# FAILURE ANALYSIS OF TAPER DIE OF BIOMASS BRIQUETTING MACHINE: A REVIEW

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## ABSTRACT

The present review provides brief information about the various types of biomass briquetting machine. [1] This technology also helps to reduce cost and production time, and improve Productivity, and eventually lead to be able to survive in competitive environments. [2] Experimental investigation of common reeds (Phragmites australis) particles compacting in closed die had been realized by laboratory hydraulic press equipment. By eliminating individual machines, the great savings in space, material handling and worker, and the improved efficiency can be realized. This paper review the various concepts

of biomass briquetting machine. The renewable energy technologies were selected for promotion within the programme : photovoltaics, renewable energy-based drying and biomass briquetting/ briquette-fired stoves. This paper gives brief review about the biomass briquetting machine, taper die and hydraulic press which is a part of briquette machine with the help of CAD/CAM technology.

***Keywords****: Biomass Briquetting Machine, productivity, taper die*

## 1. INTRODUCTION

The briquette is an alternate source of energy. In Biomass Briquetting Plant, A Taper Die or sleeve is used. it is a device to extract the finish biomass product through it. The briquetting press is a reciprocal crank type mechanical press with flywheel. One flywheel is driven by the main motor through continuous flat belt. Forced lubrication oil circulating system guaranties a long service life. The ground material is fed through a hopper by means of a screw conveyer with its own geared motor. The vertical screw pre compresses and forces the material downwards in to the feeding chamber. From the chamber the materials forced by the ram through a tapered die system on to the cooling track in the form of briquettes. Briquettes formed are cylinder shape. Which are pushed through cooling tracks under slight pressure for

cooling and transport to packing point where the briquettes are packed and ready for dispatch to local area or other place.

The biomass briquettes are substitute for coal and L.P.G., and research is going on. The Biomass briquettes are made up of renewable source of energy. We all are well known by the importance of Energy and its sources. Energy is the key factor in economic development of every country. The demand of energy is increasing day by day and the supplies of sources are limited. It is globally red alert for fossil fuel like Petrol, Kerosene, Natural Gas, LPG, and Lignite etc. This has made a huge gap between the demand and supply of energy. Renewable energy is the ultimate solution, which can fill this gap. Most of advanced countries has adopted this concept, accepted this project and retaining their natural resources to get the solution of energy and fuels. The table show the comparison between coal and biomass characteristics as shown in table 1.

Table 1: Comparison Coal and biomass characteristics

| Fuel | Density g/cm$^3$ | Calorific value Kcal/Kg | Ash content % |
|---|---|---|---|
| Coal | 1.3 | 3,800-5,300 | 20-40 |
| Biomass briquettes from : | | | |
| Saw dust | 1.1 | 4,600 | 0.7 |
| Ground nutshell | 1.05 | 4,750 | 2.0 |
| Rice husk | 1.3 | 3,700 | 18.0 |
| Sawdust cotton | 1.12 | 4,300 | 8.0 |

## 2. LITERATURE SURVEY

**2.1** Design and Development of a Compact Screw-Press Biomass Briquetting Machine for Productivity Improvement and Cost Reduction.

**Teerapot Wessapan , Nisakorn Somsuk and Theerapong Borirak**

In this paper, the authors conclude that the compact machine which combines three functions including crushing, mixing and briquetting in a single unit is able to improve the production

cost and productivity. From comparison between the new and the existing/traditional briquetting system, it was found that when using the compact briquetting machine, the required production area, production time and operating cost are reduced by 67, 16, and 22% respectively when using the compact machine.

Briquetting process is a process of compaction of residues into a product of higher density than the original raw material. In compaction stage, the charcoal is crushed into very small size as a carbonized powder. Then the powder and some binder are completely mixed at a predetermined mixing ratio. After that the mixture is brought into the molding machine to form the briquettes. The briquettes are dried and cooled.

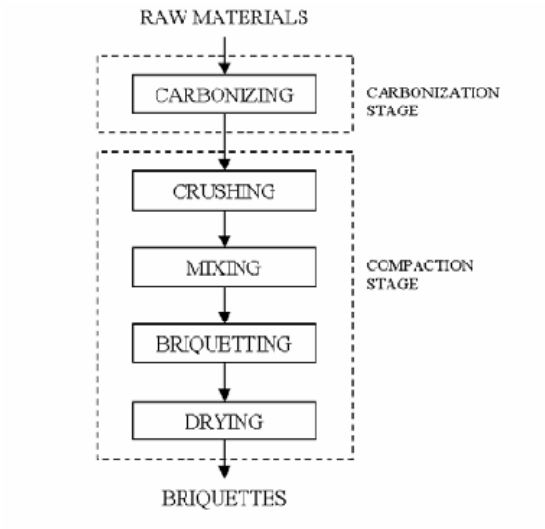


Fig. 1 Biomass briquetting process

An overview of the process flow is shown in Fig.1.There are several methods available for briquetting biomass. In developing countries, the well-known briquetting method that is suitable for small-scale applications is the screw-press briquetting. The raw material from the hopper is conveyed and compressed by a screw in the briquetting machine. This process can produce denser and stronger briquettes compared with piston presses.

2.2 Briquetting Mechanism analysis for solid biofuel production.

**Edgars Repsa, Eriks Kronbergs, Mareks Smits**

In this paper, the authors conclude that The shape of force – displacement characteristics of compacting of different size reed particles were similar – nonlinear curves with two

quasilinear parts.The designed rhomboid mechanism (Patent LV 14201) piston force – displacement characteristics are nonlinear curves with two quasilinear parts like characteristics of compacting reed particles in a closed die. The designed rhomboid mechanism with the member size 1.012 and 0.42 m is suitable for compacting of the smallest particles (including 7 – 8 mm size), if 35 g briquette is pressed in one stroke.

2.2.1 Materials and methods

The main task of this investigation was determination of the compacting force-displacement characteristics from compacting of different size common reeds particles. The compaction experiments had been carried out in a closed die with diameter 35 mm by means of laboratory hydraulic press equipment (Fig. 2). The maximum pressure 212 MPa had been achieved in compacting. The dosage of 35 grams of chopped common reeds particles was used for every briquette pressing.

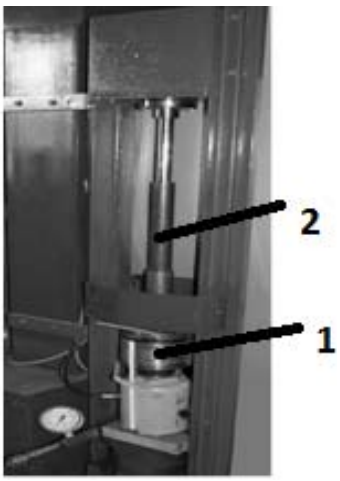


Fig. 2 **Hydraulic press:** 1 – press cylinder; 2 – closed die

2.3 Using Agricultural Residues as a Biomass Briquetting: An Alternative Source of Energy.

**Maninder, Rupinderjit Singh Kathuria, and Sonia Grover**

In this paper, the raw material including rice husk, coffee husk, saw dust, ground nutshell and cotton stalks etc. were densified into briquettes at high temperature and pressure using different technologies. We discuss the various advantages, factors that affecting the biomass briquetting and comparison between coal and biomass briquetting.

2.3.1. Biomass briquetting process

Briquetting is the process of densification of biomass to produce homogeneous, uniformly sized solid pieces of high bulk density which can be conveniently used as a fuel. Depending upon the type of biomass, three processes are generally required involving the following steps:

1. Sieving - Drying - Preheating - Densification - Cooling – Packing
2. Sieving - Crushing - Preheating - Densification - Cooling – Packing
3. Drying - Crushing - Preheating - Densification - Cooling – Packing

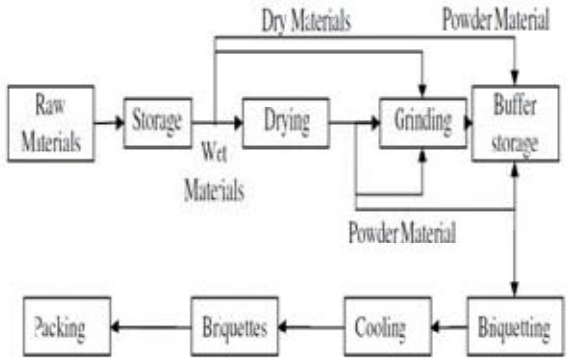


Fig 3. Flow diagram of biomass briquette production

The overview of biomass briquette production process is shown in fig 3.It is concluded that two biomass briquetting technologies dominate the Indian market: the ram and die machine and the screw machine. These two machines use different processes to densify sawdust and agricultural waste, and the end products also have different densities and shape. The hydraulic press has not been used in India and is considered unsuitable for Indian raw materials.

## 3. BIOMASS BRIQUETTING TECHNOLOGIES

Biomass densification represents a set of technologies for the conversion of biomass residues into a convenient fuel. The technology is also known as briquetting or agglomeration. Depending on the types of equipment used, it could be categorized into five main types:

3.1 Piston press densification

3.2 Screw press densification

3.3 Roll press densification

3.4 Pelletizing

3.5 Low pressure or manual presses

3.1 Piston press densification

There are two types of piston press 1) the die and punch technology; and 2) hydraulic press. In the die and punch technology, which is also known as ram and die technology, biomass is punched into a die by a reciprocating ram with a very high pressure thereby compressing the mass to obtain a compacted product. The standard size of the briquette produced using this machine is 60 mm, diameter. The hydraulic press process consists of first compacting the biomass in the vertical direction and then again in the horizontal direction. The standard briquette weight is 5 kg and its dimensions are: 450 mm x 160 mm x 80 mm. The power required is 37 kW for 1800 kg/h of briquetting [7]. This technology can accept raw material with moisture content up to 22%. The process of oil hydraulics allows a speed of 7 cycles/minute (cpm) against 270 cpm for the die and punch process. The slowness of operation helps to reduce the wear rate of the parts. The ram moves approximately 270 times per minute in this process.

3.2 Screw press densification

The compaction ratio of screw presses ranges from 2.5:1 to 6:1 or even more. In this process, the biomass is extruded continuously by one or more screws through a taper die which is heated externally to reduce the friction [8]. Here also, due to the application of high pressures, the temperature rises fluidizing the lignin present in the biomass which acts as a binder. The outer surface of the briquettes obtained through this process is carbonized and has a hole in the centre which promotes better combustion. Standard size of the briquette is 60 mm diameter.

3.3 Roll press densification

In a briquetting roller press, the feedstock falls in between two rollers, rotating in opposite directions and is compacted into pillow-shaped briquettes. Briquetting biomass usually

requires a binder. This type of machine is used for briquetting carbonized biomass to produce charcoal briquettes.

3.4 Pelletizing

Pelletizing is closely related to briquetting except that it uses smaller dies (approximately 30 mm) so that the smaller products are called pellets. The pelletizer has a number of dies arranged as holes bored on a thick steel disk or ring and the material is forced into the dies by means of two or three rollers. The two main types of pellet presses are: flat/disk and ring types. Other types of pelletizing machines include the Punch press and the Cog-Wheel pelletizer. Pelletizers produce cylindrical briquettes between 5mm and 30mm in diameter and of variable length. They have good mechanical strength and combustion characteristics. Pellets are suitable as a fuel for industrial applications where automatic feeding is required. Typically pelletizers can produce up to 1000 kg of pellets per hour but initially require high capital investment and have high energy input requirements.

3.5 Manual Presses and Low pressure Briquetting

There are different types of manual presses used for briquetting biomass feed stocks. They are specifically designed for the purpose or adapted from existing implements used for other purposes. Manual clay brick making presses are a good example. They are used both for raw biomass feedstock or charcoal. The main advantages of low-pressure briquetting are low capital costs, low operating costs and low levels of skill required to operate the technology. Low-pressure techniques are particularly suitable for briquetting green plant waste such as coir or bagasse (sugar-cane residue). The wet material is shaped under low pressure in simple block presses or extrusion presses. The resulting briquette has a higher density than the original material but still requires drying before it can be used. The dried briquette has little mechanical strength and crumbles easily.. The use of a binder is imperative.

## 4. CHARACTERIZING PROPERTY OF THE BRIQUETTES

[1] Heating value: According to the ingredient ratio, the test was conducted to study the heating value. It was found that the heating value of briquettes obtained from this machine is approximately 5,200 calories per gram.

4.1 Comparison between the Existing and the New System

Comparison of the production results between the existing/traditional system (three individual machines working together and three workers) and the new system (a compact machine and a worker) at the same conditions such as using a 5 HP electrical motor and using screw-press technology.

Table. 2 Comparison between the existing and the new system

| Sr.No. | Parameter | The Existing System | The New System |
|---|---|---|---|
| 1 | Worker required (man-day) | 3 | 1 |
| 2 | Productivity (Tonne /day) | 0.58 | 0.72 |
| 3 | Operating cost (Unit/Tonne) | 3,554 | 2,782 |
| 4 | Area required ($m^2$) | 48 | 16 |

**5. DESIGN AND CONSTRUCTIONAL DETAILS**

The improved briquetting system consists of the following: a briquetting machine (of Bangladeshi design), a biomass pre-heater, a biomass-fired die-heating stove and a smoke removal system.

Fig 4. Biomass briquetting System

Fig 5. Improved briquetting machine with electric motor (Bangladesh)

**5.1 Discussion of Taper die and System**

In Biomass Briquetting Plant, A Taper Die or sleeve is used. it is a device to extract the finish biomass product through it. The briquetting press is a reciprocal crank type mechanical press with flywheel. One flywheel is driven by the main motor through continuous flat belt. Forced lubrication oil circulating system guaranties a long service life. The ground material is fed through a hopper by means of a screw conveyer with its own geared motor. The vertical screw pre compresses and forces the material downwards in to the feeding chamber. From the chamber the materials forced by the ram through a tapered die system on to the cooling track in the form of briquettes. Briquettes formed are cylinder shape. Which are pushed through cooling tracks under slight pressure for cooling and transport to packing point, where the briquettes are packed and ready for dispatch to local area or other place.

Fig 6:- A taper Die or Sleeve

## 6. ADVANTAGES OF BIOMASS BRIQUETTING

Briquettes produced from briquetting of biomass are fairly good substitute for coal, lignite, Firewood and offer numerous advantages.

- This is one of the alternative methods to save the consumption and dependency on fuel wood.
- Densities fuels are easy to handle, transport and store.
- They are uniform in size and quality.
- The process helps to solve the residual disposal problem.
- The process assists the reduction of fuel wood and deforestation.
- It provides additional income to farmers and creates jobs.
- Briquettes are cheaper than coal, oil or lignite once used cannot be replaced.
- There is no sulphur in briquettes.
- There is no fly ash when burning briquettes.
- Briquettes have a consistent quality, have high burning efficiency, and are ideally sized for complete combustion.

## 7. FACTORS AFFECTING DENSIFICATION/ BRIQUETTING

### 7.1 Disadvantages

- Tendency of briquettes to loosen when exposed to water or even high humidity weather.
- High investment cost and energy consumption input to the process

### 7.2 Factors Affecting Briquetting

7.2.1 Temperature and pressure

7.2.2. Moisture Content

## 8. DISCUSSION

Based on the knowledge and research about the briquetting machine for solidification of biomass and getting the knowledge about the various part of briquetting machine. The compact biomass briquetting machine fabricated for this research is a prototype unit. From comparison between the new and the existing/traditional briquetting system, it was found that when using the compact briquetting machine, the required production area, production time and operating cost are reduced.

These two machines use different processes to densify sawdust and agricultural waste, and the end products also have different densities and shape. The hydraulic press has not been used in India and is considered unsuitable for Indian raw materials. The most common raw materials for heated-die screw-press briquetting machines are saw dust and rice husk.

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