enhanced stratification and high temperature occurred due to the lowered dissolved oxygen concentrations, promoted toxic cyan bacteria blooms, high air temperature,

enhanced algal production [3]. The algal levels also increased in the lake systems because of the reduction of flushing, suspension in some shallow lakes, and enhanced productivity. Conversely, turbidity and nutrient often decreased during the droughts in streams and waterways with no critical stacking from the point and horticultural non-point sources [4]. Hence, this research consists of two main aims as follow: Assessment of metrological drought including (intensity, frequency, and duration) and Evaluation of the impact of drought on water quality using statistical modeling

Conclusions

Drought plays a vital role in the degradation of groundwater quality parameters i.e. electrical conductivity (EC) sodium adsorption ratio (SAR) and residual sodium carbonate (RSC). During the metrological drought condition, the SPI values play a significant role in the assessment of drought intensity, duration, severity, and frequency. For both pre-monsoon and post-monsoon seasons, the water quality parameters were affected during drought conditions with seasonally lag the SPI values. Based on analysis it was noted that, a total of 164 numbers of drought were observed in the selected study area with a maximum duration of 8 months and a severity of -1.62. Moreover, statistical modeling between SPI and water quality parameters indicates that there is a weak relationship in corresponding time series, whereas water quality parameters provide better agreement (on an average $R^2 > 0.45$) with SPI after seasonally lag. Hence, it was observed that the drought has a significant impact on water quality with seasonally lag as compare to without seasonally lag.



(a) (b)

Figure. GIS Map of water quality data set (EC): (a) pre monsoon; (b) post monsoon season

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TREATMENT OF REAL TEXTILE WASTEWATER IN SINGLE STAGE AND MICROALGAE – BACTERIA CONSORTIUM

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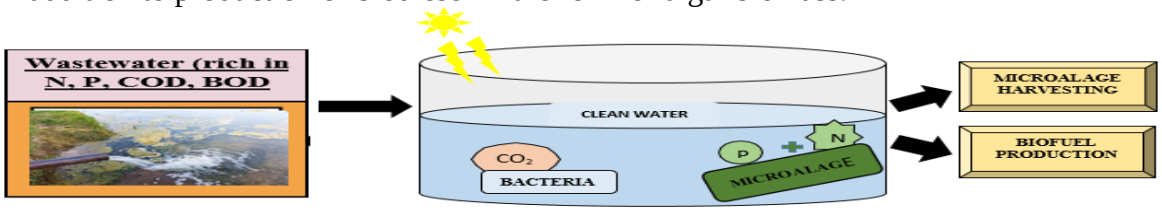
ABSTRACT

Unchecked disposal of textile wastewater (TWW) into water bodies is causing eutrophication. Textile wastewater is a cheap source for the cultivation of microalgae and bacteria, as it contain essential nutrients (inorganic and organic) and different type of dyes (carbon source). In the current study nutrients nitrate (NO_3-), phosphate (PO_4^{3-}) and COD (Chemical oxygen demand) were removed from textile wastewater by using microalgae alone, and microalgae and bacterial consortium. The consortium of microalgae and bacteria showed maximum nutrient and COD (Chemical oxygen demand) removal as compare to the microalgae alone. The consortium of microalgae and bacteria proved highly effective in textile wastewater treatment.

Key words: Microalgae, Textile wastewater, consortium, COD, nutrient removal.

Introduction

Textile wastewater contains carbon, nitrogen, phosphorus, and micronutrients in the form of dyes, nitrates, phosphates, and metals. Bioremediation of textile wastewater through the microalgae can be used to remove nutrients and dyes which result in the production of enough biomass to meet the biodiesel production and tackle the energy requirements (Elumalai and Saravanan 2016). The presence of these nutrients makes it a promising and cheap medium for the growth of microalgae (Cai, Park et al. 2013). In Pakistan, textile industries need to give cost-effective bioremediation of textile wastewater to meet the domestic needs and requirements and reduce the power consumption. The growth of microalgae in the textile industry wastewater can use to treat the same wastewater in one way in addition to production of biodiesel in the form of algal biomass.



Fig# graphical representation of textile wastewater using microalgae –bacterial consortium

Methodology

Research was conducted in batch reactor. Native microalgae was collected from local canal and grown in BG-11 medium. The growth of microalgae was monitored by checking optical density OD at (690 nm) using UV-Visible spectrophotometer and dry cell weight (DCW)

using APHA standard method. Meanwhile, bacteria was isolated from textile wastewater sample through pour plate method (APHA standard) and was further inoculated in nutrient broth on shaking incubator at 37^{o}C for further growth. Whereas bacterial growth was monitored by checking optical density at 600 nm in UV- spectrophotometer. The salicylic acid method, ascorbic acid method and open reflux method (5220) were used for the analysis of nitrate (NO_3-), phosphate (PO_4^{3-}) and COD (Chemical oxygen demand) respectively.

Results and Analysis

In the single experiment 0.5g/L of biomass of native microalgae was able to remove 53.33% nitrate, 50% phosphate, and 72.85% COD(Chemical oxygen demand) within 5 days. In order to improve the treatment of textile wastewater in second experiment consortium of microalgae –bacteria was used. In consortium 0.1g/L of bacterial was inoculated with 0.5 g/l biomass of microalgae. With the consortium of microalgae-bacteria maximum nitrate, phosphate and COD (Chemical oxygen demand) removal were 74.13 %, 86.40 % and 80.55 % respectively. The consortium was highly effective in textile wastewater treatment.

Conclusions

In this study native microalgae and bacteria were used for the treatment of real textile wastewater. Microalgae alone and algae bacterial consortium were used for the wastewater treatment. Microalgae alone was not very effective in textile wastewater treatment. So, consortium process showed better removal efficiency of nitrate, phosphate and COD (Chemical oxygen demand).

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DEVELOPMENT OF POINT-OF-USE FILTRATION FOR HARVESTED RAINWATER USING NATURAL INDIGENOUS MATERIAL

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ABSTRACT

In Pakistan and other water stressed countries, most of rural communities rely on harvested rainwater as a source of untreated drinking and domestic water supply in the summer monsoon until it lasts. Particulate matter and air-borne microbes were the main component in the process of ice nucleation and also rainwater brings suspended impurities & microorganism due to dry and wet deposition on the catchment in rural areas. The aim of this study is to utilize natural and local material for the removal of suspended particulate matter and microorganism from harvested rainwater in rural communities in Thar - desert. 50% of harvested rainwater samples collected was contaminated with *Escherichia Coli* (2 – 15CFU/100mL) with exceeded turbidity's values than WHO guidelines before filtration in column study at pilot lab scale. The novel indigenous filter was made by compressing the milkweed floss fiber in the column vessel at different compression ratios and the fabricated filter showed a good removal efficiency of 99.33% - 100% of *Escherichia Coli* and 89.38% - 99.61% turbidity's from harvested rainwater samples. The overall result showed that the fabricated filter suitable for filtrating harvested rainwater and it is also concluded that filter can be used for point-of-use and point-of-entry water treatment system. This paper presented a very easy, low- cost, and manually operated mechanism to extract the stored underground tank rainwater and simultaneously purifying it to reduce water-borne diseases in rural communities of Thar – desert, Pakistan.

Key words: Point-of-use filtration, Harvested rainwater, Natural indigenous fiber, Micro-impurities, Water-borne diseases, and Water scarce region.

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GREEN SYNTHESIS ROUTE BASED NANOPARTICLES INTERCALATED WITH GRAPHENE OXIDE FOR HIGHLY EFFICIENT WATER PURIFICATION APPLICATIONS

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ABSTRACT

Nanofiltration membranes with greater water permeability and virtuous separation efficiency accompanied by adequate stability are significantly demanded for numerous requests. Graphene based membranes contribute significantly in several nanofiltration practices including water purification. Though, it is quiet challenging to attain high separation adeptness and efficient water permeance simultaneously. Here, we synthesized novel kind of Graphene oxide (GO) based composite membranes by intercalating green synthesis route based metal nanoparticles (NPs) in the GO sheets. These membranes exhibited up to 100 % efficiency for the rejection of dyes making the material ideal for the industrial water purifier manufacture. The greater water permeance and rejection potentials of GO based composite membranes are beneficial due to their uses in water purification.

Key words: graphene, purification, membrane

Introduction

Recently, graphene based material has been extensively validated among the supreme encouraging sieving resources for the water purification practices [1, 2]. Producing extraordinary separation membranes, with suitable shape, pore size and diffusion channels, is greatly anticipated. The carbon atoms linked to oxygen atoms signifying hydroxyl, epoxy and carboxyl groups comprise distorted sections because of sp^3 bonding among them. This causes the structural flaws and nanoscale creases in the basal plane of GO sheets, thus providing the passage for water transport in graphene-based membranes. Currently, various composite membranes based on GO [3] were recognized as nanofiltration membranes. However, maximum quantity of the synthesized membranes undergo stumpy rejection or very little water permeance [4]. In order to meet the current pure water and environmental demands, there is a need for the synthesis and fabrication of GO based membranes possessing efficient water permeance and pollutant rejections along with ultimate stability.

This study involves the synthesis of metal nanoparticles by environmental friendly approach and using them as crosslinker among the GO sheets to enhance the selectivity and permeability of membranes. The greater water permeance and rejection adeptness clarify the prodigious prospective of currently synthesized GO based nanoparticles composite membranes for water purification and further uses.

Methodology

We synthesized GO sheets through a previously reported method [5]. Metal NPs were synthesized at room temperature by mixing plant extract with aqueous solution of metal. Change in color represented the synthesis of nanoparticles. Finally, the composite membranes were fabricated while using vacuum filtration assembly on polyethersulfone (PES). The fabricated membranes were further used for separation performance while taking various dyes as pollutants.

Results and Analysis

The fabricated membranes were analyzed by various techniques in order to identify their morphology and composition. Scanning electron microscopy was used to study the morphology of membranes. The bonding among nanoparticles and GO sheets was investigated by Fourier Transform Infrared Spectroscopy (FTIR). X-ray diffraction (XRD) spectra confirmed the presence of composite material in the respective membranes. The water purification efficiency was estimated by using UV–vis spectrometric analysis for various dyes. The separation of dye molecules via GO-based membranes is dependent upon three factors *i.e*. electrostatic interactions among dye molecules and negatively

charged GO sheets, absorption of dye on GO sheets, and physical filtering of the 2D nanochannels optimized by size exclusion effect.

The separation performance efficiency of water and selected dyes in the membranes was studied by using vacuum filtration assembly of an effective area as 14.5 cm^2 under 1.0 bar pressure. Feed solution of 250 mL was practiced and the time taken for the separation process was noticed which was used to calculate the efficiency as shown in figure 1. The permeability (J) (L m^{-2} h^{-1} bar^{-1}) and the rejection (R) (%) were obtained by using equation 1 and equation 2 respectively:

$$J = \frac{V}{A\,\Delta t\,P} \qquad \text{(Equation 1)}$$

$$R = 1 - \frac{C_p}{C_f} \times 100\% \qquad \text{(Equation 2)}$$

Where, V (L) is volume of the permeate, A (m^2) is the area of membrane, Δt (h) is permeation time, P (bar) is vacuum pressure, Cp and Cf is concentration of permeate and feed solution respectively.

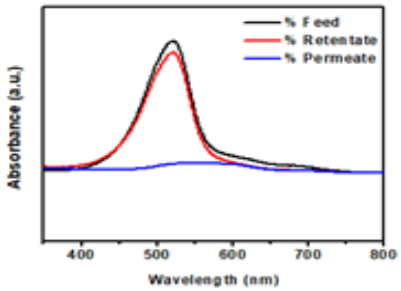

Figure 1: Separation performance of GO based membrane

Conclusions

We have fabricated great-performance GO based metal oxide composite membranes for nanofiltration requests. The GO based composite membranes display greater rejections (~100%) accompanied by higher water permeance performances. These exceptional belongings direct the encouraging claims of these combination membranes for water treatments. While following these fabrication practices we can recommend that further graphene based composite materials can be used for membrane fabrication and water purification applications.

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ELECTROCHEMICAL BEHAVIOR OF COMPOSITE ANODE TI/$RU_{0.3}TI_{0.7}O_2$ TOWARD RECALCITRANT DYE WASTEWATER DECONTAMINATION

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ABSTRACT

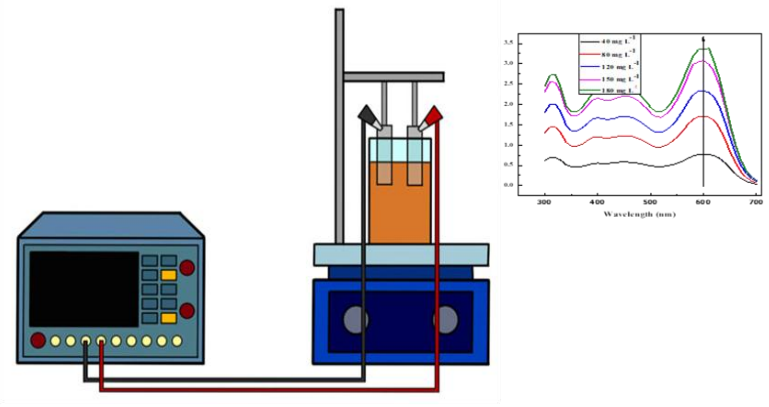
In current study, Ti/$Ru_{0.3}Ti_{0.7}O_2$ composite anode was used to electrochemically degrade acid black 234 dye of textile and leather industry origin by preparing its aqueous solution in a lab scale glass reactor. . The obtained results show that the degradation of the industrial dye is greatly increased by an increase in the NaCl concentration, lowering of the pH (i.e. at acid pH) and decrease in the current density (low energy consumption in kWh m^{-3}). The TOC removal achieved in one hour (60 minutes) was 43%.

Key words: Textile dye, Electrochemical Degradation, Electrode, acid black 234

Introduction

The synthetic dyes are more notorious in this regard which are produced about 7 x 10^5tons per year[1,2], whose 2 % amount goes to water bodies directly [2,3]. The elimination of hazardous dyes from the contaminated water can be done by using various available water treatment strategies like photo degradation [4], physical, biological, advance oxidation (ozonation, photo catalysis, and photo-Fenton) and electrochemical oxidation technology [5]. The electrochemical treatment technologies of wastewater are promising alternatives because they are inexpensive, energy efficient, operational and environmental friendly and in nature as only electrons involved in the process are believed as the "clean reagent".

In this study, a common leather industry dye, acid black 234, was electrochemically treated at room temperature and pressure conditions and influence of various important factors like type and concentration of electrolyte, pH of the electrolyte and current density was evaluated. The Ti/Ru0.3Ti0.7O_2 electrode was used as anode whereas a stainless steel plate was employed as the cathode. In addition, the kinetics of electrochemical reaction and the energy consumption calculations and total organic carbon analysis (TOC-Analysis) were also done.



Electrochemical degradation tests

Methodology

The electrochemical degradation tests were carried out in 600 mL glass beaker. Various types of electrolytes were employed to electrolyze the waste water samples of 500 mL in volume each. A DC power supply, Gwinstik, was used to do the bulk oxidation experiments keeping the current constant. A parallel two electrode arrangement was made where both electrodes (cathode = stainless steel, anode/working electrode=$Ti/Ru_{0.3}Ti_{0.7}O_2$) were vertically inserted into the waste water sample solution while maintaining 1.0 cm as the inter electrode distance and 14.0 cm^2 as the exposed surface area for both electrodes. A spectrophotometer (model 4201/20) was used to record the UV-visible spectra of the dye (Acid black 234).

Conclusions

The study successfully evaluated the degradation of acid black 234 dye in NaCl and Na_2SO_4 electrolyte solutions as the function of various parameters like concentration of NaCl and Na_2SO_4, concentration of the dye itself, value of current density, treatment time and pH of the solution. It also evaluates the psudo 1st order behaviour of the electrochemical process in order to evaluate the rate constants and half-life of the reactions. The % removal (degradation) of acid black 234 dye increases with an increase in the current density and the amount of NaCl in the electrolyte solution. Whereas in case of Na_2SO_4 added in the electrolyte, the degradation of dye is slowed down as compared to the NaCl addition..

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INVESTIGATION OF RAINWATER HARVESTING POTENTIAL FOR NON-POTABLE USE IN INSTITUTES

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ABSTRACT

Water is the key component to achieve the United Nation's Sustainable Development Goals (SDG). Growing population and urbanization at an alarming rate are hitting the water supply and demand balance in big cities. Groundwater abstraction and piped water supply is the only source in big cities around the world and both sources are under stress. A century-old rainwater harvesting system needs to be reconsidered as an alternate source of water at least for non-potable use in urban environment. Present study was conducted at Pir Mehr Ali Shah Arid Agriculture University Rawalpindi (PMAS AAUR) with the key objective to investigate the rainwater harvesting potential for non-potable use in urban environment. University have almost 950 full time employees and over 11000 total student enrollment. Daily operational time and discharge of different pumping station was recorded to estimate the institute's water consumption. It was assessed that 16930 m^3/month water is being consumed for offices, labs, academic blocks @40 hours/week and daily use of hostels and on campus faculty residences. ArcGIS software was used to digitize the university and geo-database was developed to categories the university into zones, groups and subgroups. It has been estimated that 86373 m^2 (27%) area covered under CG-I (rooftop) out of 332000 m^2 approximated total area of the university. Results showed that CG-I contributes maximum 39% in annual rainwater harvesting potential. It has been estimated university has potential to harvest 84131 m^3 of rainwater per year maximum contribution 49232 m^3 during monsoon period. The available capacity of underground water storage tanks in university is 1331 m^3 which is not enough to store rainwater during peak period. It has been estimate that additional storage of 6065 m^3 is required harness the maximum rainwater potential. Geo-coding technique has identified 25 potential sites for rooftop rainwater harvesting adjacent to existing pumping stations. It can be safely concluded that rooftop rainwater harvesting potential can replace upto 42% of annual potable water use. It is suggested that a pilot project may be introduced to utilize existing water storage capacity of university for rooftop rainwater harvesting. Precise study for estimation of water demand and supply balance on daily basis is recommended to extend the scope of present research work.

Keywords: Rainwater harvesting; urban area; GIS, Geo-coding

Introduction

Urban development and population growth affects the balance of supply and demand of water. Rainwater harvesting is century old technique but in present world different organizations promote the

research and development in rainwater harvesting technique. According to survey [1] approximately 1.7 M households installed rainwater harvesting systems in Australia. Numerous research and development work were carried out to address the water scarcity issues via adoption of rainwater harvesting techniques. Some studies reported from different countries i.e. Turkey [2], USA [3], Pakistan [4], Iran [5].

Materials and Methods

PMAS Arid Agriculture University Rawalpindi was selected as a research site, which is located in the middle of Rawalpindi and Islamabad. University have almost 11000 total enrollments and more than 950 working employees. ArcGIS software was used to digitize the different features of university. University was categories into different zones on supply based, catchment groups on catchment properties based and subgroups on the basis of water supply, existing water storage tanks and rooftop area. A unique geo-code grouping technique was applied by considering the available storage tanks and water supply network and catchment properties for identification of potential rooftop area for rainwater harvesting. Weibull's Formula for rainfall frequency analysis was used to analyze 20 years' rainfall data. Runoff was estimated using SCS-CN method and rainwater harvesting potential was estimated by multiplying the runoff and potential catchment areas of each group and subgroup. Existing capacity of underground water storage tanks and daily water supply, water supply network and per capita consumption were estimated for each zone, catchment groups and subgroups.

Results and Discussion

Geo-coding techniques was applied and analyzed that university have two zones (Zone-A and Zone – B), four Catchment Groups (CG-I to CG-IV) and sixteen sub groups. Half of the area of university is covered by CG-III, which is almost 50% of total area and CG-I, CG-II & CG-IV covered 27, 20 & 3% respectively. Result showed that CG-I has maximum rainwater harvesting potential 39% annually and other catchment groups CG-II, CG-III and CG-IV contributes 28, 5, 28%, respectively. Maximum potential 49232 m^3 has been estimated for monsoon season due to heavy rainfalls while minimum potential 77 m^3 has been estimated for December due to low rainfall. Further, it has been studied that existing water storage tank capacity of 1331 m^3 is insufficient to store rainwater particularly during monsoon period. Therefore, it has been identified that addition storage of 6065 m^3 is required to ensure the maximum storage of rainwater. It has been observed that average water demand of university is 16930 m^3 per month for offices, labs, classes during working hours (40 hr/week) and residence at student hostel and employees houses. Reduction in groundwater abstraction from deep aquifer will contribute to energy saving and economic return.

Conclusion

It has been concluded that according to university's current water supply scenario, the rainwater harvesting potential of 84131 m^3 can replace approximately about 42 % of potable water needs. Finally, it has been concluded that implementation of RWH system in education sectors and other institutes is suitable technique to deal with water scarcity situation and has potential to store rainwater for non-potable use. Demonstration projects should be undertaken to improve community acceptance and assist in eliminating institutional barriers.

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EXPANDED CLAY INSPIRED GEOPOLYMER BEADS THROUGH MICROWAVE IRRADIATION FOR WATER CONSERVATION PURPOSES

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ABSTRACT

This research presents the geopolymer foams as water-retaining materials for agricultural applications. A range of precursor compositions was identified, which resulted in superior properties and homogenous slurry preparation. High-strength geopolymer foams were attained by slurry curing in a microwave oven. Apparent, bulk, and true densities were evaluated by determining the close, open and total porosities of various cured samples. A few of the compositions resulted in high porosity combined with an adequate compressive strength.

Key words: Geopolymer foam, agricultural applications, compressive strength.

Introduction
Keeping in view that the major source of income of Pakistan is associated with agriculture and globally, it is estimated that 70% of freshwater is bounded to agriculture; such statistics urge the need for efficient water retention systems for crops that also serve to conserve water. Geopolymer beads, therefore, can be revolutionary material in this regard due to their superior water retention properties.
Methodology
Natural soil geopolymer foams were prepared by curing the slurry in a microwave oven that was attained by mixing the precursors in the respective precursor composition. Curing was done twice. Water was added in minute amounts to enhance the plasticity.
Results and Analysis
Geopolymer beads were obtained by mixing the natural soil with varying amounts of the activating agent, sodium silicate. Heating from the microwave forced the silicate groups to react. So the crosslinks increased the viscosity of the prepared slurry. The water solubility test and water retention test exhibited that foams were entirely water insoluble due to alumina silicate linkage and could store water in them as the water was retained in a reasonable ratio.

Conclusions

In this study, geopolymer beads of the natural sand with varying amounts of sodium silicate and sodium bicarbonate were successfully made through microwave irradiation. The geopolymer foams obtained will serve for agricultural purposes due to excellent water retention properties and will be the source to conserve water resources.

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PROMOTING BIOENERGY CROP PRODUCTION THROUGH APPLICATION OF ACETOGENIC POULTRY WASTE-PHOSPHATE BIOPRODUCT

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ABSTRACT

Anaerobic digestion is an effective and multipurpose biological method for treatment of organic waste because it produces numerous value-added products such as bioenergy, organic acids and biofertilizers etc. In the present study, poultry and banana waste were digested to obtain acetogenic digestate from anaerobic co-digestion of poultry waste with banana waste as co-substrate. Experiments were conducted to optimize the acidogenic process of anaerobic digestion of poultry waste using banana waste as co-substrate in varying concentration. Acids rich acidogenic digestate containing 55 % poultry waste and 45 % banana waste was then applied for phosphorus solubilization in rock phosphate to develop a phosphorus-based fertilizer. The results revealed that highest percentage of soluble phosphorus was found in treatment containing 50 % rock phosphate and 50 % anaerobic digestate i.e. 4.92 %. Afterwards, a pot experiment was performed to evaluate the effect of rock phosphate enriched digestate (phosphate-biofertilizer) on growth of maize (*Zea mays*) and compared with commercially prepared single super phosphate. It was found that the phosphate-biofertilizer significantly promote the growth of maize in comparison to the unamended soil and chemical fertilizer. This is due to the more available phosphorus in bio-fertilized soil which improve the growth of the plants. Moreover, poultry litter is rich in organic nitrogen and can be used as organic nitrogen supplement. Overall, it can be concluded that the digestate obtained as a result of anaerobic digestion could be helpful in improving phosphorus solubilization of rock phosphate solving the problem of phosphorus deficiency in agriculture soil.

Key words: acetogenesis, poultry waste, organic acid, phosphorus, biofertilizer

Introduction

Anaerobic digestion is effective and multipurpose biological method for treatment of organic waste because it produces bioenergy, conserves ammonia type fertilizer and produces less sludge (Kumar and Samadder, 2020). It accounts for 27.5 percent of biological organic solid waste treatment processes. Anaerobic digestion is a very good option in dealing with problem of waste management.

Poultry litter is example of that waste that can be used as organic nitrogen supplement (Fabrice et al., 2020) because it is rich in organic nitrogen. But during anaerobic digestion its protein degradation enhances the level of ammonia-nitrogen. Excess of ammonium can hinder the breakdown of organic compounds, volatile fatty acids production and methanogenesis. Other challenges for poultry litter anaerobic digestion are low carbon to nitrogen (C/N) ratio and high level of lingo-cellulosics (Sharma *et al*., 2013).

Co-digestion is the mutual treatment of two or more wastes possessing different characteristics. This combined treatment increases the rate of anaerobic digestion process because nutrients can be provided by co-substrates which may be deficient in case of digestion of only one substrate.

Phosphorous is one of the most important macronutrients for growth and development of plants and plays vital role for crops cellular activities. Plants overcome deficiency of phosphorus by getting it from soil (Behera *et al*., 2014). Most soils contain only 0.05 percent Phosphorus and 0.1 percent of which is available for plants. So for maximum growth of plants great application of fertilizers is required that is usually expensive and a major part of applied soluble phosphorus (P) as fertilizer converts into insoluble P containing products by reacting with soil components. For sustainable growth, utilization of other technologies using cheaper natural plant nutrient sources such as rock phosphate is field of interest. The acids produce during acidogenic state of anaerobic digestion play

very important role in phosphorus solubilization. Rock phosphate is a cheap source to compensate the deficiency of phosphorus in soil. But percentage of soluble phosphorus present in rock phosphate is very low. This can be achieved by using the organic acid produced during the acetogenic stage of anaerobic digestion process. So present study is designed to enhance the fertilizing capability of rock phosphate by applying with acidogenic slurry produced in anaerobic co-digestion process of poultry waste.

Methodology

This study was designed to use the organic waste materials such as fruit waste and poultry waste for production of short chain organic acids through acetogenic anaerobic digestion, thereby, these organic acids were used for phosphorus solubilization of rock phosphate. Experiment 1 was conducted to optimize the acidogenic process of anaerobic digestion of poultry waste using banana waste as co-substrate. Various concentrations of banana waste were applied with poultry waste for anaerobic acetogenic digestion. In second experiment different quantities of rock phosphate were added in the anaerobic acidogenic digestate of treatment containing 55 % poultry waste and 45 % banana waste obtained as a result of experiment 1. 50 ml of water was also added in every treatment to maintain moisture level. Finally, the rock-phosphate digestate was applied to the maize crop. The growth of the maize plants was analyzed by measuring various growth parameters including; shoot and root length, and plant biomass etc.

Results and Analysis

During 1st experiment, a decreasing trend in C/N ratio was observed when percentage of poultry waste was increased in treatments. The best performance was shown by 55% poultry waste digested with 45% banana waste, achieved the most optimized conditions for efficient degradation. After optimizing co-digestion experiment to produce maximum acids solubilization of rock phosphate was done. Results of soluble phosphorus obtained for treatments of experiment 2 showed increasing trend. Increase in percentage of soluble phosphorus was seen at the start of experiment till 4th day of experiment in treatments. After solubilization of rock phosphate, pot experiment was conducted to estimate the effect rock phosphate enriched digestate (RPD) and single super phosphate (SSP) on growth of maize plant. Results of pot experiment exhibited that maximum growth of maize plant is achieved in RPD and SSP in ratio 3:1 having root length and shoot length 17.16 and 45.66 cm respectively. Maximum weights of root and shoot were also found in the same treatment. As this treatment contains maximum amount of rock phosphate enriched digestate. In a study effectiveness of rock phosphate enriched compost was investigated.

Conclusions

Phosphorus (P) deficiency is one of the important issues in most of the soils of Pakistan and phosphorus is the second most necessary element needed for the healthy growth of plant. Use of phosphatic fertilizers is a common practice but these fertilizers when applied on crops immediately form complexes in soil and again become unavailable for plants. The rock phosphate enriched digestate (RPD) obtain can be used as a fertilizer to improve plants growth replacing the expensive fertilizers. This study provides a useful reference for possibility of organic waste management including poultry waste and fruit waste using anaerobic digestion process.

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EVALUATION OF HEAVY METALS IN VARIOUS INDUSTRIAL EFFLUENTS OF FAISALABAD AND RISK ASSESSMENT

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Abstract
Industrial effluents discharge has increased due to rapid urbanization and industrialization. Irrational use of this water due to its cost and free availability for irrigation has caused environmental and health issues. The objective of this study is to evaluate the treated effluents of textile, ghee and chemical industries for major heavy metals (Cd, Cr, Ni, Pb and Fe) content. Effluent samples were collected from the discharge of the three industries located in Faisalabad city. Heavy metals contents were determined through atomic absorption spectrophotometer. The mean comparison in heavy metal concentration showed that the trend of heavy metals in textile effluents was followed as Ni > Cr > Pb > Cd, while in Ghee Mill as Cr > Ni > Cd > Pb. Similarly, in chemical effluent this trend was followed as Ni > Cr > Pb > Cd. The concentration of Cd, Cr and Ni were within the safe limits; however, Pb and Fe were higher than the safe limits in industrial effluents. From our results we conclude that before discharge into a receiving stream, the effluents must be treated one more time with a treatment method that removes Pb and Fe within standard limits else the discharge will pose pollution and health risks to humans as well as soil and water.

Key words: Heavy metals; Industrial effluents; Atomic absorption spectrophotometer; Health risk

Introduction

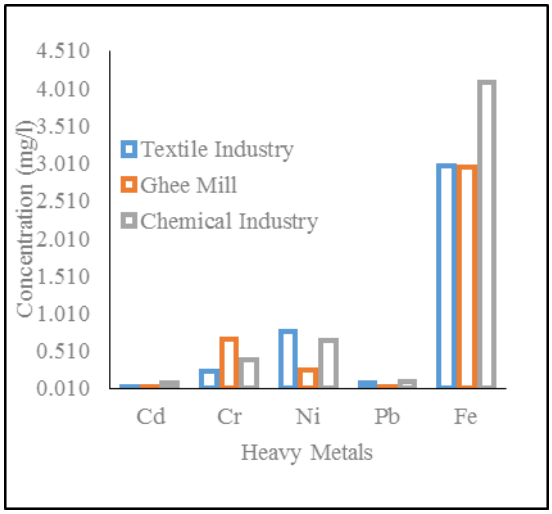
Globally, it has been recognized that water is one of the most important and critical natural resources to sustain life on this earth. The composition of water is continuously disturbing due to natural and anthropogenic activities that ultimately cause environmental pollution [1]. Heavy metals contamination is the most important and widespread environmental issue all over the world. Among all the issues either natural or anthropogenic, entry of toxic elements from industrial water is considered the major source for contamination in a natural reservoir of water [2]. Faisalabad (Lyallpur) is the 3rd largest and well known industrial city of Pakistan and quoted as the Manchester of Pakistan. The farmers consider this water as a cheapest irrigation and richest source of nutrients especially for vegetable fields to compensate for the nutrient requirement of the plant (Govt. Punjab, 2016). Even industrial water is the best alternative source of water but also have a very harmful effect on crop and soil likewise heavy metals pollution with a health concern. Regarding the environmental concern of industrial effluents, a study was designed to analyze the heavy metals in different industrial wastewaters and associated health risks.

Methodology

The current study was carried out to analyze the heavy metals in a different type of industrial effluents samples. For this industrial zone of Faisalabad city was selected and wastewater samples were taken from textile, ghee and chemical industries during March 2020. Three samples were taken from the same industrial wastewater outlet which was treated one time before entry into the main drainage. Water samples were filtered using Whatman Number 40 and analyzed by technique of Flame Atomic Absorption Spectrophotometer. A technique of Flame Atomic Absorption Spectrophotometer with 300 analysts of Atomic Absorption Spectrophotometer using Perkin Elmer was used for quantification of the concentration of heavy metals (Cd, Cr, Pb, Ni and Fe) in industrial wastewater samples following all standard heavy metal protocol. A burner of acetylene with air equipped was used and controlled and read by the computer. For preparation and analysis of the sample, and analytical grade with 99.0 % purity chemicals was used. Each sample was replicated three times and their average was taken.

Results and discussion

It was found that the concentration of Pb and Fe were out of safe limits in all the types of industrial effluents, while the concentration of other heavy metals; Cd, Cr and Ni varied from industry to industry (US-EPA, 1992). The dangerous concentration of Fe was only found in the chemical industry. The highest concentration of Fe was 4.093 mg/l found in chemical industry effluent which was followed by the textile industry and ghee mill. This trend was found similar for Pb, the highest concentration of Pb was 0.105 mg/l in chemical Industry which was followed by the textile industry and ghee mill, 0.084 and 0.029 mg/l respectively. Similarly, the trend for Cd, Cr and Ni was found varied but lower than the permissible limits. The highest concentration of Cd was found 0.086 mg/l in the chemical industry which was followed by ghee mill and textile industry 0.036 and 0.030 respectively but below the permissible limit of 0.1 mg/l. The trend for Cr and Ni was found opposite to Cd, the maximum concentration of 0.667 mg/l was found for Cr and 0.760 mg/l for Ni in ghee mill and textile industry respectively but lower than permissible limit of 1 mg/l. Even these are lower concentrations but long time discharge of industrial effluents into main discharge streams will increase the level of heavy metals and their presence causes water pollution and serious health risks. The overload concentration of Fe can cause a toxic effect on some organs such as skin is a trivial and hemosiderotic harmful effect on other organs as the liver can be affected. Similarly, cumulative Pb toxic effect on multiple parts of body systems and particularly harmful to young children. High uptake of Pb distributed to the brain, liver, kidney and bones. The heavy metals containing wastewater is discharged into the Chenab river as well as directly used by farmers for irrigation purpose. Same time, industrial water can also be mixed with groundwater and heavy metals leached down and caused many kinds of water-borne diseases.



concentrations with critical limits

Table.1. Comparison of heavy metals

Heavy Metals	Cd	Cr	Ni	Pb	Fe
Unit			mg/l		
Critical Limits	0.1	1	1	0.01	2
Textile Industry	0.030	0.241	0.760	0.084	2.979
Ghee Mill	0.036	0.667	0.246	0.029	2.959
Chemical Industry	0.086	0.384	0.640	0.105	4.093

Fig.1. Concentration of heavy metals in different industrial effluents

Conclusion

It is concluded that industrial effluents should be treated to remove the toxic heavy metals before disposal or for irrigation use.

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REDUCING PLASTIC BAGS FROM THE ENVIRONMENT

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ABSTRACT

Key words: *Plastic Bags, Aspect Ratio of Plastic Bags, Workability, Pullout Strength, Compressive, Split, Flexural, Sorptivity, Volume of Permeable Voids.*

Introduction:
Plastic bags are most commonly used in our daily life for different purpose. The consumption of plastic bags is a challenging environment problem. Degradation of plastic bags is very slow, it takes many decades. Similarly, disposal of large quantity of plastic bags may cause pollution of land, air and water bodies.
Methodology:
We incorporated the plastic bags in concrete was to evaluate the mechanical properties of concrete, for example to reduce the cracking to some extent and increase the tensile and flexural strength and deformation capacity while using the plastic bags and comparing the results with control specimen. For this study, total six number of mixtures were used with varying percentage of waste plastic bags
Results and Analysis:
Experimental results showed that by increasing the plastic bags in concrete, flexural and split tensile strength of concrete increased and compressive and pullout strength of concrete were decreased. A 50% decrease in slump results demonstrated that addition of plastic bags up to 1.5% leads to low workability and increased sorptivity.

Conclusion

It could be remarkable to use non-recyclable plastic bags in concrete to overcome the issue of disposal of leftover plastic bags in the environment.

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DESIGN AND DEVELOPMENT OF CASTING PART BY SIMULATION

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ABSTRACT

Solid cast simulation software may be a very robust model supported pc and builds software utilized in the printed industry. Solid cement is formed after analysis and focuses on real-time problems and problems when designing and making solid coatings. Unlike other software engineers from academic backgrounds, the software engineers who develop this Casting Simulation software have real knowledge within the Foundries and within the broadcast industry. In the present study a casting part was developed by using simulation techniques. Solid Cast software was used in this context. Our vision is to create simple patterns with mold, then we will export them to Solid cast software to perform casting simulation. If we are able to learn the method of casting simple parts, then we can apply the same criteria to complex parts.

Key words: Simulation, casting, pattern, solid cast, mold.

Introduction

Solid Edge maybe a portfolio of affordable, easy-to-use software tools that address all aspects of the merchandise development process. Solid Edge combines the speed and ease of direct modeling with flexibility and control of parametric design - made possible by synchronization technology.[1, 2]. Solid cast Cling Simling simulation software may be a very robust model supported pc and builds software utilized in the printed industry. Solid cement is formed after analysis and focuses on real-time problems and problems when designing and making solid coatings. Unlike other software engineers from academic backgrounds, the software engineers who develop this Casting Simulation software have real knowledge within the Foundries and within the broadcast industry. they need been using their knowledge since 1985 to develop SOLID Cast Casting Simulation software and therefore the solid cast product family. Their combined experience in Software and Foundries engineering has made SOLID Cast the foremost effective software within the broadcast industry. Currently, we are working on solid edge 2021 to design our assembly parts such as Pattern
Mold, Riser. Our vision is to create simple patterns with mold, then we will export them to Solid cast software to perform casting simulation. If we are able to learn the method of casting simple parts, then we can apply the same criteria to complex parts. [4-5].

Methodology

Tools We Have used in this work are extrude, revolve, hole round, thin wall square, line, circle, mirror, move, cut, sketch.

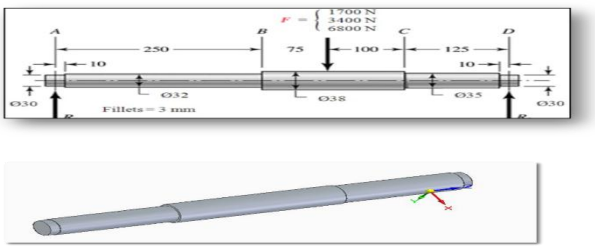

Fig. 1 Design of pattern in 2D and 3D. techniques.

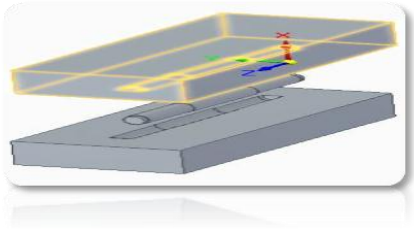

Fig. 2 Design of Mold by simulation

Conclusions

Solid Cast software was used in this context. Our vision is to create simple patterns with mold, then we will export them to Solid cast software to perform casting simulation. If we are able to learn the method of casting simple parts, then we can apply the same criteria to complex parts. [1]. The design and part were successfully developed by using solid cast simulation software. It finds its application in foundry casting. However, it is recommended that the results should be compared with practical work.

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COMPARATIVE THERMAL STUDY OF EXHAUST MANIFOLD OF A DIESEL ENGINE COATED WITH HIGH TEMPERATURE RESISTANT CERAMIC MATERIALS

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ABSTRACT

The aim of this study was to reduce the thermal stresses generated in the conventional cast iron exhaust manifold of diesel engine. Exhaust manifold of diesel engine is exposed to exhaust gases of high temperatures around 450K to 1000K. This continuous exposure to heating produces thermal stresses in manifold which results in blow holes resulting in reduced life of component. To date, many researchers have focused on cooling of exhaust gases and thus investigated the high thermal conductive coatings to facilitate the heat dissipation from material of exhaust manifold to produce low temperature exhaust gas. However, very few have focused on low thermal conductive coatings to save the life of exhaust manifold and the environment. In this study, thermal stress analysis of exhaust manifold was conducted by finite element analysis. Two different temperature resistant ceramic materials named Mullite ($3Al_2O_3.\ 2SiO_2$) and Aluminum Titanate (Al_2O_5Ti) were applied as a coating on the internal side of the exhaust manifold. Analysis was done setting the coating thickness at 200, 300 and 400 microns respectively and compared with conventional uncoated cast iron exhaust manifold. The results indicated that the maximum value of the temperature, heat flux and thermal stresses in general decreases with increase in coating thickness. It has been concluded that Mullite with range of 200 - 300 microns of coating thickness is a suitable ceramic material which reduced the thermal stresses by greater difference as compared to Aluminum Titanate. However, heat flux and temperature reduction on the outer surface of manifold found in this case was not greater when compared to Aluminum Titanate, still this small reduction was beneficial resulting in protection of manifold from corrosion as well and low exhaust gas temperature in this case was also beneficial for environment.

Key words: CFD, Exhaust Manifold, Diesel Engine, Mullite, Aluminum Titanate

Introduction

The exhaust manifold is part of the compression ignition engine and is designed to gather the exhaust gases from the cylinder and transfer it to the exhaust system. Forward into a low-carbon environment, the combustion mechanism in the engine has been strengthened and, as a response, the temperature of the exhaust gas continues to rise [1,2]. Previously, researchers have focused on high thermal conductive coatings for the purpose of heat dissipation to lower the exhaust gas temperature. Recently in 2020, Assi et al. also investigated the opportunities to geometrically improve the exhaust manifold and thus they suggested to add the fins on the exterior surface to reduce surface and exhaust temperature [3]. To reduce cost of this technique, we employed a novel approach to add temperature resistant coatings to already existing component without additional modification to find the solution to protect manifold material and the environment as well. Thus, in the present study, finite element approach was used to thermally analyze the ceramic coated conventional cast iron exhaust manifold of a diesel engine exposed to exhaust gases of high temperature due to continuous exposure to hot flue gases.Temperature resistant coating material should have high melting point, low thermal conductivity and high coefficient of thermal expansion. Mullite is a ceramic material which can be

found in a type of thermally metamorphosed rock called porcellanite [4]. Aluminum Titanate is a synthetic ceramic material usually prepared by reactive sintering of aluminum and titanium powders, forming a solid stoichiometric solution [5].

Methodology

Computational fluid dynamics analysis of exhaust gases was conducted to obtain exhaust gas temperature and heat transfer coefficient profile. These results were then utilized to conduct steady state thermal analysis to obtain the temperature and heat flux profile on coated and uncoated exhaust manifold. This temperature profile was further utilized to conduct structural analysis of exhaust manifold in order to examine produced thermal stresses.

Results and Analysis

As shown in **Fig. 1**, maximum heat flux was found in the case of uncoated exhaust manifold of cast iron while minimum heat flux was found in the case of aluminum titanate with 400 microns of coating thickness. It was also observed that in case of mullite, heat flux value decreases in the range of 200 - 300 microns of coating thickness but just after 300 microns of coating thickness, it goes on increasing. Hence, it was concluded that 300 microns of coating thickness is critical thickness insulation value for mullite. Maximum thermal stresses were found in the case of uncoated exhaust manifold of cast iron while minimum thermal stresses were found in the case of mullite with 300 microns of coating thickness. In case of thermal stresses, same trend for mullite was observed as it was in case of heat flux that thermal stress value decreases in the range of 200 - 300 microns of coating thickness but just after 300 microns of coating thickness, it goes on increasing.

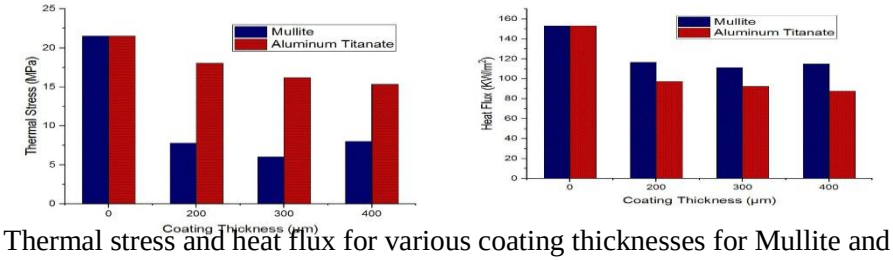

Fig. 1. Thermal stress and heat flux for various coating thicknesses for Mullite and Aluminum Titanate

Conclusions

It has been concluded that mullite with range of 200 - 300 microns of coating thickness is best among other tested coating materials and respective coating thicknesses as it reduces thermal stresses by 64% as compared to non-coated conventional exhaust manifold. However, heat flux and temperature reduction on the outer surface of manifold found in this case was not greater when compared to Aluminum Titanate, still this small reduction is beneficial as low exhaust gas temperature in this case is good for environmental sustainability. We believe this coating will be beneficial for protecting the environment by having a sustainable product development of exhaust manifold in a diesel engine.

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UNDERSTANDING THE INTERACTIONS BETWEEN CARBON NANOTUBES AND EPHEDRINE MOLECULE APPLYING DFT CALCULATIONS AND MD SIMULATIONS

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ABSTRACT

Interactions between frequently used ephedrine (EPH) molecule and carbon nanotube have been studied applying density functional theory (DFT) calculations and molecular dynamics (MD) simulations. The aim of this computational study is to assess whether carbon nanotube might adsorb EPH on the basis of noncovalent interactions, which might be of importance for the removal of this important molecule from water. Another aim of this study was to estimate whether carbon nanotube is sensitive enough, in terms of electronic properties, to the presence of EPH which might be useful for the development of novel methods and devices for its detection. While DFT calculations have been used in order to calculate binding energies and identify the most important noncovalent interactions between interacting structures, the MD simulations were used in order to understand the interactions in the presence of water.

Key words: Molecular detection, Quantum mechanical calculations, Radial distribution functions

Introduction

Properties of the ephedra plant are known for centuries. The most important active component of this plant is called the ephedrine (EPH), which has been used as a medication, stimulant and precursor for the synthesis of illicit drugs. As a medication, EPH is known for its ability to increase blood pressure, because of which it has been applied as a bronchodilator [1]. On the other side, it is also known that EPH is used in treatments of hypotension and influenza [2].

EPH is a substituted amphetamine, which means it possesses stimulant effects [3] and that is the reason why it has been frequently abused. It is important to note that due to its stimulant effects, it has been abused in sports activities, because of which the World Anti-Doping Agency (WADA) has listed it on a list of prohibited substances in sport [4].

However, much more important abuse of ephedrine molecules is related to the production of illicit drugs. Namely, owing to its very close structural similarity with methamphetamine, it has been used as a substitute for recreational drugs, or as a precursor for the synthesis of recreational drugs. Production and distribution of pure EPH are monitored by different authorities, however, the problem is that EPH is used in many "over the counter" medications, so it is available for extraction and usage as a precursor for the synthesis of forbidden substances.

On the other side, since it is available in many, frequently used, medications, it is not strange that it has been detected in tap water [5]. It is also worrying that the ecological toxicity of EPH to aquatic organisms was identified. Because of this, EPH presents a serious threat from an environmental standpoint as well.

Carbon nanotubes (CNT) are well-known representatives of organic nanostructures, and significant attention has been focused on this class of materials as adsorbents of selected molecular species. Good adsorbing properties of CNTs place them in the center of the development of devices that can be used for molecular detection or application as drug delivery systems. In this work, interactions between CNT and EPH molecule have been investigated in detail, to understand whether CNTs can bind EPH

molecule and to check if the presence of EPH in the near vicinity produce a significant response which could be identified by certain devices.

Methodology

A combination of quantum mechanical and classical calculations have been used to gain insight into interactions between CNT and EPH. Quantum mechanical calculations were based on the density functional theory (DFT) calculations, which were used for geometrical optimizations of studied systems and identification and quantification of the noncovalent interactions that formed between CNT and EPH. Binding energies were also calculated by using quantum-mechanical calculations. To take into account the influence of water, MD simulations employing the OPLS3e force field have been utilized. Thanks to calculations of the radial distribution functions, we were able to identify which atoms of the EPH were closest to the CNT in the water medium. Quantum mechanical calculations were performed with the Jaguar program, while MD simulations were performed with the Desmond program, both as incorporated in the Schrödinger Materials Science Suite 2020-4.

Results and Analysis

Systems consisting of CNT + EPH have been successfully optimized using the DFT approach with dispersion corrected functional. Calculated binding energies indicated strong interaction between CNT and EPH, however, the binding energies were not too strong, which indicates that there is a possibility that desorption under reasonable experimental conditions might be achieved as well. Corresponding noncovalent interactions have been analyzed based on the analysis of electron density between selected atoms.

MD simulations have been calculated to understand the evolution of CNT+EPH systems in water surrounding. For these purposes, radial distribution functions were calculated, which indicated the importance of the oxygen atom of the EPH molecule.

The influence of EPH presence in the near vicinity of CNT on its charge transport properties has been investigated through calculations of the I-V curve. For these purposes, two I-V curves have been calculated. The one for the CNT alone and the one for the case when EPH is adsorbed on top of the CNT. The results have been compared and it is shown that the presence of EPH causes significant changes of I-V curves as a consequence of EPH adsorption, in which case the current intensity significantly increases.

Conclusions

Conducted computational study indicates that the CNT might adsorb efficiently EPH molecules based on the noncovalent interactions. MD simulations indicate the importance of oxygen atoms within the EPH molecule. Calculations of I-V curves indicate that the response of the system changes significantly as a consequence of EPH adsorbed on top of the CNT surface, which might be used for the development of devices for the detection of EPH.

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EFFECT OF DIFFERENT PHOSPHOROUS LEVELS ON WHEAT YIELD AND SOIL NITROGEN AVAILABILITY UNDER THE PLASTIC MULCHING

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ABSTRACT

A field trial was conducted to examine the effect of different phosphorus levels on wheat yield and soil nitrogen availability under the plastic mulching. The experimental plots were divided into two categories; one is under the plastic mulch while other has no mulch. Phosphorous fertilizer was applied at four different rates such as @ 0, 60, 80 and 100 kg ha-1. Results indicated that interactive effect of plastic mulching and phosphorous fertilizer at rate of 100 kg ha-1 yielded significant results. Treatments with plastic mulching showed increase in plant height (30.97%), chlorophyll contents (26.26%), grain yield (29.41%) and soil nitrogen availability (53.72%) as compared to treatments with no mulch. It was concluded that application of plastic mulching improved the wheat growth, yield and increased soil nitrogen availability.

Key words: Wheat, Physical Properties, plastic Mulching

Introduction

Soil is basic resource for agriculture crop production and its management performs a critical role in sustainable crop production. Use of fertilizer enhances the crop yield by modifying WUE of soil. Mulching improves the soil physico-chemical properties and environment [1]. It minimizes the soil BD, increases the water inflow rate in soil and distribution of pores of diverse size. Utilization of plastic sheet as mulch enhances the production by modifying use of solar energy and lessening water loss [2]. Soil fertility level can be amended by many ways for example biological nitrogen fixation, maintaining the plant residue cover, use of fertilizer, reutilizing of animal manures [3]. Plastic mulch minimizes the reduction in soil organic matter, increase in N mineralization, decreases N leaching and increases the N availability to plant.

Methodology

An investigation was performed at the Research area, University of Agriculture, Faisalabad during the period of 2019-2020 to pertain the outcome of various phosphorous (P) quantities on wheat production and soil nitrogen availability under the plastic mulching Just earlier the sowing of crop, representative soil samples were occupied from the experimental area in random fashion. To check out different soil characteristics such as soil physico-chemical properties, composite samples were dried in air, pulverized, mixed properly and allowed to filter through 2 mm sieve and examined in laboratory.

Experiment was performed following randomized complete block design by using two factors. Area of each plot was consisted of 12×10=120 sq. ft by length and width respectively. Eight treatments were used in this experiment with three replications. According to treatment plan, four various rates of phosphorous were applied as 0, 60, 80 and 100 kg ha^{-1}. Wheat variety "Galaxy 2013" by using the seed rate 40 kg $acre^{-1}$ on November 25, 2019. Five irrigations were applied to crop with canal water during whole experiment.

Results and Analysis

It was observed that chlorophyll content was higher in those treatments in which phosphorous is applied at higher rate. Application of phosphorous at 0, 60, 80 and 100 kg ha-1 produced the average chlorophyll content of 29.83, 36.83, 40.66 and 45 respectively. Treatment in which mulch was applied showed average chlorophyll reading of 42.50 and 33.66 was recorded in no mulch treatments. Outcome indicated that application of plastic mulching considerably increased the chlorophyll content. In figure 1 and table 1 data relating to chlorophyll content is represented.

Treatments	Chlorophyll (SPAD)	Plant height (cm)	Grain yield (Mg ha^{-1})
P_0M_0	28.0f	45.2f	2.0e
P_1M_0	32.6de	59.6e	2.9cd
P_2M_0	35.0d	72.1d	3.1cd
P_3M_0	39.0c	81.9c	3.4c
P_0M_1	31.6e	56.5e	2.5de
P_1M_1	41.0c	89.0bc	3.0cd
P_2M_1	46.3b	94.8ab	4.2b
P_3M_1	51.0a	98.8a	5.1a
LSD (p 0.05)	2.45	9.6	0.6

Table: Mulching and Phosphorus effect on wheat

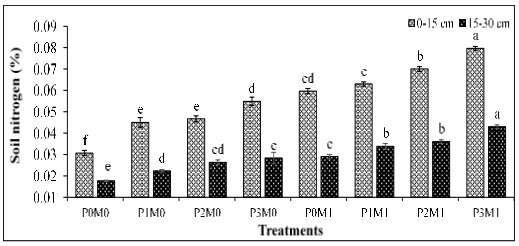

Fig.: Mulching and Phosphorus effect on soil N

Conclusions

Plastic mulching is best technique to modify the soil quality by reducing the bulk density of soil and increasing the WSA. It improved the WUE owing to improvement in water storing ability of soil and modification in solar surface radiation budget. Phosphorous was utilized at four various rate such as at the rate of 0, 60, 80 and 100 kg ha^{-1} before sowing.

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INVESTIGATING SURFACE AND GROUND WATER QUALITY USING HPI MODEL IN VICINITY OF KATHA SAGHIRAL COAL MINES, DISTRICT KHUSHAB PAKISTAN

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ABSTRACT

Water availability and quality are two major environmental concerns faced by developing nations like Pakistan. Safe drinking water is one of the basic necessity of life and important indicator of economic growth. Therefore, current study assessed the quality of surface and ground water in the vicinity of coal mined area.

Key words: Proximity analysis, FAAS, HPI, NEQS

Introduction
The economic development of a country is highly dependent on its industries such as coal mining, but this industry is also contributing to the deterioration of the environment. Coal is an essential energy source which is playing an active role in meeting the energy demands of any state. It has been widely used around the world to generate electricity [1]. There are many adverse effects of exploiting the coal reserves. Water resources are most likely to have detrimental impacts on them from mining activities [2]. Generally, the main source of toxicants such as heavy metals in water from mining operations is mine tailings [3].
Methodology
The concentration of Cd, Ni, Cr, Co, Fe, Pb, Mn, Hg and As were analyzed using Flame Atomic Absorption Spectrophotometer (FAAS) for determination of seasonal fluctuations and a heavy metal pollution index (HPI).
Results and Analysis
The HPI values were below the critical pollution index value of 100. Metal concentrations were higher in the pre-monsoon season as compared to the post-monsoon season. The, Ni, Mn, Cr, Co, and Pb concentrations did not exceed the desirable limits for drinking water in either season. However, at many sites, concentrations of Fe, As, Cd and Hg were above the desirable limit of the WHO and NEQS in both seasons.

Conclusions

These results can be used as a helping tool for the prediction of environmental risks associated with coal mining in Khushab area. Therefore, this study strongly recommends the provision of safety measures, rules, and regulation to avoid health hazards in the future.

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A DETAILED ASSESSMENT OF LAHORE SMOG TO PREVENT ITS RE-OCCURRENCE WITH SPECIAL EMPHASIS OVER THE DISTRIBUTION OF PARTICULATE MATTER

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ABSTRACT

Currently, air pollution is the most concerning environmental problem faced by humans. In the 1990s and 2013, air pollution ranked as the fourth major health risk resulted in 4.8 million deaths of children at their early age. The high concentration of particulate matter, especially the PM2.5, resulted in haze and smog incidents in South and South-Eastern Asia. The high level of particulate matter is because of unchecked emissions from several sources. According to WHO report, the exposure of PM2.5 for an extended period had caused several deaths worldwide, which reached 4.2 million deaths and disability in many people. "State of Global Air 2018" reports that the level of people exposed to air pollution in China has declined slowly. Whereas, in Pakistan, India, and Bangladesh, people face a continual increase in the concentrations of PM2.5 particles in the air since the year 2010. Pakistan is one of the world's polluted countries, with Lahore and Faisalabad occurring in the list of the most polluted cities in the world. Lahore had also gone through a major episode of smog in winter. Due to air pollution, WHO reported that almost 60,000 Pakistanis died from a high fine particulates level. Smog is a major issue in Lahore for the last three years and has appeared as the fifth season in Lahore. This study was conducted to monitor the particulate matter concentration of both PM2.5 and PM10 in Lahore. The questionnaire survey was conducted to know about the sources and impacts of the air pollution-related to smog. We found the average concentration during the smog days was from 600µg/m^3 to 800µg/$m^{3.}$ During post smog days, the average concentration was from 250µg/m^3 to 450µg/m^3. The night concentration was high compared to daytime because the late-night fog was a primary reason for this high concentration. The analysis of the collected air samples can also help us determine the type of pollutants in the air, which could minimize the source's pollutant concentration.

Key words: Smog, Particulate matter, Air pollution

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ECO-FRIENDLY TEMPERATURE SENSOR FOR INDOOR ENVIRONMENT MONITORING

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ABSTRACT

We report graphite-on-paper based fabricated eco-friendly and low-cost interdigitated capacitive temperature for indoor environment monitoring in this work. The sensor was fabricated through direct writing of pencil graphite on a paper-based solvent-free and cleanroom-free fabrication process. Sensors fabricated through low-cost and bio gradable materials which are easily, locally, and readily available like as pencil and paper. The temperature sensor exhibits a negative temperature coefficient of capacitance of -0.35 pf/°C. This approach further expands the development of sensors for green electronics, thereby causing no environmental contamination either in their production or disposal.

Key words: indoor environment, eco-friendly, low-cost, temperature sensor

Introduction

Now a days, people spend up to 87% of their time in indoor environment, whether it be a commercial or residential place and another 6% in their vehicles [1]. Overall, all of us are being continuously exposed to the indoor environment. Therefore, it is of immense importance to fully comprehend the factors affecting indoor environmental quality (IEQ) and their dynamic, interdependent, and complex nature, and their effect on the productivity and health of people. Temperature is one of the essential parameters of comfort in an indoor environment. Indoor temperatures higher or lower than (18-23°C) cause discomfort and affect the performance of humans and machines.

The current typical fabrication techniques for electronic sensors and circuits are complex, environmentally unfriendly, energy-consuming, and expensive. A vital part of the electronics industry is based on printed circuit boards (PCBs) for electrical connections of electronic components. Conventional PCBs are having a significant negative impact on the environment throughout their life cycle. Moreover, PCB manufacturing is known to be a chemical-intensive and energy-intensive industry. It encompasses many materials and chemical processes that are potentially harmful to the environment. The waste disposal and recycling stages of the PCB industry cause potential environmental issues. According to the estimation, annually, 20-50 million tons of waste electrical and electronic equipment (WEEE) is disposed of. An enormous entirety of WEEE is offhandedly collected and reprocessed, especially in developing countries of Asia and Africa [2]. WEEE contains a large number of organic compounds and heavy metals [3]. These constituents can cause severe health and environmental problems if disposed of inappropriately.

Considering the recent interest in green, disposable, and environment-friendly electronics, we reported interdigitated capacitive (IDC) temperature sensors for green and disposable electronics. Facile, ultra-low-cost, non-energy intensive, lab- and solvent-free fabrication techniques such as direct writing (penciling) conductive materials on a paper substrate using solvent-free adhesives are reported. Reported sensor results are repeatable for temperature sensing.

Methodology

IDC sensor fabricated through facile and solvent-free fabrication processes from locally available materials. Standard A4 printer and copier paper with a thickness of around 100 µm were used as a substrate for the capacitive sensor. Sensor designed through Microsoft (MS) Word was printed on paper through a commonly available printer. Commercially available 8B pencil of MONO from the local bookstore with graphite content of 90 ± 2% was used to pencil graphite films on printed IDC sensor on paper. The pencil on paper-based fabricated IDC temperature sensor is shown in Figure 1

Figure 1. Photograph of graphite-based IDC temperature sensor.

The fabrication of the IDC temperature sensor tested for temperature sensors by increasing and decreasing the environment artificially using resistive light bulbs of 200 watts. LM35 sensor is used as a temperature sensor to measure the temperature of the environment. The bulb is used in a transparent acrylic sheet box as a heating source to a consistent increase in temperature inside the box. In the start, the temperature increases exponentially from room temperature and slowly because of room temperature. The capacitance of sensors measured through Arduino UNO and decision could be made based on measured values of capacitance through the Arduino Board to maintain the indoor environment.

Results and Discussion

A nine-finger pair IDC sensor fabricated from 8B pencil is employed as a temperature sensor. The capacitance of sensor was measured for twelve minutes by increasing the room temperature from 20 °C to 40 °C. The increase in temperature was done through high-power resistive light and heat sources, and the increase in temperature was exponential. The temperature of the environment increased exponentially as it increases initially drastically, and then a higher increase in temperature take time and go up slowly. As the temperature increase is exponential, so the decrease in capacitance was exponential because of the negative temperature coefficient of capacitance. Figure 2 shows the decrement in sensor's capacitance over time with increase in temperature. The decrease in capacitance of sensor with an increase in temperature indicating the semiconductor nature of graphite.

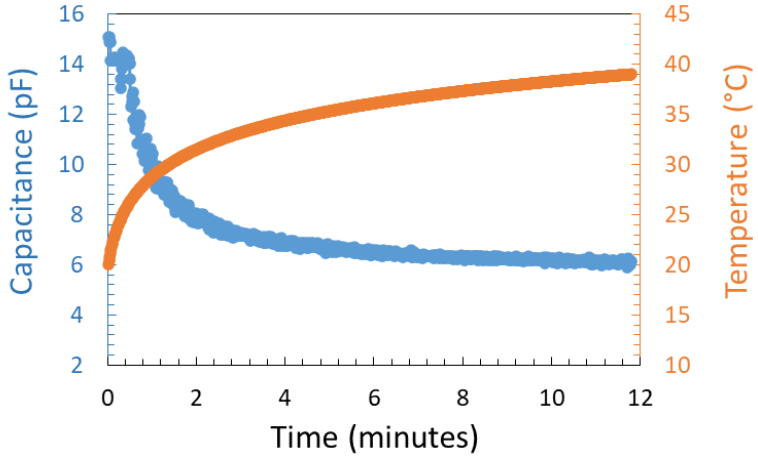

Figure 2. Capacitance of IDC sensor as a function of temperature.

Conclusion

Graphite and paper are used here to implement electronic IDC sensors for temperature sensing of the indoor environment. The sensor was fabricated through the facile fabrication of graphite on paper. The decrease in sensors capacitance with increase in temperature is distinguishable. This offers a low-cost and eco-friendly fabrication of sensors for inexpensive and green electronics.

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GSCM PRACTICES AND GREEN INNOVATION: A WAY TO IMPROVE ENVIRONMENTAL SUSTAINABILITY AND CORPORATE FINANCIAL PERFORMANCE

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ABSTRACT

Key words: *green supply chain management, green innovation, environmental sustainability, financial performance, globalization, green products*

Introduction
Environmental challenges such as rising temperatures, ozone layer reductions, climate change, acidification of the oceans are a product of globalization. Such drastic changes highlighted the importance of environmentally sustainable policies and their alarming importance, which raised demand for green innovation goods and put pressure on businesses to fulfill their environmental corporate social responsibilities. Despite massive globalization, the implementation of green supply chain management has played a vital role in achieving the best outcomes. Although much has not been studied about green innovation in literature, its optimal execution results in augmented practices in the area. This study advocates the idea of sustainable goods, by investigating the impact of GSCM and Green innovation practices on corporate environmental performance and increased profitability. GSCM is an emergent approach to resolve environmental issues and to decrease harmful ecological conditions, as well as to balance the competitive environment. GSCM is an emerging solution for addressing environmental challenges and reducing the harms to the ecosystem as well as ameliorating the climatic conditions.
Methodology
A questionnaire was conducted to gather data of 413 employees of renowned GSCM firms in Pakistan. Partial Least Square model (PLS-SEM) based approach tested the viability of suggested structural model. Workers from renowned institutions provided useful data particularly from National Federation of Environment and Health. Gender, marital status, education, age, and job tenure were used as control group variables to prevent any partiality. The items of questionnaire were measured on a scale of 1 to 5(strongly disagree to agree).
Results and Analysis
GSCM and Green Innovation practices had an efficacious impact on environmental sustainability which in turn amplified firm financial performance. The research adds to the GSCM literature by offering an environmental approach to the management ramifications of increased financial results.

Conclusions

This study will assist the regulatory authorities, policymakers, government, managers, and suppliers to improve. The findings show that both companies will benefit from GSCM activities and green innovation, leading not only to environmental sustainability but also to financial success. This research helps to generate green products for the industry. This research is essential to innovate in the supply chain and to provide insight into green technologies that can lead to radical changes.

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RECOVERY OF CARBON FIBERS FROM END-OF-LIFE CARBON FIBER REINFORCED COMPOSITE WASTES THROUGH A TWO STEPS PYROLYSIS PROCESS

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ABSTRACT:

It is estimated that by 2025 aviation industry would generate 170,000 tonnes of end-of-life carbon fiber reinforced composite wastes (CFRC). The high cost of producing fibers and the environmental associated with their disposal are forced to find better ways for waste reduction, reuse and recycling in a circular economy. To address this research challenge, a better way could be to recover the fiber and re-apply which would results in favourable combination of environmental and economic advantages. As per author information, this is first study which aims to investigate the mildest possible pyrolysis process conditions to recover a clean fiber using a simple reactor. Pyrolysis temperatures ranging from 350 to 450 °C and residence times up to 30 min have been in a investigated and for the post-pyrolysis step temperatures from 400 to 500 °C and residence times for 30 min have been considered. The decomposition behaviour of powdered CFRP is investigated in both nitrogen and air atmosphere using thermogravimetric analysis (TGA). Optical and SEM pictures are shown to demonstrate the morphology of the recovered fibers.
The TGA results showed a decomposition of epoxy above 250 °C and a residual mass of 70%. Pyrolysis test in a N2 atmosphere in a tunnel oven showed that a minimum pyrolysis temperature of 425 °C is required and that the temperature in an air atmosphere should be at 475 °C for 15 minutes to recover the clean fibers.

Keywords: Recovery; Carbon fibers; Epoxy; end-of-life; composites; pyrolysis

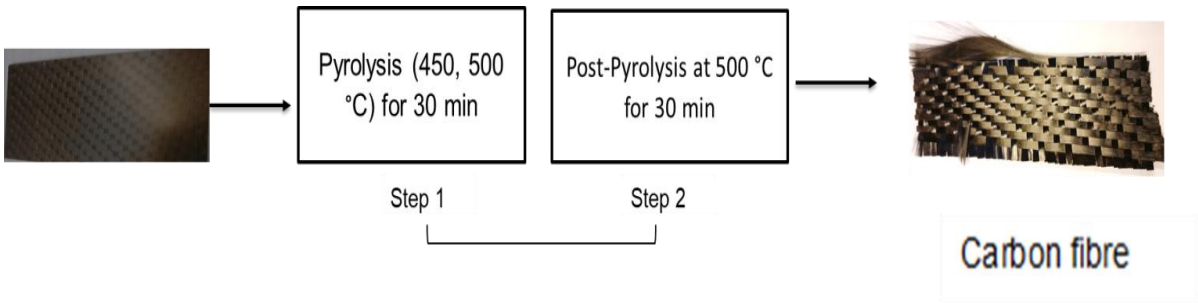

Figure 1: Scheme of recovery of carbon fiber using batch pyrolysis process

PRODUCTION OF BIO-METHANE FROM TEXTILE SLUDGE WITH BUFFALO DUNG THROUGH ANAEROBIC CO-DIGESTION USING SAMPTS (SEMI AUTOMATED METHANE POTENTIAL TEST SYSTEM)

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ABSTRACT

In Asia, Pakistan is the 8th largest exporter of textile products. Textile sludge contains heavy metals like Cu, Ni, Hg, and Zn these elements have severe effects on humans and environment. Anaerobic digestion is multi stage process that comprises of Hydrolysis, acidogenesis, acetogenesis and methanogenesis steps. Different ratios were run on BMP (bio methane potential), from textile sludge that is mixed with buffalo dung 100/0, 80/20, 60/40, 40/60, 20/80, 0/100. The ratio of blank sludge has 45.7 ml/ g VS, 80/20 has 49.2 ml/g VS, 60/40 has 58.7 ml/g VS, 40/60 has 25.4 ml/g VS, 20/80 has 82.5 ml/g VS and blank dung has 76.6 NM/L. The optimum ratio of textile sludge and cow dung that has maximum methane yield is 60/40.

Key words: *Textile sludge, anaerobic digestion, Methane Generation*

Introduction

Globally, due to urbanization and economic growth the demand for textile product is increasing continuously. There are so many problems which is being faced by textile industry [1]. Textile waste water has severe effects in increasing the water pollution. With this waste water ample quantity of textile sludge is discharged, which affect the Eco life system and creates environmental pollution but also causing soil and ground water contamination[2]. Anaerobic digestion is an effective method for obtaining bioenergy in the form of methane from organic wastes [3]. Conventional method of raw biogas comprises of 60% CH_4 and 40% CO_2, water vapor and produces certain amount of hydrogen sulfide [4]

Methodology

Sample of sludge was collected from textile industry Nooriabad. While the buffalo dung was collected from buffalo yard located in Qasimabad, Hyderabad. . The samples textile sludge and cow dung were characterized into elemental and proximate analysis. In pilot scale lab of USPCAS-W cow dung and textile sludge were mixed at different ratios and run on lab instrument known as SAMPTS as shown in figure 1 to see the maximum methane yield. The nitrogen was purged in these ratios to create anaerobic conditions. The readings were recorded on a daily basis.

Figure 1 Semi-Automatic Methane Potential Test System (SAMPTS)

Results and Analysis:

The elemental analysis of textile sludge and cow dung were done by SGS Pakistan private limited Karachi as shown below in table 1. Whereas the Moisture content, total solids, volatile solids and ash content of textile sludge and cow dung were analyzed in Micro wave oven located in water lab USPCAS-W MUET Jamshoro. *Table 1 Ultimate analysis*

Parameters	**Textile sludge**	Cow dung
Carbon	24.52%	36.83%
Nitrogen	1.85 %	2.02%

Oxygen	26.79%	39.95%
Sulphur	1.09%	0.91%
Hydrogen	4.96%	3.99%

l

Table 2 Proximate analysis[2]

Parameter	Textile sludge	Cow dung
Moisture content	96.33%	82.21 %
Total solids	3.66%	17.78 %
Volatile solids	73.33%	83.35%
Ash content	26.66%	16.64%

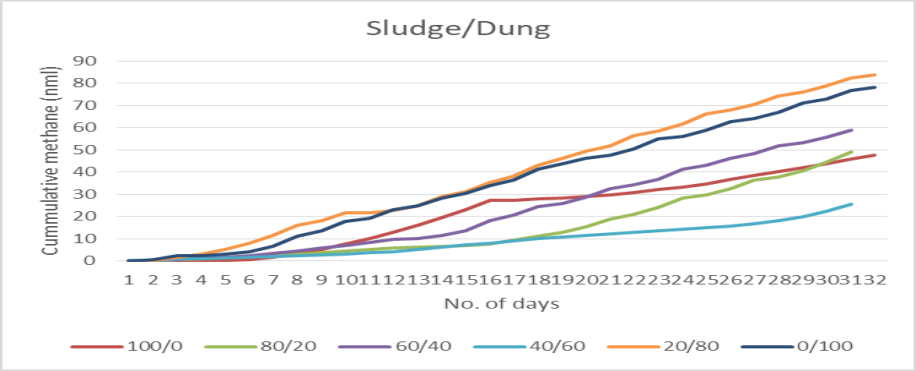

Figure 2 Graphs of Cumulative methane

The figure 2 shows the different ratios cumulative methane generation including blanks of textile sludge and buffalo dung.

Conclusions

Treatment of textile sludge and cow dung by anaerobic co-digestion not only yield maximum methane but also their by product that is bio fertilizer would be used as a compost. Six ratios were made that includes blank dung and sludge. Whereas ratio of 60/40 textile sludge and dung have optimum methane yield.

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OPTIMIZATION OF RATIO OF FOOD WASTE AND BUFFALO DUNG IN ANAEROBIC DIGESTION FOR BIOGAS PRODUCTION

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Abstract
In this study, food waste was mixed at different ratios with buffalo dung in six Bio methane potential (BMP) reactors, each having a different ratio. The aim of the study was to find the ratio of food waste to buffalo dung (FW: BD), at which cumulative methane production will be optimum. The mixture was anaerobically digested for 35 days and the volume of biogas was found for each ratio. The ratio; FW: CD, at which the highest cumulative volume of biogas was formed was 2:3. Inoculum used for all the ratios was 15% and a temperature of 37^0C was maintained throughout the experiment. Carbon to nitrogen (C/N) ratio for the study was 30:1. The electric motors of the stirrers in the reactors were given 60 rotations per minute (rpm).
Key words: *Anaerobic digestion, Bio methane potential, Inoculum*

Introduction

About 1.3 billion tons of the food waste is wasted annually, which is one third of the total global food production [i]. In Pakistan, an estimate of 40% which becomes 36 million tons of FW is wasted annually [ii]. Excess generation of food waste can be a cause of emission of greenhouse gases (GHGs) which impacts the environment negatively. Food waste can be utilized and digested anaerobically to produce biogas. The biogas produced, produces less greenhouse gases than fossil fuels and there is less contribution to greenhouse gas emissions (GHGs) [iii]

Food waste, when used as only substrate for anaerobic digestion, is not effective for biogas production because of production of fatty acids and low PH. It can be used with buffalo dung to regulate the pH. In order to make the mixed substrate affective for food waste of any area, its optimum ratio has to be found [iv]

Methodology

Food waste was collected from department canteen of US-Pakistan Centre for Advanced Studies in Water (USPCASW) and grinded to the particle size of 0.4 mm. Food waste was mixed with buffalo dung and 15% inoculum in each reactor. Six BMP reactors were set up and run for 35 days, each at different ratio. Ratios for FW: BD were: 1:0, 4:1, 3:2, 2:3, 1:4, and 0:1. Volume of each reactor was 400 ml. Reactors were filled till 200 ml having a ratio of 1:1 of water to substrate. A temperature of 37^0C was maintained. Substrates were stirred at 60 rpm throughout. Following were the proximate analysis results for the substrate chosen.

Table 1. Proximate properties of substrate

Properties	**FW**	**CD**
TS	16%	18 %
VS	10%	6.4%
SCOD	980 mg/l	1500 mg/l
pH	6.04	7.12

Results and Analysis

Figure.1 shows the results for gas produced for all the 6 ratios.

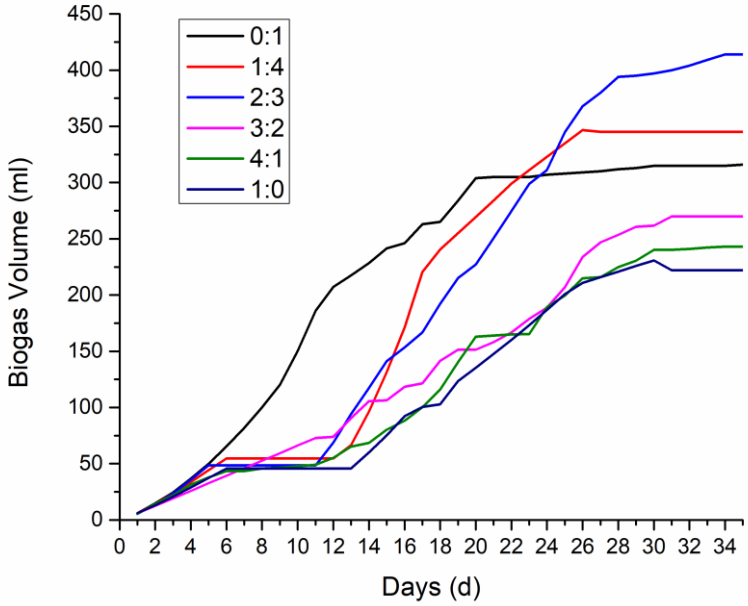

Figure 1. Results for biogas produced at different ratios in BMP reactors

Minimum cumulative gas was produced at the ratio: 1:0 which was 222 mL and maximum was produced at 2:3 which was 414 mL. The reason of less gas production at 1:0 was because of lowered PH due to presence of 100% food waste. The more the food waste the more VFAs are inhibited and the more is the chance of lowering of pH. At 2:3 pH fluctuations were rare and the cumulative biogas produced was in highest volume.

Conclusion

Only food waste substrates lower the pH, which leads to inhibition of biogas production. We will need to regulate the pH frequently, if used at a higher scale. Food waste can be used in 40% volume with buffalo dung in order to optimize the production.

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ASSESSMENT OF BIOMASS TO HYDROGEN ENERGY POTENTIAL IN PAKISTAN UTILIZING THE PRODUCT SPACE MODEL

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ABSTRACT
This study aims to assess optimum hydrogen production pathways from various biomass sources. Product space model will be utilized for this purpose. Hydrogen is regarded as clean fuel for the future. For Pakistan, one of the promising sources for hydrogen production is biomass, which is widely available, clean and renewable. Environmental friendly and economically feasible pathway mixes will be optimized, for biomass to hydrogen conversion, such as pyrolysis and gasification. The estimated Biomass potential of Pakistan is 50,000 GW h/year (Farooqui, 2014).
Key words: *Hydrogen energy, Biomass, Product space model*

Introduction
Currently, Pakistan is facing serious energy crisis that is hindering economic development. Also the current energy mix of Pakistan is highly dependent on fossil fuel resources. Regarding the global warming situation, we need to develop more and more renewable energy resources which are environmental friendly. Biomass is a clean and renewable energy source which is widely available in Pakistan. Various biomass sources are available in Pakistan such as agricultural residue, municipal solid waste, agro-industrial residue and animal manure. Biomass Agriculture is the second largest sector of Pakistan's economy. The estimated agricultural residue was calculated to be 81 million tons per annum (Ghafoor *et al.*, 2016). Other than that, urban areas of Pakistan produce more than 64,000 tons of municipal solid waste daily (Aziz, 2013), the major portion of which consists of organic waste.
Methodology
Literature review will be carried out from online sources. Data will be collected from waste management sources and agriculture department. Data will be entered in Product space model. Optimum feedstock mixes and best optimal pathways for biomass to hydrogen conversion will be determined.

Conclusion
The results of this study will act as a baseline to formulate policies and action plans in the country for hydrogen-based energy technologies. This will also reduce the burden on waste management facilities in Pakistan. The dependence on fossil fuels for energy generation will also decrease with significant reductions in the greenhouse gas emissions and global warming.

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ANALYSIS OF POWER CONSUMPTION FOR THE DRYING OF VARIOUS CLASSES OF PAKISTANI LIGNITE COAL

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Abstract
Coal has been considered as a cheap source of electricity and it adds around 41 % in the total electricity production of the world. It has been proved that coal has maximum potential for the production of electricity in future, but, emissions of greenhouse gases such as carbon dioxide are major obstacles during power generation from coal. Integrated gasification combined cycle (IGCC) technology has ability to utilize low-quality fuels with reduced emissions. Slurry feed and dry feed are two important technologies of an IGCC system. It has been proved that low rank or high moisture coals are more capable with dry feed gasifiers. Pakistan can benefit from dry feed technology of IGCC to cope with its energy requirement by utilizing available reserves of low-quality lignite coal. Drying of the high moisture coal to make it able to be processed in dry feed gasifier is an important step. In this study, power consumption during the drying of the average, high and very high moisture Pakistani coals has been studied.
Key words: *Dry feed, IGCC, low-quality coal, energy*

Introduction

The fast industrial growth and improved living standards has led to an ever-increasing world energy demand, especially electric power. Fossil fuels are still considered for power generation by many developing countries. Coal is still considered a cheap and major source of electricity generation, and has huge potential in future [1]. However, emissions of harmful greenhouse gases (GHGs) from coal combustion, such as CO_2 are of major concern. Pakistan has huge reserves of low-quality coal, estimated up to 175 billion tonnes, located in the Thar Desert of Sindh. Other lignite coal reserves are present in in Lakhra, Sonda, Indus East coalfields in Sindh [2].

Environmental pollution is a big challenge in power generation using coal. Advanced power generation technologies are important to be considered which can help mitigate the effect of emissions to the environment. Integrated gasification combined cycle (IGCC) technology has ability to utilize low-quality fuels with reduced emissions. Slurry feed and dry feed are two important technologies employed in IGCC power generation system. It has been proved that low-quality or high moisture coals are more capable with dry feed gasifiers [3].

IGCC Power plants consume a lot of energy e.g. compression of air, nitrogen and oxygen in ASU, CO_2 compression, acid gas removal section etc. are major contributor in auxiliary power consumption. Drying of the wet coal is also important to be considered if dry feed technology of IGCC system has to be used. Lowering the energy consumption of IGCC plant is one essential key to increase the overall efficiency of the IGCC plant.

Superheating steam heating (commonly known as WTA) technology for coal drying is an important consideration to enhance the overall efficiency of the plant [4]. In this study, the WTA fluidized bed has been simulated in Aspen Plus® to estimate the feasibility of the local coal in power generation. Total power consumption analysis on coals of various moisture levels has been performed.

Methodology

The model is developed in Aspen Plus® for drying process of IGCC system. WTA, which utilizes superheated steam drying process by vapor recompression technology has been considered. The WTA dryer has been simulated using RStoic and Flash2 blocks in Aspen Plus®. Latent heat exchange from superheated steam to coal in dryer, and preheating of the coal using sensible heat of the condensate have been simulated using heater blocks. The calculator block has been used to control the moisture level in the downstream coal. The SOLIDS physical property method has been used to model drying reaction in RStoic and Flash2. Upstream milling up to 100 micrometer has been performed in separate hierarchy block. Locally available Thar coal with moisture level of up to 50% has been considered for predicting the feasibility of indigenous resources by performing power consumption analysis for the drying of coal. The coal is dried from 35-50% moisture content down to 12% moisture for the different classes of coal. Power consumption for the drying of coal, entering at the rate of 407.02 ton/hr has been estimated, using a validated model [5].

Results and Analysis

Results for three Pakistani coals, Thar Lignite A (TL-A) with 35% moisture, Thar Lignite B (TL-B) with 44.92% moisture and Thar lignite C (TL-C) with 50.24% moisture have been presented in Fig. 1. All coals have been dried up to 12% moisture level using superheated steam. Power consumption during vapor compression for TL-A to achieve the target was 11.806 MW_e, for TL-B the consumed power was 16.898 MW_e and for TL-C up to 19.634 MW_e electrical power was consumed during drying. An IGCC power plant of up to 500 MW_{net} capacity based on low-quality coals, consumes approx. 200 MW_e auxiliary power [5]. Drying process consumes up to 19 MW_e, if flow rate of 407.02 ton/hr of lignite coal is considered, as seen in Fig. 1. The assumed flow of coal is sufficient for the IGCC plant of capacity up to 500 $MW_{e, net}$. This study provides a guideline for decision makers for the feasibility studies of Pakistani coal for power generation. Power consumption for the ND lignite in Fig. 1, is presented for comparison purpose [5].

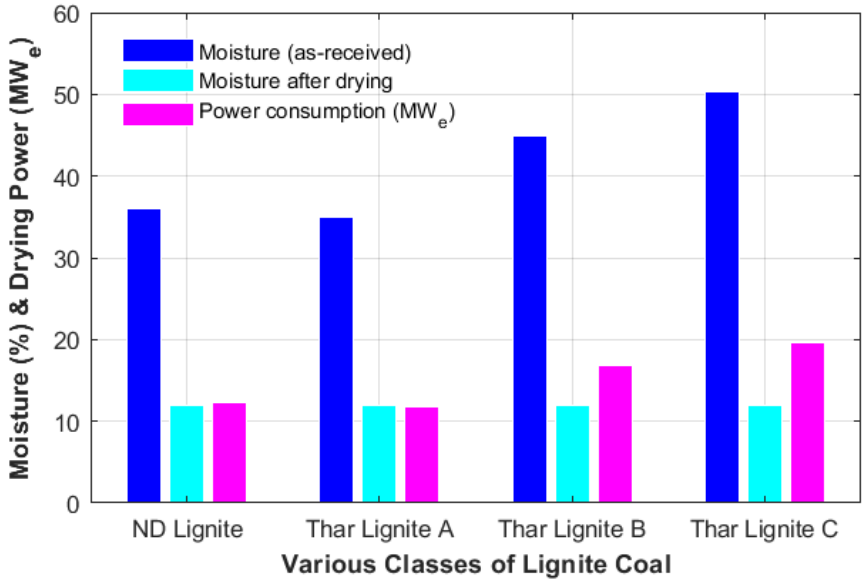

Fig. 1. Power consumption for the drying of the different classes of Thar lignite coal

Conclusions

Three Pakistani lignite coals have been used for the estimation of power consumption in drying. Power consumption increased with the moisture contents to be separated. Less than 19 MW_e power was required for drying the coal such that it could be used in dry feed gasifier of an IGCC system.

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MODELING AND RECYCLING OF ABLUTION WATER WITH FILTRATION TECHNOLOGY AT DATA SHIRINE LAHORE

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Abstract:
Pakistan is at the seventh position in the list of countries, which are facing water crisis. Presently, Pakistan has 145-million-acre feet supply of water and only save 13.7 MAF. Surface water of Pakistan is 153 MAF and underground water resources of only 24 MAF. It is expected that Pakistan will face the water shortage of 33 MAF during the year, 2025. There are nearly 30,000 mosques in Lahore city. Muslims offers five times Prayer in mosque and spends up to 3.5-to-5-liter water per ablution. We are going to do our research on Data Darbar water system. Daily wastage water in Darbar is 100000 Liters if we recycle all this water on daily basis, we save up to 1212 millions litter of water and utilize this recycled water for other purposes. WEAP is used as modeling tool for forecasting.
Key words: Water Modeling, Forecasting, Data Shrine Lahore, WEAP

Introduction:
Water is the premise of life and it is our obligation to spare water and create water assets. Bathing is an obligatory strict everyday practice for Muslims that is rehashed a few times day by day for supplications and different deeds. Bathing activities ordinarily incorporate washing of hands, face, mouth, nose, arms, cleaning on head, ears and feet. In bathing process, the tap is normally left running; much good water is squandered simultaneously. It very well may be said that regarding half of the faucet water streams straightforwardly to the channel with no sullying. At present, Muslims consume more water in their ablutions and previous studies showed different evaluations of the average amount of ablution water used. We measured the amount of water used in ablution in Data Darbar. The shrine remains open at all hours, and welcomes visitors who freely enter the complex. The shrine is visited by approximately 30,000 to 60,000 visitors on a daily basis. Thought the number can double on religious holidays, and on Thursday. Data Darbar with a seating capacity of over 1500 people. According to our estimated we can retrieve 100,000 liter of ablution water from Data Darbar. Water gracefully in Punjab expending 72%. Even following a time of its development, the Punjab Aab-e-Pak Authority – which is liable for guaranteeing the arrangement of clean water over the territory has stayed broken. 1850 billion liters Agriculture is the biggest utilization of water and expending practically 95.3 MAF [1]. The projections for 2025, as expressed in the Draft Punjab Water Policy, show the mechanical water use will be 2.44 million section of land feet, which speaks to an expansion of 0.94 MAF or 1160 million-cubic-meters/annum [2]. The common water request and gracefully standpoint and future strategy structure have been depicted in the Draft Punjab Water Policy, which is resting with the common place government for endorsement for last longer than a year. The postponement in sanctioning commonplace water strategy has somewhat been accused on non-selection of national water strategy at government level [3].

ANALYTICAL STUDY ON RESIDENTS PERCEPTION CONCERNING ADAPTATION OF GREEN ROOFS: CASE STUDY OF METROPOLITAN LAHORE, PAKISTAN

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Abstract
Meteoric pace of urbanization coupled with industrialization are wreaking havoc on environment in developing countries. Growing economies are facing multifaceted problems like dramatic increase in motorized traffic, urban sprawl, smog, urban heat island and other climatic changes. Environmental Performance Index report states that Pakistan is ranked on 169th number among 180 countries due to ill planned development on prime agriculture land, poor air, water quality and resultantly jeopardizing ecosystem of the country. The change of land-uses from the natural to the built environment have created problems like loss of vegetation and habitat, enlarged surface flow and heavy flood to solve the issue this research has assessed the willingness and perception of residents of Lahore city for the adaptation of green roofs technology. The resident perception has been obtained by a structured questionnaire and analyzed by regression tests. The findings of the research highlight that adaptation of green roof is primarily linked with the four factors i.e., awareness of green roof among all stakeholders, special provision in building regulation concerning green roof, people are willing to adapt green roof because it promotes sustainable and healthy activities in the society and subsidized cost of green roof materials.
Key words: *Urbanisation, Adaptation, Green roofs, Lahore,*

Introduction

The world is experiencing perilous time concerning environmentally friendly infrastructure, technologies and building materials, which reduce the harmful impacts of contemporary patterns of urban development [1]. Meteoric pace of urbanization and industrialization has wreaked havoc on global ecology and the world is suffering from the several social, economic and environmental problems [2]. The prime accelerators of urban heat island are multifaceted such as massive deforestation, lack of green areas, proliferation of urban infrastructure on rich agriculture land, industrial emissions, traffic emissions and increasing demand for air conditioning caused exorbitant emissions of anthropogenic heat [3].

As a corollary to that, the international researchers have introduced the idea of green roofs for the mitigation of the negative environmental consequences such as air pollution, urban heat island, noise pollution and it also reduce run off. Green roofs or green walls and facades have emerged as innovative technique to add green substructure to a town and its surroundings as they can be comprised on new-fangled structures or retrofitted onto existing old buildings, and require little, if any, space at crushed and ground level. Green roofs can be fitted in an extensive range of structures that include industrial, educational, offices, other commercial and residential areas [4]. Green roof is the living system that contains the ecosystem of vegetation that contain lightweight soil and vegetation that are self-sustain. It is alive in the biological prospective as it gives the protection to the building from the elements that exists naturally like wind, sun, rain, and storms, its pabulum itself [5].

Idea of urban green roofs is now emerging as one of the sustainable solutions for the betterment of the environmental quality, reduce the ambient temperature of cities and resultantly it promotes green urban development. Moreover, green roofs absorb CO2 emissions, act as supplement to urban

biodiversity, improve urban aesthetics and impart cooling effect in urban ecology. Lack of green spaces in urban areas may lead to numerous undesirable consequences for instance, increased urban heat island effect, decline in urban biodiversity, and rise in pluvial run-off as well as flash flooding. Furthermore, there is fewer recreational spaces for citizens to enjoy and relax. This absence of recreational spaces disconnects residents from nature which can be harmful to human psychological and physical health. This research study focusses on finding the perception, expectations and willingness of residents regarding rooftops as well as to examine the attitude of people in participating in green roofs development and the barriers they are facing. Designing and planning of green rooftops can be made if urban planners and policy makers are aware of resident's perception regarding it as, they could set up mandatory planning approvals or can offer grants or subsidies for urban green space development.

Methodology

Primary data is collected from the all established built up and newly developed zones and towns of Lahore District. The study applied simple random sampling technique to obtain opinion from 400 respondent regarding the installation of green rooftops to make Lahore a sustainable and livable city for all.

Case Study

According to 2017 Population and Housing Census Metropolitan City Lahore has emerged as 2nd largest city on global landscape with population of 11,126,285. unprecedented pace of urbanization coupled with ill planned development has deteriorated the urban environment of the Lahore City. Therefore, Lahore City is selected as case study to analyze the resident's perception concerning adaptation of green roofs.

Sample Size

Slovin's Formula is used for the calculation of sample size

Population of Lahore District = 11,126,285

By using Slovin's Equation:

$$n = N / (1 + Ne2)$$

Here, "n" represents the sample size or number of respondents included in survey study and "N" shows the "Total population" of case study area i.e. Lahore District and "e" is the margin of error. Researchers have used a confidence level of 95% for a better accuracy, which will give a margin error of 0.05.

$$e = 100\ \% - 95\ \% = 5\% = 0.05$$

$$n = 11{,}126{,}285 / 1 + 11{,}126{,}285\ (0.05)2$$

$$= 11{,}126{,}285/27815.713$$

$$= 399.99 \approx 400$$

Results and Analysis

Perception and Willingness

Considering the perception of people about roof gardens is an approach which is well-grounded in the line of research of urban planning, environmental consciousness and city design that truly assist the development of a city where individual wish to reside.

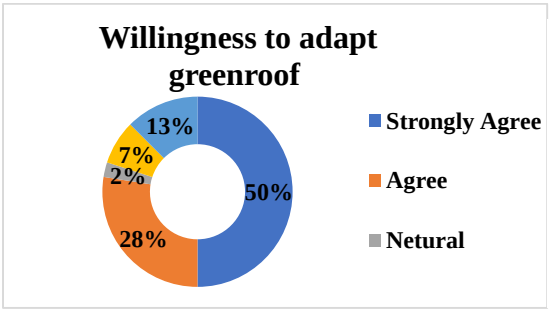

Figure 2

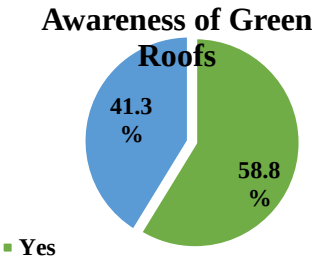

Figure 3

The word 'perception' in general means how something is 'seen'. It also reflects attitude, likings, intentions, and preferences to space. Researchers after conducting surveys anticipated that 58% of people are aware of roof gardens at home and 41% were unaware of it. Whereas, researchers obtained results shown in figure 2 represents that 50% of the populations want to have green roofs.

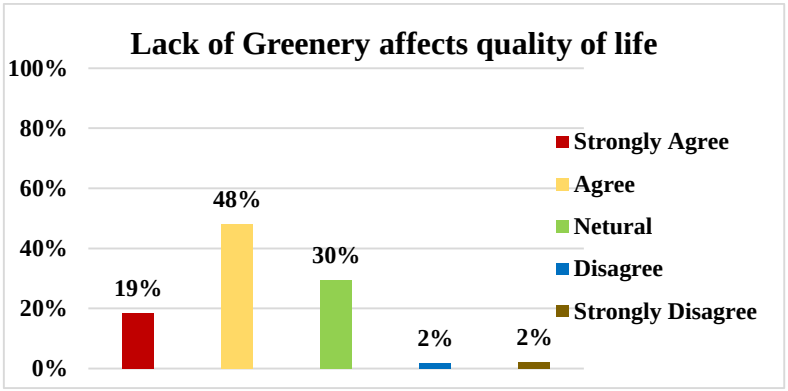

Figure 4

Inhabitants are the strongest feature of open places. They usually select the places that assure the utmost benefits to them. Residents were asked about their opinion that whether gardens promote quality of life, from which 48% people responded that they completely agree.

Conclusions

Pakistan being rapidly urbanizing and environmentally stressed country should adopt green roofs to reduce the environmental pollution in metropolitan cities of Pakistan. The findings of the research suggested that residents are willing to adapt green roof technology considering that development authorities will facilitate them by relax budling byelaws and provision of subsidies on green roof materials. Strong coordination among development authorities and participatory policy planning on adaptation of green roofs can help to make Lahore City more livable and sustainable.

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STUDY AND ANALYSIS OF DECARBURIZATION POTENTIAL, ECONOMIC ANALYSIS AND SUSTAINABLE POLICY OF THE POWER GENERATION SECTOR OF PAKISTAN USING LEAP

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ABSTRACT

Pakistan has a wide-ranging gap in energy supply and demand. Correct measurement is required to establish a forecast that helps in establishment of solid policy and framework for future work in energy sector. Keeping the global warming under strict control and considering it as major threat we need to shift the energy generation towards clean energy resources as soon as possible. Pakistan should move as quick pace for shifting its energy production from fossil fuels to clean and renewable energy that needs US $211millions for increase in supply of electricity per capita. This study is done for the analysis of decarburization potential of Pakistan energy sector to increase the clean energy input in line and reduce CO2 emissions. Two different scenarios are considered in this analysis based on the results a conclusion has drawn in cross examination of the scenarios best suitable for mass application at national scale. To make Pakistan greenhouse gas free nation at global scale decarburization of energy is inevitable. While analyzing carefully it is suggested that Pakistan has correct and up to the scale potential of decarburization of energy at 23% per annum gradually till 2035 with 12 million US Dollars cost involved overall.

Key words: LEAP Energy Analysis, Energy Estimation, Energy Policy

Introduction

It is now a fact that more the fossil fuels are burnt, more is the production of Greenhouse Gasses (GHG) in environment and warmer the globe will be [1]. Due to increase in global temperature, a very adverse effect has been seen in recent past that severely hit global climate [2]. The current global condition demands decreasing the burning percentage of fossil fuels and focus towards renewable energy sources to cater the declining climate conditions [3]. Moreover, in the coming decades, a major reduction in GHG emissions will be required in order to limit the global mean temperature increase to 20^{o}C [3].

Along with its Vision 2025, Pakistan has given its determination onward the sustainable development with commitment to the matter of change of global climate in the national level energy strategies [4]. As a result, Pakistan faced criticism by the other signatories and in the media on submission of IDNC without any concrete pledge (detailed roadmap) to mitigate or cap the GHG emissions [5].

This research provides a sustained solution for electricity problems and helps for long term projection in demand and supply of electricity keeping in view the GHG emission reduction from energy sector [6]. The reported electricity supply growth rate from 2006-16 was 2.1% only. Pakistan need more capital to create supply resources, poor infrastructure and delayed in policy implementation is the basic reason of slow growth in supply side [7]. In 2016 the electricity demand supply gap was 31.6 TWh annually which lead to 2.5% decrease in GDP and more than 0.5 million unemployment in industrialized sector [8].

Conclusions

The Pakistan LEAP model was developed undercurrent study for the period 2016-2035 to meet the electricity demand in the country. Initially the BAS scenario was calibrated for year 2016 and

alternative scenarios namely,450 and green Pakistan scenarios to reduce the CO2 emission gradually in the end year, Green Pakistan is totally emission free.

Business as Usual scenario shows a variety of energy-mix but is the emissions rates as high ranges from 155.8 MMtCO2 equivalents in 2016 to 319.2 MMtCO2 equivalents in 2035 with a generation of 335,546 GWh by the year 2035. Its capital cost ranging from 55 to 211.5 Million US$ during the study period.

450 scenarios is based on IEA guidelines in which share of electricity generation from non hydel renewables is 25%. The 450 scenario ensures 25 to 34 % cap on the CO2 emissions steadily by the year 2035. The major share of CO2 emission during the study period 2016-2035 is from the fossil fuel-based electricity generation. Cost of this scenario is 5.6% higher than BAS but through this modeling we can achieve Pak-INDC (Pakistan's Intended Nationally Determined Contribution) goal to limit the global mean temperature to 20C.

It clearly concludes that we should reschedule our policies. We should minimize our dependence on oil and find new means of energy which will be sustainable and environmentally friendly. Electricity generation by oil must be changed by renewable and biofuels must be promoted for all other sectors. Pakistan has abundant coal reserves but its share in energy mix of the country is very small however this share must be increased after functioning of coal-based electricity generation capacity.

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SYNTHESIS AND CHARACTERIZATION OF $SRZRO_3$ MODIFIED $BIFEO_3$-$BATIO_3$ LEAD-FREE PIEZOCERAMICS

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Abstract

The current research work is about the synthesis and structural and electrical characterization of a new class of piezoelectric ceramics. Eco-friendly lead-free $SrZrO_3$ modified $BiFeO_3$-$BaTiO_3$ (BFBT-SZ) piezoceramics is synthesized by Solid State Reaction method. This is the most widely used and effective method for the fabrication of lead-free piezoceramics where different ceramics powders are mixed in a stoichiometric proportion to get a desired product.

Keywords: Piezoceramics; Quench Treatment; Energy storage, Relaxor ceramics

Introduction

Sustainable materials and processes with environmentally friendly nature are the current research drive in functional ceramics. Large number of Pb free piezoelectric ceramics are discovered and are of great importance for the researchers which draw enough attention to the modern researchers because of its applications and scientific importance. Potentially modern ceramics are used in electronic devices e.g. nanogenerators, phase shifters, capacitors, piezo sensors etc [1-5].

Methodology

Binary solid solution of lead-free bismuth ferrite barium titanate ceramics was synthesized by a conventional solid-state method. An extensive high energy ball milling process was used to obtain the submicron or nanometre range of ceramics particles. All samples were analyzed by X-ray diffraction (XRD), Fourier transform infrared spectrometer (FT-IR), field emission scanning electron microscopy (FE-SEM), and impedance spectroscopy (IS) employed to study crystal structural, bond nature, microstructure, and electrical properties, respectively.

Results and Analysis

XRD results confirmed the formation of a stable solid solution in pure composition with tetragonal symmetry while the addition of SZ shows tetragonal to pseudocubic transformation. Absorption peaks in FT-IR spectra confirmed the presence of phases.

Conclusions

SEM study revealed that addition of SZ content improved densification with the evolution of coarse grains. High-temperature impedance studies suggested that both grain and grain boundaries contribute to the impedance of sintered solid solutions while the addition of SZ results in the change defects at grain boundaries.

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SYNTHESIS AND CHARACTERIZATION OF BI-BASED PIEZOELECTRIC NANOGENERATOR FOR ENERGY HARVESTING APPLICATION

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Abstract

Binary solid solution of Lead-free Bismuth Ferrite Barium Titanate ($0.67BiFe_2O_3$-$0.33BaTiO_3$) ceramics were synthesized by a conventional solid-state method. An extensive high energy ball milling process was used to obtain the submicron or nanometer range of ceramics particles. To obtain flexible piezoelectric nanogenerator (PNG), nanoparticles were dispersed in silicon-based organic polymer, polydimethylsiloxane (PDMS) with xylene and curing agent. Polarization of BF-BT nanoparticles dispersed in PDMS assisted to align its nanodomains and generate electric response signals upon mechanical load.

Key words; Piezoelectric Nanogenerator; Sensors; Actuators; PDMS; Energy Harvesting

Introduction

Piezoelectricity is the ability in certain crystalline materials to develop an electric charge from a mechanical stress, or vice versa [1]. Based on the unique properties, piezoelectric materials have been utilized to fabricate various types of electronic devices, including piezoelectric sensors, piezoelectric actuators, piezoelectric transducers, and so on [2]. The piezoelectric devices have found a wide range of applications from consumer products to scientific equipment [3-5].

Methodology

BF-BT powder was prepared by weighting it on weight balance. Then it was ball milled for 4 h in ball milling at 200rpm.Then after drying and calcination we got a BF-BT powder for solution making.10g PDMS and little quantity of xylene is added for to make it thin then we add a powder slightly 1g. Then we make film of 150 micron on film applicator.

Results and Analysis

SEM image shows BNT particles. Moreover, particle size distribution also has been determined and the average particle size is around 500 nm. Piezoelectric nanogenerator generates voltage by the application of pressure. Oscilloscope can be used to show this voltage generation. The graph represents voltage verses time in which voltage oscillate with time.

Conclusions

It can be concluded that BF-BT nanoparticles manufactured using solid state method are perovskite in structure. Oscilloscope results show that 10% BF-BT and 90% PDMS give the optimum output voltage. It is demonstrated that the output power from the PNG can directly drive the light-emitting diode (LED) and charge capacitor by tapping PNG, electric charges stored in capacitor and 2 LEDs blink when circuit is closed.

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REMOVAL OF ARSENIC BY TEA BAG MODEL USING FERRIC-COATED CHITOSAN

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ABSTRACT
Arsenic contamination in water is a major problem around the word. It is well known that consumption of arsenic contaminated groundwater leads to chronic health effects. World Health Organization (WHO) provisional guideline value for arsenic in drinking water is 10 μg/l. There are various treatment techniques for removal of arsenic from water, such as adsorption, filtration, ion exchange and membrane process, reverse osmosis, phytoremediation, chemical precipitation, electrokinetic methods, and electrocoagulation. Among these, adsorption is an effective and versatile method due to the low cost, effectiveness, and simplicity. Chitosan is a cationic polysaccharide with an excellent adsorption capacity to adsorb the arsenic. In this study ferric coated chitosan was synthesized and used as an adsorbent in tea bags for the batch study. In this paper these different parameters were studied to investigate the effect of the arsenic removal percentage such as contact time (15,30,60,120) in minutes, initial arsenic concentration (50,100,150,200) in ppb, and adsorbent dose (0.25,0.5,0.75,1.0) in grams. The optimized parameters at which maximum arsenic was removed (98%) from water at contact time 60 minutes, adsorbent dose 0.25 g, initial arsenic concentration 50ppb.
Key words: Adsorption, Arsenic removal, Batch study, Fe-Coated Chitosan, Tea Bag

Introduction
Arsenic, commonly available substance in nature, is considerably toxic and one that causes cancer. Keeping the hazards associated with the arsenic that is found in shallow water zones, it is considered as a predicament worldwide. Quite unsurprisingly, the water obtained from shallower subsurface structures in many Asian countries, is full of Arsenic and is widely used for Industrial, commercial, domestic as well as drinking purposes. The common concentrations of Arsenic in various parts of the Asian continent, particularly India, Pakistan, China, Bangladesh, Egypt, Nepal, Philippines & Indonesia, is more than 50 ppb [1,2]. The use of water with such a high level of contamination happens to be responsible for diseases like cancer in the bladder, kidney, skin and even lungs [3]. To cope up with this issue related to this excessively high concentration of Arsenic in water, the World Health Organization (WHO) and United States Environmental Protection Agency (USEPA), have set forth the maximum standards values of 10 ppb for drinking water purposes [4].
There have been scores of several methods employed for the purification of water and removal of Arsenic, adsorption, coagulation, co-precipitation, ion-exchange and oxidation-reduction process, but the specialties associated with adsorption process when it comes to removal of arsenic have made this process the most viable one [5].
In this research fe-coated chitosan is synthesized to increase its removal efficiency of arsenic and used in tea bags to study the adsorption of arsenic and batch study were carried out.

Materials and Methods
Preparation of ferric solution
Ferric solution was prepared by taking 0.5406 g of ferric chloride hexahydrate in ethanol and distilled water in the ratio of 1:1 respectively and stirred well.
Coating of ferric to chitosan material
Fe-coated chitosan was prepared by initially pouring 10 g of chitosan in 100 ml of ferric solution. The solution was mixed at magnetic stirrer 300 rpm for 2 h. Adsorbent was filtered and dried in muffle furnace at 90oC for 3 h. Fe-coated chitosan was ready.
Tea bag model containing fe-coated chitosan
Different grams of adsorbent in tea bags were added. The Tea bags model containing fe-coated chitosan are dipped in arsenic contaminated water, and shaked well.

Batch studies of Tea bag model contained adsorbent

Tea bag model containing fe-coated chitosan has been developed and used to remove the arsenic contaminants from water. Batch study was carried out to investigate the effect of contact time, adsorbent dose, & arsenic initial concentration.

Results and Analysis

Batch study of tea bag model containing adsorbent

Effect of contact time

Effect of contact time shown in figure 3.6, the adsorption rate of arsenic was observed & to find the optimum time. Other paraments were kept constant such as adsorbent dose 0.25 grams, pH 7, Initial Concentration of arsenic 50 ppb & shaking speed 150 rpm. It was observed that at 60 minutes contact time maximum arsenic was removed which was 98% with an increased in contact time the adsorption rate decreased.

. **Figure 3.5** Effect of contact time

Effect of adsorbent dose

To see adsorbent dose effect on removing of arsenic is shown in figure 3.7

. The Adsorbent dosage were varied from 0.25 to 1.0 grams. Other parameters were kept constant such as arsenic initial concentration 50ppb, contact 60 minutes, pH 7, and shaking speed 150rpm.The optimized adsorbent dose was 0.25grams at which maximum (98%) arsenic was removed. By increasing the adsorbent dose arsenic removal % was decreased.

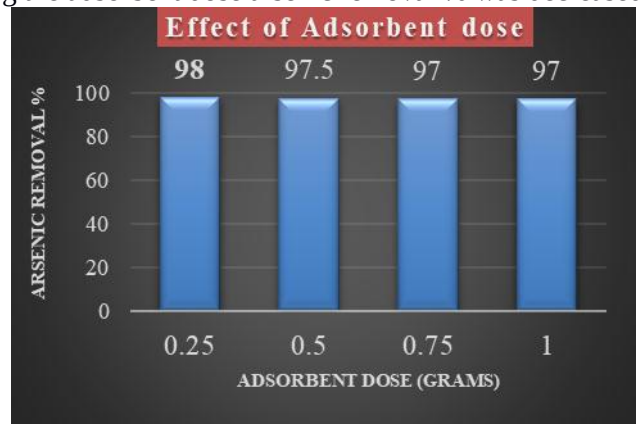

Fig 3.7: Adsorbent dose effect

Effect of arsenic concentration

In order to see the effect of arsenic, the concentration of arsenic was varied from 50ppb to 200ppb. Other parameters were kept constant such as adsorbent dose 0.25grams, time of contact 60 minutes, pH 7, and shaking speed 150rpm. It was observed that maximum arsenic was removed 98% at initial arsenic concertation 50ppb.By increasing the arsenic concentration adsorption of arsenic was decreased.

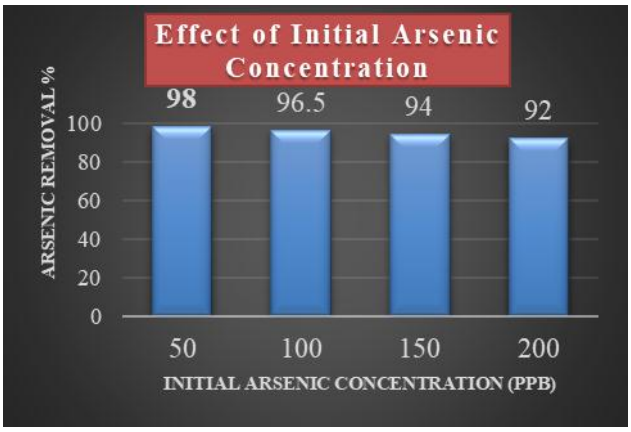

Fig 3.9: Effect of initial arsenic concentration

Conclusion

Adsorption of arsenic was investigated by using fe-coated chitosan Tea bag model. The batch study of the adsorbent was carried out for finding the effectiveness of the adsorbent.

Following parameters were optimized in this research, time of contact, adsorbent dose, and initial arsenic concentration.

- In the batch study by fixing the other optimized parameters constant and varying the contact time. From this research it can be concluded that at 60 minutes, maximum percentage i.e. 98% of arsenic contaminants was removed. With an increase in contact time, the removal efficiency of adsorbent was decreased. So, the optimized contact time was 60 minutes.
- In the batch study by fixing the other optimized parameters constant and varying the adsorbent dose. After performing tests, it is concluded that the maximum percentage of arsenic (98%) was removed at 0.25 grams. It was also noticed that by increasing the adsorbent dose, the removal efficiency of adsorbent was decreased. So, the optimized adsorbent dose value was at 0.25 g.
- In the batch study by fixing the other optimized parameters constant and varying the initial arsenic concentration. It was seen that 98% of arsenic removal was at 50 ppb. With an increase in initial arsenic concentration, the removal efficiency of adsorbent was decreased. So, the optimized initial arsenic concentration value was at 50 ppb.

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