Refuse Derived Fuel To Electricity

T.Ganesh[#], P.Vignesh[*]

[#]*Mechanical Department, Kingston Engineering College, Vellore.*

**Mechanical Department, Kingston Engineering College, Vellore.*

#ganeshhr555@gmail.com

**pvigneshv1@gmail.com*

***Abstract*— If we focused on solid waste management (SWM) the waste produced was collected and dump in dump yard which causes many environmental pollutions and health hazards. In solid waste management land filling is a major problem. Many difficulties arise while extending the land for land filling. In order to overcome those problems Refuse-Derived Fuel (RDF) is one of the best options. Refuse-Derive Fuel is obtain from municipal waste and it is one of the alternative fuels. It is the process of converting waste into useful energy. By doing so the problem with solid waste management get reduces and RDF can be substituted for coal in boilers. This paper deals about the manufacturing and application of RDF in India.**

***Keywords*— Refuse Derived Fuel (RDF), Solid Waste Management (SWM), Alternative fuel.**

I. INTRODUCTION

Solid Waste Management is collection of waste which is generated by every person in the society. Mainly the solid waste consists of Household waste, Industrial waste, Agricultural waste and Bio Medical waste. Those wastes consist of biodegradable waste, recyclable waste, inert waste, electrical and electronic waste, composite waste, hazardous waste and toxic waste. Those wastes must be properly disposed in dump yards. When the wastes are dumped in dumping yard causes much health hazardous and environmental pollution. The health hazardous is spreading various diseases like Malaria. And also polluting land, water bodies and atmosphere. In order to overcome those problem wastes can be converted into useful work. To convert waste into energy one of the best solutions is **Refuse-Derived Fuel (RDF)**. Refuse-Derived Fuel is an alternative fuel which is obtained from Municipal solid waste. It is a Renewable form of energy and we can able to replace coal by RDF in boilers. By replacing this we can able to eliminate problems like ash handling, flue gas emission and air pollution which is associated with fossil fuels.

II. MANUFACTURING PROCESS

Municipal solid waste (MSW) is processed through five important steps for manufacturing Refused Derived Fuel. The major steps involve preliminary liberation, size screening, shredding, magnetic separation and Pelletizing.

A. Preliminary Liberation:

Preliminary liberation involves separating the municipal waste into Bio-degradable, Glass, Rags, Paper, Plastic, Leather and Rubber, Metals and other domestic hazardous, Inert. Form those to manufacture RFD the main particles involves Bio-degradable, Paper, Plastic, Leather and Rubber.

B. Size Screening:

Size screening involves separating the municipal waste based on the size and shape of the particle. It helps in material handling comfortably.

C. Shredding:

Shredding involves the process of destructing the large amount of solid waste into smaller pieces by crushing and cutting. The process converts the larger particles of municipal waste into smaller particles for easy handling and transporting.

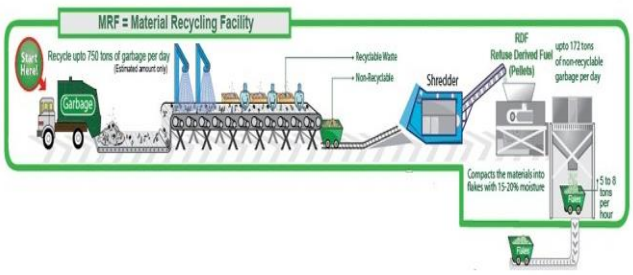
D. Magnetic Separation:

Magnetic separation is a process in which magnetically susceptible material is extracted from a mixture using a magnetic force. This process is useful in separating the metal particles from the crushed particles. Because metal particles are not suite for RDF.

E. Pelletizing:

After magnetic separation the RDF particles are added with binders such as calcium hydroxide and then it is mixed thoroughly. Then it is converted into pellets into required size and shapes normally 30mm capsules. A refuse derived fuel (RDF) pellet having about 11% or more particulate calcium hydroxide which is utilized in a combustion able mixture. The pellets are used in a particulate fuel bring a mixture of 10% or more, on a heat equivalent basis, of the RDF pellet which contains calcium hydroxide as a binder, with 50% or more, on a heat equivalent basis, of a sulphur containing coal. Combustion of the mixture is effective to produce an effluent gas from the combustion zone having a reduced SO.sub.2 and polycyclic aromatic hydrocarbon content of effluent gas from similar combustion materials not containing the calcium hydroxide.

F. Overall review of manufacturing of RDF:



The above diagram shows the production of RDF from Municipal waste. The process involves collection of garbage and put it on material recycling conveyor where recyclable

waste and non recyclable waste are getting seperated. The non recyclable waste are collected by trommel and putting into shredding machine where the waste is crushed and cutted into small pieces. Then the pieces are putting into pelletizing machine along with calcium hydroxide as binder then it is converted into pellets of RDF. It is estimated that 750 ton of municipal waste is collected per day and putting into the machine gives upto 120 – 192 ton of RDF per day in the ratio of 5:1.

III. CHARACTERISTICS OF RDF PELLETS

TABLE 1

Size	dia 8/20/30 mm, length 8-40 mm
Calorific value	4000 Kcal / Kg (minimum)
Bulk density	0.7 MT per cu.m.
Density	1.3 gm per cc. (minimum)
Ash content	< 15%
Moisture	10% (approx.)

TABLE 2
PROXOMATE ANALYSIS OF RDF PELLETS

Moisture	3.00% - 8.00%
Ash content	12.00% - 20.00%
Volatile matter	50.00% - 65.00%
Fixed carbon	12.00% - 18.00%

TABLE 3
ULTIMATE ANALYSIS OF RDF PELLETS

Moisture	3.0 - 0% - 8.00%
Mineral matter	15.00% - 25.00%
Carbon	35.00% - 40.0%
Hydrogen	5.00% - 8.00%
Nitrogen	1.00% - 1.50%
Sulphur	0.20% - 0.50%
Oxygen	25.00% - 30.00%

TABLE 4
GROSS CALORIFIC VALUE

With binder	4000 – 45000 Kcal/Kg
Without binder	3500 – 3700 Kcal/Kg

IV. COMPARISON BETWEEN RDF AND OTHER FUELS

A. RDF vs Coal:

TABLE 5
COMPARISON OF RDF vs. COAL

Fuel/Factor	**Coal**	**RDF**
Calorific Value (Kcal/Kg)	4000	3500-3700
Equivalent Ton in calorific value	1	1.14
Cost per Ton in Rs.	6000	2000
Sulphur content (weight %)	0.4	0.2-0.5
Moisture content (weight %)	39	10
Ash content (weight %)	4.2	<15
Nox content (weight %)	1.2	1-1.5
Carbon (weight %)	31.4	35-40
Oxygen (weight %)	7.4	25-30
Hydrogen (weight %)	4.3	5-8

Above are the comparison values between coal and RDF. In India generally for production of electricity Thermal based power plants are employed. In all power plants coal is the essential fuel for burning to convert water into super saturated steam. While using coals in power plants there are many problems are associated with it namely ash handling, flue gas emission causes air pollution. The major problem is coal which is fossil fuel. By seeing the above table it is clear that sulphur content in RDF is lesser than the content in coal. Hence RDF is not polluting the environment more. And also cost of RDF for one ton is only about Rs.2000 but coal is about Rs. 6000. Hence it is cheaper than coal. The moisture content in RDF is much lesser than coal so that the calorific value is much more improved than coal.

B. RDF vs Fire Wood:

TABLE 6
COMPARISON OF RDF vs. FIRE WOOD

Fuel/Factor	**Fire wood**	**RDF**
Calorific Value (Kcal/Kg)	4000	3500-3700
Equivalent Ton in calorific value	1	1
Cost per Ton in Rs.	16500	2000
Sulphur content (weight %)	0.01	0.2-0.5
Moisture content (weight %)	10-20	10
Ash content (weight %)	24.5-26	<15
Nox content (weight %)	0.75	1-1.5
Carbon (weight %)	3.2	35-40
Oxygen (weight %)	-	25-30
Hydrogen (weight %)	-	5-8

For rice mills and other industries requiring hot fire for drying purpose use fire wood for burning. While burning of fire wood causes ash and flue gases emission which leads to global warming and air pollution. Ash handling is one of the difficult job which pollutes the land and water bodies etc. Burning of fire wood leads to deformation. Deformation leads to global warming, failure of seasonal rainfall, climatic changes, soil erosion and reduced underground water level, etc. And the major advantage of RDF over firewood is cost. The cost of RDF for one ton is only Rs. 2000 but the cost of Fire wood is about Rs.16500.

C. RDF vs. Furnace oil:

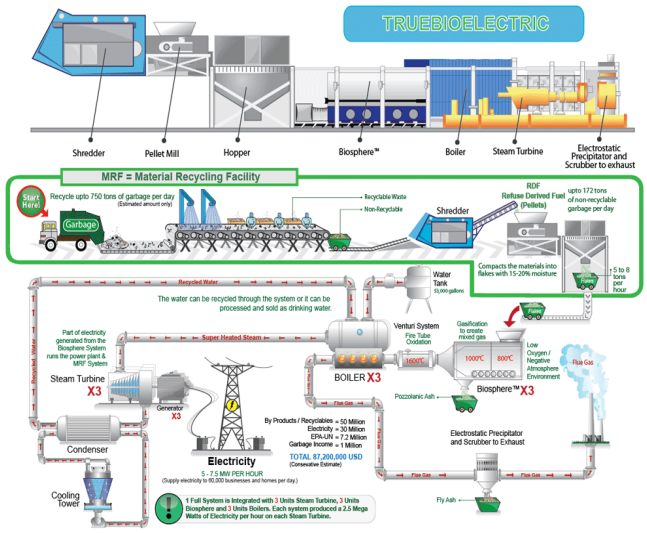
TABLE 7
COMPARISON OF RDF vs. FURNACE OIL

Fuel/Factor	**Furnace oil**	**RDF**
Calorific Value (Kcal/Kg)	10000	3500-3700
Equivalent Ton in calorific value	1	1.14
Cost per Ton in Rs.	44000	2000
Sulphur content (weight %)	4.0	0.2-0.5
Moisture content (weight %)	1.0	10
Ash content (weight %)	0.1	<15
Nox content (weight %)	0.1	1-1.5
Carbon (weight %)	8-30	35-40
Oxygen (weight %)	5-20	25-30
Hydrogen (weight %)	0.1	5-8

Furnace oil is mainly used in power plant furnaces. The firing of furnace oil gives clean combustion but the cost is very much higher than other fossil fuels. The cost of one ton of furnace oil is about Rs.44000 but one ton of RDF is about only Rs.2000 which is very much lesser than furnace oil and

profitable. But the firing of RDF produces ash and flue gas emission in smaller amount.

V. PRODUCTION OF ELECTRICITY THROUGH RDF



In India electricity is generated by thermal power plants by maximum. In Thermal power plants for generating steam they use coal. As stated above the burning of coal causes many environmental effects. While burning coal the ash formation and ash handling is very much difficult and also they emit flue gases which cause air pollution. There are many advantages in replacing coal by RDF. By manufacturing RDF from Municipal waste the land filling problem is minimized and also the disease spreading in drastically reduced. It is a renewable forms of energy so the availability of RDF anytime. The process of generating electricity from waste is converting Municipal waste into RDF and then it is replace to coal in boilers of thermal power plant. When the RDF is burn in boiler in form of gas it produces temperature of 1600°c. After by pulverized ash is formed which is utilized for making cements in cement industries. The heat is utilized for converting the steam into super heated steam and then it is expanded in the turbine. The turbine is coupled with generator to produce electricity. Then the flue gas is passed towards electrostatic precipitator to separate the fly ash then the flue gas is allowed to atmosphere. For 750 Tons of garbage waste 192 Tons of RDF is generated. With that RDF we able to generate up to 7.5MW of electricity output.

VI. APPLICATION OF RDF IN INDIA AND ABROAD

RDF has many applications in India as well as in abroad. By using RDF we can able to generate electricity, RDF can be use instead of coal in boilers of power plants, RDF is used in boilers instead of fire wood and RDF is used in boilers instead of furnace oil. RDF also used in cement industries for heating purpose of limestone. 5MW power plant is installed in Lucknow which uses RDF as fuel. SELCO industries which are one of the power generators installed 7MW power plant in Hyderabad. RDF plant in Rajkot handles about 300Tones of MSW per day. RDF plant in Mumbai also produces RDF from 80 tons of MSW. AAPL infrastructure private limited has invested about 25 cores for setting up RDF plant in Thirunelveli of Tamil nadu. As per Vellore District is considered there are about 120MT of solid waste is generated per day. With that we can able to generate 30MT of RDF per day and able to generate electricity of about 2.5MW of electricity per day. And recently in Arcot they adopt self-sufficient scheme of producing electricity of 265 to 285 units per day by running 30kV generator to produce electricity from municipal solid waste. It can able to light up to 100-150 street lights in Arcot.

VII. ADVANTAGE

The main advantage of RDF is conversion of waste into energy which helps in effective handling of Municipal Waste. The other advantage includes the problem associated with Solid Waste Management and Fossil fuels are eliminated. RDF is one of the alternative and renewable resources of fuel which is derived from municipal waste. Production and utilization of RDF leads to green environment.

VIII. CONCLUSION

RDF is considered as one of the green fuel and leads to green environment. It resolves both problem exist with Municipal waste and energy requirement.

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