ISSN PRINT 2319 1775 Online 2320 7876

 **Journal Volume 11, Iss 01, 2022**

# DEVELOPMENT OF BIOMASS BRIQUETTES FOR BOILERS

**Dr Bantesh K Bammannavar[1],Abdulqhadar khidmatgar[2]**

[1]Sr. lecturer

Dept. of Science Govt Polytechnic Belagavi

bantu1236@gmail.com

[2]VTU University

Dept of Mechanical Engineering

Assistant Professor, SCET Belgaum

abdulqhadar@gmail.com

## ABSTRACT

In today's emerging era, renewable source of energies for power generation has become one of very promising source. It is common knowledge that non-renewable or conventional energy sources are extremely scarce and rapidly running out. There is a power demand gap due to the world's growing population and rising energy needs, necessitating the use of alternative energy sources. Thus, the goal is to produce an increasing amount of power from sources of renewable energy.

As there are variety of renewable energy sources forms. Among those sources one significant source of sustainable energy is **biomass.** India offers enormous potential for the production of renewable energy. Approximately 500 million people live in India. According to International Energy Agency (IEA), a huge metric tons of biomass energy is produced every year. Renewable energy could meet almost half of the global energies demand by year 2050. Waste biomass is collected and crushed into briquettes, which may be transported & used as fuel to produce heat. Examples of this biomass include sawdust, dry leaves, rice husk & coffee husk, etc. The time to act to convert biomass into an energy source is now. Therefore, we assume responsibility for turning waste from forestry and agriculture into functional biomass briquettes that can also be used in place of coal. This research aims to investigate the renewable energy scenario, the effects of various parameters such as the ash content, moisture content & calorific value of biomass briquettes, & innovative methods to improve the efficiency of industrial boilers.

*Keyword: Biomass briquettes, Renewable energy, saw dust, Agro waste, engine oil, Biofuel.*

## 1. INTRODUCTION

In rural regions of India, households rely heavily on firewood as their primary energy source due in part to the high cost of non-bio fuels and the scarcity of reasonably priced fuel substitutes for electricity, gas, coal, kerosene, and fuel for cooking[1,2]. Biofuels are expected to be used by 96% of rural households. As these fuels are the most often utilized in the home and are mostly used for cooking purpose. For cooking, fuel wood accounts for about 78% of the energy consumed in rural communities. Additionally, when it comes to actual volumes consumed, fuel

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wood comes in first place with 252.1 million tons, followed by dung-cakes with 106.9 million tons & agricultural residue with 99.2 million tons. Similarly, around 250 kg for fuel wood, 50 kg for animal manure, & 134 kg for crop residues, the per capita consumption figures are likewise high [10,11].

It has been observed that in many of the developing or under developing countries produce huge quantities of agro residues but they are being used inefficiently which causes extensive pollution to the environment. The major residues such as groundnut shells, rice husk, jute sticks, mustard stalks, coffee husk, coir pith, cotton stalks & Sawdust, a milling residue is also available in larger quantities [3,13]. In addition to the challenges pertaining to conveyance, retention, and manipulation, the open burning of loose biomass in traditional grates is linked to exceedingly low thermal efficiency & pervasive air pollution. There are more than 3000 mg/Nm$^2$ of particle emissions in the flue gases, and conversion efficiencies as lower as 40%. Furthermore, a significant portion of the unburned carbonaceous ash needs to be disposed of. This is equivalent to more than 40% of the feed is burned in the case of rice husk [9].
For instance, burning of 2000 tons of rice husk produces roughly 800 tons of rice husk ash every day in Ludhiana, Punjab, India.
Briquetting of the residual husk could mitigate these problem of pollution while at the same time making usage of these products which may leads to an important domestic / industrial resource of energy. The briquettes can be used for domestic usage such as (heating, cooking, barbequing) & industrial purposes (food processing & agro-industries), in both urban areas & rural areas. Therefore, using pressure to densify loose biomass material into a compact form, solid composites of various sizes is known as **biomass briquetting**. In direction to create briquettes, pressure, heat, and a binding agent are applied to loose materials during the briquetting process. In India the potential of biomass briquetting was estimated 61000MW (million watts), but the employment generation estimated by the industry is about 15.52 million & hence farmers earn almost about 407.1 Indian rupees per ton of farm residue [10].

Briquettes are primarily used to generate power through the gasification of biomass briquettes & to replace coal in industrial process of heat applications (such as space heating, steam generation, tea curing, metal melting, brick kilns etc.). There has been a current movement to use biomass instead of burning fossil fuels. The amount of pollution in the globe would decrease if biological waste were used in place of these nonrenewable resources [14]. Dry wastes are frequently burned in dump yards and by the side of the road, polluting the air and creating a number of issues. Here, we've taken the effort to create electricity from waste biomass. Additionally, to lower the amount of shredded garbage generated, which will lower waste management expenses. We build a superior type of briquetting machine to accomplish this. By compressing the dry waste that has been ground, this machine effectively creates briquettes. Because these briquettes include less carbonaceous material and other ingredients than charcoal, as they differ greatly from charcoal.

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Because the materials utilized in the briquettes are already a part of the carbon cycle, they emit fewer net total greenhouse gas emissions than fossil fuels. Due to this, these briquettes are an excellent substitute for fossil fuels like coal or oil.[4] Not only may compressed briquettes save money by minimizing the amount of waste produced, but they can also be utilized as insulation or as a fuel source for fires. In todays developed world, briquettes are increasingly being used to heat industrial boilers, which generates steam energy from. Hence utilization of biomass briquettes prevents fossil carbon from entering the atmosphere and is a green energy source. Additionally, biomass briquettes reduce boiler fuel costs by 30% to 40% & offer a higher calorific value per kilogram, as compared to burning firewood, burning wood briquettes is significantly more efficient. Briquettes can have as little as 4% moisture content, whereas young firewood might have as much as 65%.

Used motor oil that has been gathered from oil-changed workshops, garages, & industry sources, including turbine, hydraulic, process, & metal working fluids, which is commonly referred to as spent engine oil. Additionally, spent oil may come from ocean-going ships that dock at seaports. These fuels may comprise heavy & intermediate fuels made from saline water, as well as a number of heavy metals that are typical of such fuels. Gasoline and diesel fuel from the engine it lubricated are present in used engine oil. Additionally, it could include erroneous substances like chlorinated solvent. Following generation, wasted engine oil can be evaluated using specific tools & processes. This information is useful in determining the type of handling safety that various sectors will require from the spent engine oil or in determining its potential categorization for future usage. Briquettes of different kinds, such as wood briquettes, white coal briquettes, saw dust briquettes & agro waste briquettes, recycled & biomass briquettes, are gathered together [10,15]

## 1.1 TYPES OF BREQUITTES

In India, various other different types of briquettes are being manufactured by the technique of briquetting using machines. And all these types of briquettes are prepared from purely agricultural waste or forestry waste which are fuel briquettes etc. Following below listed briquettes are some of the various collection of briquettes.

### 1.1.1 Biomass Briquettes

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The collected green trash, including biomass, is gathered, crushed under high pressure & then turned into biomass briquettes. We refer to this entire procedure as the biomass briquetting process. These biomass briquettes are an excellent alternative to lignite & coal. In industries, these biomass briquettes are utilized to heat boilers. It doesn't release any pollutants into the atmosphere, like sulfur.

**Figure 1:** Biomass briquettes

### 1.1.2 Sawdust Briquettes

Sawdust briquettes are one the most quality assured briquettes. These briquettes deliver smokeless usage & have a low composition. These briquettes are frequently used to heat industrial boilers, which use steam to generate power. The biomass briquette maker offers affordable & dependable sawdust briquettes. These briquettes are being produced using a sawdust briquette machine, which is a highly efficient machine. These are offered at a competitive price in the industrial sector.[11].

**Figure 2:** Sawdust briquettes

### 1.1.3 Agro-waste Briquettes

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Agro waste briquettes are one of best alternative to charcoal & coal. As these briquettes are made from either agriculture waste or forestry waste & which have high specific density when compared to lose biomass. These briquettes are easy to store, handle, & transport. These are inexpensive than coal & offer high boiler efficiency due to lower moisture content. These have no sulphur content that pollutes surrounding environment. These briquettes manufactured by using machine press

**Figure 3:** Agro waste briquettes

### 1.1.4 Wooden Briquettes

Wooden briquettes burn with great efficiency and produce no flash. It is an essential energy source that can replace firewood and coal. These briquettes burn with exceptional efficiency & produce no pollution. Because wood briquettes release the same amount of carbon dioxide (CO2) into the atmosphere that nearby trees would absorb through photosynthesis during growth, the carbon dioxide (CO2) environment is balanced.

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**Figure 4:** Wood briquettes

## 2. METHODOLOGY

### 2.1 PREPARATION OF BIO-MASS BRIQUETTE

With respect to our method of heading, we have prepared briquettes to burn as a fuel, from the residue remained or wasted after agricultural occupation, which will reduce the dirt & pollution & keep the rural areas of India clean & hygienic.

The steps involved in the manufacture of briquettes are as follows:

1. Collection of raw the materials
2. Crushing
3. Mixing of materials with binders agents
4. Quenching / Ramming
5. Drying

#### 2.1.1 COLLECTION OF RAW MATERIALS

The raw materials used are a complete agricultural waste which is easily available in rural regional areas. To enhance the density of briquettes the raw materials need to be pulverised. Pulverising helps us to get compactness of the briquettes & which gives a

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longer life to the briquette. As we have a collection of agricultural residues, mostly which have high calorific value & rich thermal properties.

### 2.2 CRUSHING

In this stage the collected raw materials are cleaned from dust or soil residues and sun dried to obtained it in pulverised form. Following are some of the raw materials used with their calorific value

#### 2.2.1 Groundnuts shells

Calorific value: 4200 k cal/kg & Ash contents: 3.80%

(Before pulverising)

(After pulverising)

**Figure 5:** Groundnuts shells and its crushed form

**2.2.2 Rice husk** Calorific value- 3040 kcal/kg & its Ash contents- 25%

(After pulverising)

(Before pulverising)

**Figure 6:** Rice husk and its crushed form

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### 2.2.3 Dry leaves

Calorific value- 3800kcal/kg

(Before Pulverising)

(After Pulverising)

**Figure 7:** Dry leaves and its crushed form

### 2.2.4 Sugarcane Bagasse

Calorific value-3800kcal/kg [13]

(Before Crushing) (After Crushing)

**Figure 8:** Sugarcane bagasse and its crushed form

### 2.2.5 Poultry waste

Poultry waste has a calorific value that varies with humidity; for air-dried samples, it is approximately half the calorific value of coal, ranging from 9 to 13.5 MJ/Kg.

**Figure 9:** Poultry waste

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### 3. Mixing of materials with binders and Punching or Ramming

In this stage the crushed material is mix with the binder material and compressed with machine compressor. Then powdered material is press under the high compression ratio ranging from 2.5:1.0 to 6:1.0 & more. In this process, the biomass is constantly extruded by a second crew through a taper temperature rise, which fluidizes the biomass's lining and serves as a binder for a standard-size die that is heated outside to reduce friction. Hence due to the application of high pressure of a briquettes is 16mm diameter.

**GCBC-I Series Biomass Briquette Press**

| Model | GCBC- I |
|---|---|
| Output capacity kg/h | 180-210 |
| Motor Power (kw) | 15 |
| Electric heater (kw) | 2.2kw*2 |
| Life of the inner former | 1-2years |
| Size of briquettes | Dia.50mm*L.480mm |
| Size of inside hole | Dia.16mm |
| Density of briquettes | 1.3 g/cm3 |
| Weight(kg) | 700kg |
| Overall dimension(mm) | 2700*600*1600 mm |

**Figure 10:** Biomass briquettes press machine with its specification

### 4. QUENCHING PROCESS

In this quenching process we made briquettes to quench in different oils mainly

1. Used engine oil.
2. Neem oil.
3. Partially used engine oil.

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### 4.1 USED ENGINE. OIL

**Calorific value: 6070.7 KJ/Kg**

### 4.2 NEEM OIL

**Calorific value: 6094.7 KJ/Kg**

### 4.3 UNUSED ENGINE OIL

**Calorific value: 6258.8 KJ/Kg**

### 4.4 UNIMMERSED SAMPLE

**Calorific value: 4668.6 KJ/Kg**

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## 5. FORMULATION AND CALCULATIONS

### 5.1 BRIQUETTES QUIENCHED FOR UNUSED ENGINE OIL

$$Cv = \frac{Mw \times Cpw \times \Delta T}{Mf}$$

Ti=27.95℃,

Tf=28.79℃

$\Delta T=(Tf-Ti)$

$\Delta T=(28.79-27.95)$

$\Delta T=0.84℃$

$$Cv = \frac{2 \times C4.187 \times \Delta T}{1.13x10^{-3}}$$

$$Cv = 6258.8 \text{ KJ/Kg}$$

### 5.2 BRIQUETTES QUIENCHED FOR NEEM OIL

$$Cv = \frac{Mw \times Cpw \times \Delta T}{Mf}$$

Ti=29.43℃,

Tf=30.21℃

$\Delta T=(Tf-Ti)$

$\Delta T=(30.21-29.43)$

$\Delta T=0.82℃$

$$Cv = \frac{2 \times C4.187 \times 0.82}{1.13x10^{-3}}$$

$$Cv = 6094.7 \text{ KJ/Kg}$$

### 5.3 BRIQUETTES QUIENCHED FOR USED ENGINE OIL

$$Cv = \frac{Mw \times Cpw \times \Delta T}{Mf}$$

Ti=30.47℃,

Tf=31.28℃

$\Delta T=(Tf-Ti)$

$\Delta T=(31.28-30.47)$

$\Delta T=0.81℃$

$$Cv = \frac{2 \times C4.187 \times 0.81}{1.13x10^{-3}}$$

$$Cv = 6070.7 \text{ KJ/Kg}$$

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### 5.4. SAMPLE BRIQUETTES

$$Cv = \frac{Mw \times Cpw \times \Delta T}{Mf}$$

Ti=31.40℃,

Tf=32.02℃

$\Delta T=(Tf-Ti)$

$\Delta T=(32.02-31.40)$

$\Delta T=0.62℃$

$$Cv = \frac{2 \times C4.187 \times 0.62}{1.13x10^{-3}}$$

$$Cv = 4668.6 \text{ KJ/Kg}$$

## 6. RESULTS AND DISCUSSION

**Table 1: LAB TEST REPORT**

| SAMLES | CALORIFIC VALUES IN KJ/kg |
|---|---|
| 1.Briquette Sample | 4668.60 KJ/kg |
| 2.Briquettes quenched in fresh engine oil | 6258.80KJ/kg |
| 3.Briquettes quenched in neem oil | 6094.70 KJ/kg |
| 4.Briquettes quenched in used engine oil | 6070.70 KJ/kg |

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## 7. CONCLUSION

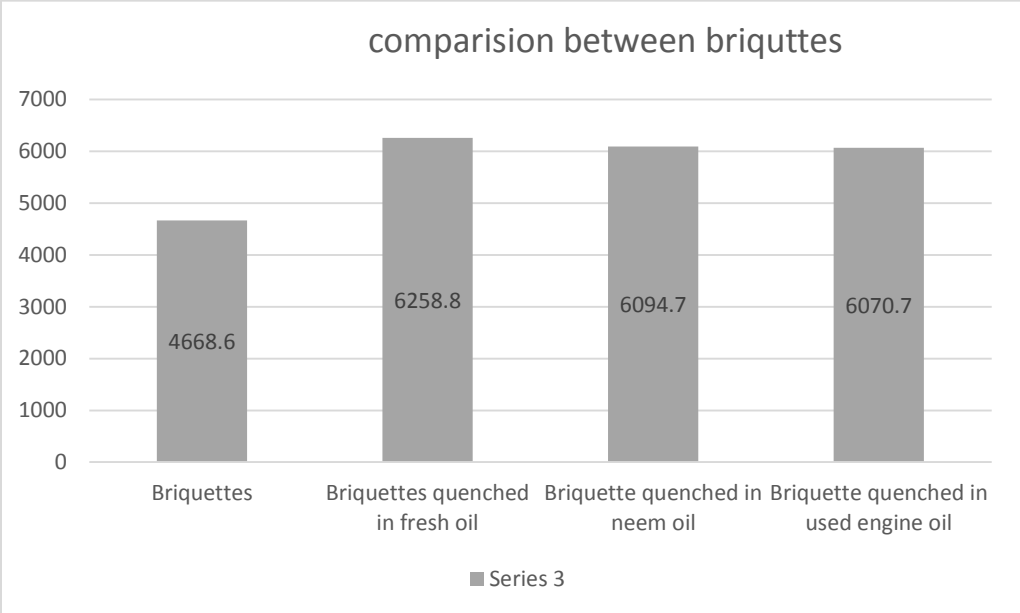


**Figure 6:** Graphical representation of briquettes immersed in different oils with their calorific values

India generates a large volume of agricultural by products & which constitute environment hazards. Hence by this project a call for an effective utilisation of those high grade biomass material for solid fuel called briquettes is found. Therefore it can be concluded that the waste material such as wheat straw, dry leaves & saw dusts are feed stocks for the biomass briquette. In generally dry leaves & wheat straw are burnt to reduce waste. Which than causes several other types pollution to our environment, but if we wisely handled these kind of wastes generated, than it could be a better option for briquetting. Therefore, using agricultural waste to make briquettes can be a financially feasible, environmentally responsible, and sustainable solution for a countries like India that produces a significant volume of agricultural waste annually. A large volume of agricultural by copy the same till and friendly solution comparing with coal the briquettes quenched in oil has higher calorific value (cv) so we can say the project we put forward is worked our briquette price is also low compare to the coal.

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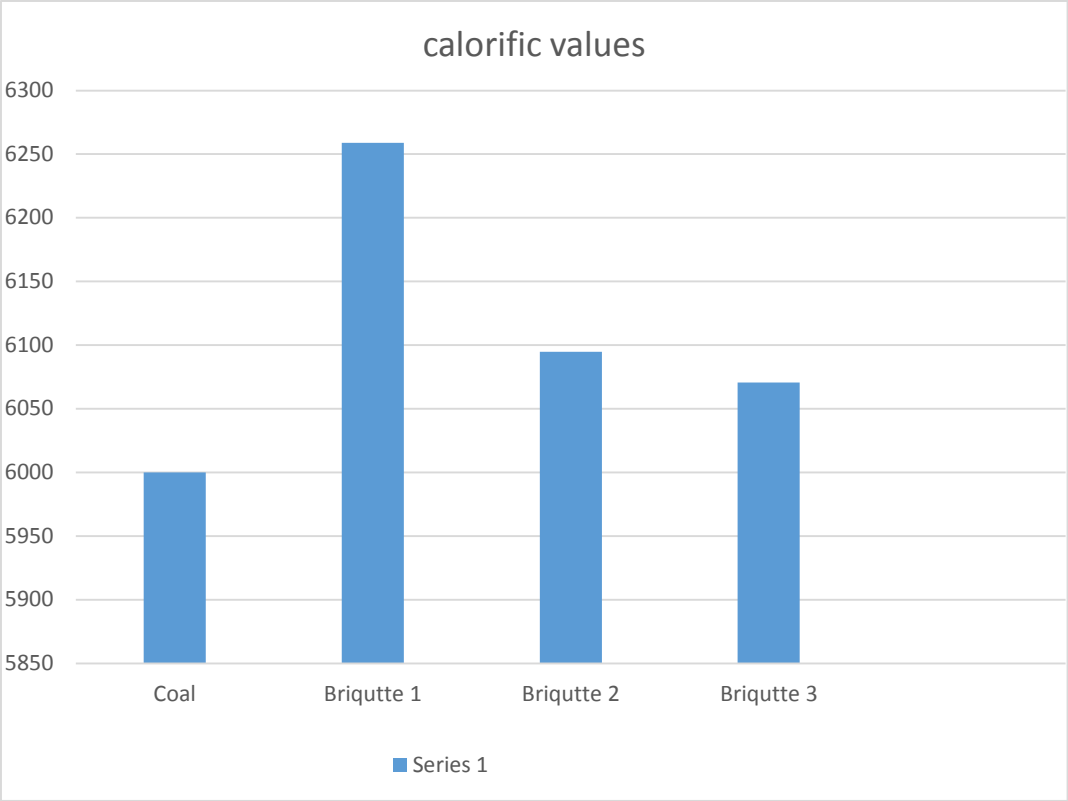


**Briqutte1= Quenched in fresh oil**
**Briqutte2= Quenched in neem oil**
**Briqutte3= Quenched in used engine oil**

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