A Study of Biofuel Briquettes & Fabrication of Bio-Residence Briquetting Machine

Kanishka Jha[a*], Ravinder Kataria[a], Syam Kumar Degala[a]

[a] School of Mechanical Engineering, Lovely Professional University, India

Abstract

A study was made to investigate the property of organic waste briquettes to utilize them as a fire source in household and industrial purposes. Various organic waste from local area were collected and then compressed under varying pressure condition in a chamber to enhance the burning capabilities and allowed to dry out. In order to achieve the compacting pressure, a compressing machine was fabricated. Various compositions were selected from raw materials based on their weight fraction. Maximum contribution in enhancing the calorific values of the briquettes was found with bagasse, coal dust and wood dust. Whereas, molasses helped to bind the dispersed phase.

Keywords: Briquettes, Calorific value, Organic waste.

1. Introduction

One of the major produced crops in India is Rice and specially in the state of Punjab. Yearly, nearly 100 million tonnes of paddy rice is produced in india which is the second largest in the world and hardly lag by few million tonnes [1]. This enormous amount of production directly relates to generation of agriculture residue which being a burden on farmers to process and dispose. Milling of Sugarcane results in extracted sugarcane juice for sugar production and also leaves sugarcane bagasse (SCB) as fibrous material, altogether treated as residue [2]. For every ton of sugarcane 31 pieces milled, accounts to 280 kg (containing 50% moisture) of SCB is generated [3]. Rice waste is generally produced during harvesting times, which limits is utilization to that period only [4]. Paddy rice waste after harvesting contains high source of silica, which limits its disposal and also slow decomposition in soil [5]. Therefore, the briquetting of these various bio-wastes into some useful product such as fire starters or also as a main fuel source for small boiler or any other energy generation. The densification through briquetting enhances energy density, storage issues, transportation and handling [6-9].

2. Materials and Methods

Details of materials and methods used for making the briquettes as well as the methods used to characterize them.

2.1 Machine Fabrication

The briquetting machine that was fabricated will be consist of three main part which are the main frame, the compaction chamber and base plate.

Main Frame: The main frame houses and support the other parts of the machine. The main frame was made from mild steel angular iron bars.

Compaction Chamber: The compaction chamber was made with mild steel block. Mechanism used is screw with piston, operated manually with the help of a turning rod at top.

Base Plate: The base plate of the machine is made from mild steel and is housed within the frame of the machine just beneath the compaction chamber. The rack and pinion mechanism operate and supports the base of the machine to support the ejection piston.

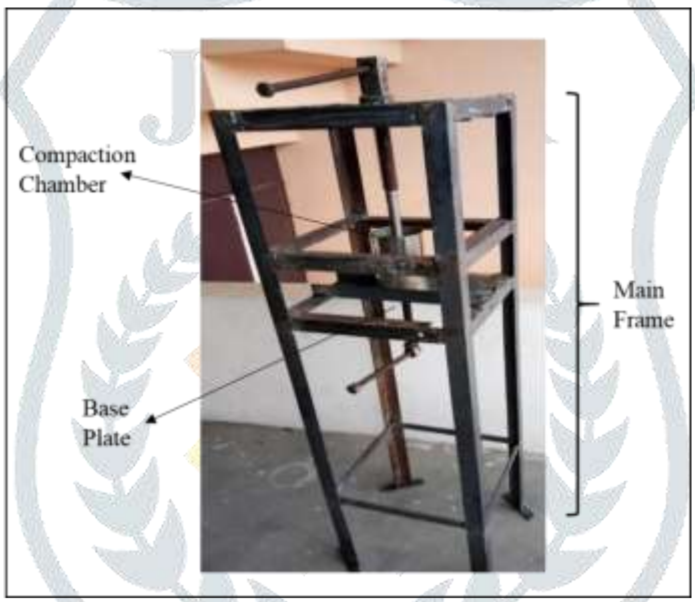

Figure 1. Briquetting machine

Operation and Cost of the Machine: The cost consists of the material, machining, transportation, survey and testing are expected.

2.2 Design Aspects

Force applied by the piston from the top (F) = $W\ d_m \tan(\varphi + \alpha)/2$

p = pitch = 6 mm

d = nominal dia. = 30 mm

d_c = core dia. = 30 – 6 = 24 mm

Table 1. Major Dimensions of Machine

S. No	Parts Name	Dimensions (cm)
1	Top frame house	26
2	Bottom frame house	75
3	Middle frame house	15
4	Frame size	29 x 29
5	Cylinder height	14
6	Length of screw	34
7	Dia. of top screw	2.5
8	Dia. of cylinder	8.1
9	Dia. of Disc	8
10	Length of top handle	25
11	Length of bottom screw	10
12	Length of bottom handle	17
13	Plate thickness	0.4
14	Cylinder thickness	0.2
15	Angle thickness	2.5
16	Total height	26+15+75=116 cm

2.3 Raw Material

Bagasse: It is a bio-residue of sugarcane with very content of fibrous material, and it is a end product after extraction of sugarcane juice. Its calorific value is of high order and therefore can be utilized for briquetting.

Coal dust: It is harmful if inhaled as it is a very fine powder obtained by crushing, grinding or pulverizing of the coal rocks.

Wood dust: Wood is a fine powder form of wood, generally used for particle boards and coarse particles used for pulp development.

Material Used: Coal Dust, Wood Powder, Paper Waste, Molasses, Field Waste, Bagasse, Cardboard, Cow Dung.

Figure 2. Raw Materials

2.4 Briquette (Samples) Classification

Type –I [Coal Dust/Powder (10%) + Field Waste (20%) + Paper Waste (20%) + Wood Powder (20%) + Baggase (20%) + Molasses (10%)]

Type –II [Coal Dust (20%) + Wood Powder (25%) + Cow Dung (10%) Bagasse (10%) + Paper Waste (10%) + Cardboard (5%) + Baggase (10%) + Molasses (10%)]

Type -III [Coal Dust (10%) + Wood Powder (10%) + Paper Waste (20%) + Bagasse (30%) + Field Waste (10%) + Cardboard (5%) + Molasses (15%)]

Type –IV [Wood Powder (80%) + Molasses (20%)]

Type –V [Baggase (80%) + Molasses (20%)]

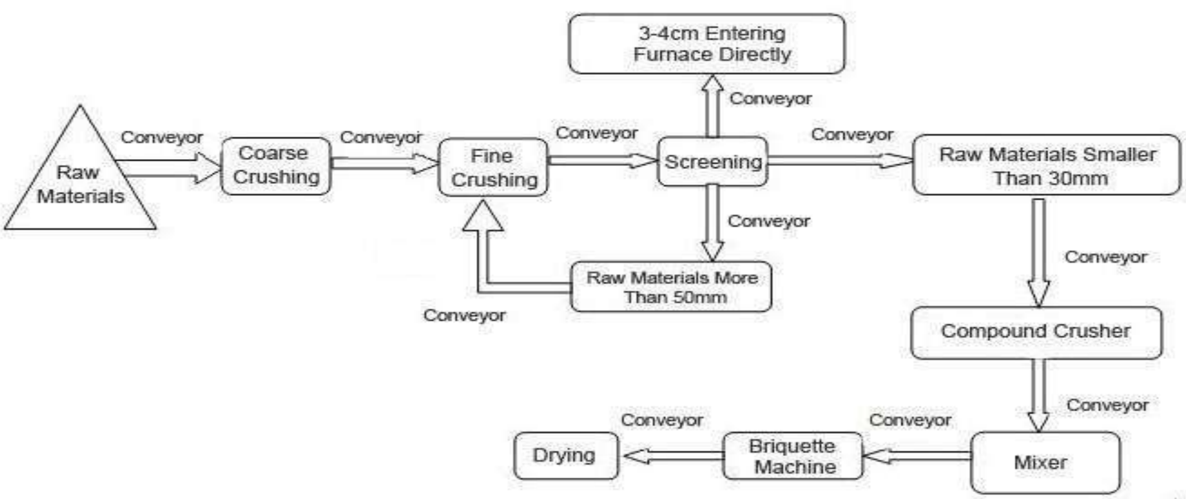

Figure 3. Flow diagram of briquetting

2.5 Determination of Calorific Value

Calorific Value of fuel is "the total quality of heat liberated from the combustion of a unit ass (or unit volume) of the fuel in air or oxygen". It is determined using a bomb calorimeter. A known mass of fuel is burnt and the quantity of heat produced is absorbed in water and measured. Then the quantity of heat produced by burning a unit mass of the fuel is calculated.

$$CV = \frac{(W+w)(t2 - t1 + cooling\ temp) - (error\ correction\ factor)}{mass\ of\ fuel\ sample\ in\ gms.} \quad \text{cal/gm or kcal/kg}$$

W= mass of water in the calorimeter (in gm)

T_1= initial temperature of water in calorimeter

T_2= initial temperature of water in calorimeter x= mass in gm of fuel sample

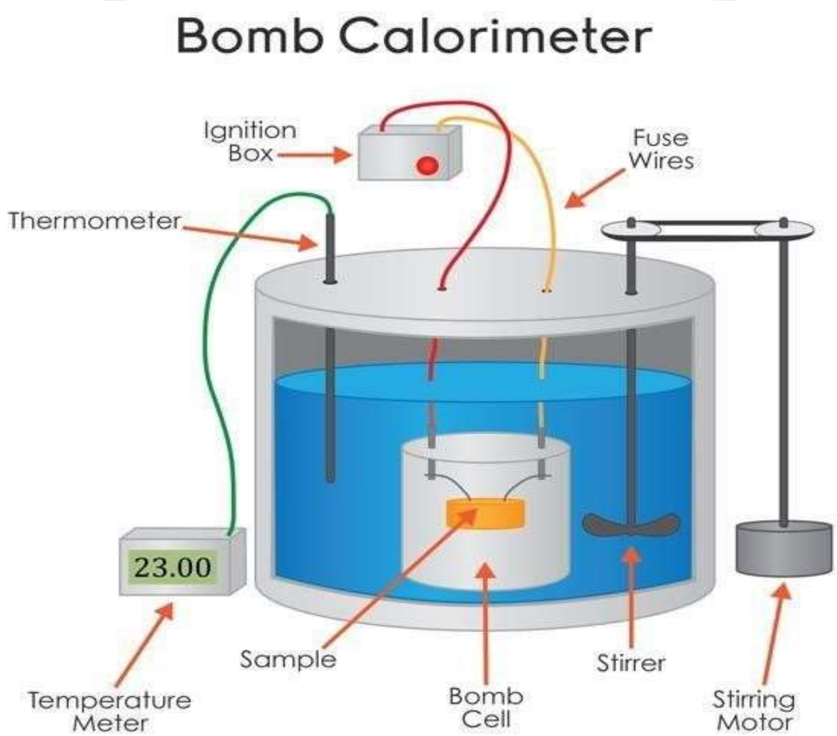

Figure 4. Bomb calorimeter

Table 2. List of Materials

S. No.	Materials	Nos
1	Heavy angle (for stand)	8
2	Plate (top & bottom)	2

3	Top Handle	1
4	Bottom Handle	1
5	Cylinders	2
6	Screw	2
7	Small Nut	4
8	Heavy Nut	2
9	Locking Nut	1

2.6 Cost Analysis

Cost of raw material

Approximate Weight of Machine = 30 kg

Cost of Angle 30*55 = 1650 Rs

Machining cost.

Cost of Screw, Nuts, Cylinder etc = 1500 Rs

Fabrication cost = 1500 Rs

Miscellaneous cost = 500 Rs

Cost of Briquettes Material = 60 Rs

Cost of binders (molasses) = 100 Rs

TOTAL = 5,310 Rs

3. Results & Discussions

This chapter presents the results of the tests for physical and mechanical properties of the sample briquettes. The main aim of this section is comparison between different parameters and relate to their advantages and science behind them.

Table 3. Result data

SAMPLE NO	CALORIFIC VALUE (cal/gm)	
	HIGH COMPACTING PRESSURE (12MPa)	LOW COMPACTING PRESSURE (6MPa)
1.	3610	3440
2.	3820	3670
3.	4850	3650

4.	2400	N/A
5.	2700	N/A

3.1 Testing and Results Analysis

3.1.1 Calculation of Calorific Value of Sample

TYPE-I Sample1 [Coal Dust/Powder (10%) + Field Waste (20%) + Paper Waste (20%) +Wood Powder (20%) + Baggase (20%) + Molasses (10%)]

CV= (**Weight of water**)(**Change in Temp**)

Mass of Sample used

Weight of Water = 2kg

Mass of Sample Used = 2g (0.002kg)

Change in Temp. = 3.61 CV= **3610 cal/gm**

TYPE -II Sample 1 [Coal Dust (20%) + Wood Powder (25%) + Cow Dung (10%) + Baggase (10%) + Paper Waste (10%) + Cardboard (5%) + Baggase (10%) + Molasses (10%)]

Weight of Water = 2kg

Mass of Sample Used = 0.002kg

Change in Temp. = 3.82

CV= **3820 *cal/gm***

TYPE -III Sample 1 [Coal Dust (10%) + Wood Powder (10%) + Paper Waste (20%) + Baggase (30%) + Field Waste (10%) + Cardboard (5%) + Molasses (15%)]

Weight of Water = 2kg

Mass of Sample Used = 0.002kg

Change in Temp. = 4.8 CV = **4850 *cal/gm***

Figure 5. Samples of Briquettes

TYPE –IV [Wood Powder (80%) + Wood Powder (20%)]

(High Compacting Pressure)

Weight of Water = 2kg

Mass of Sample Used = 0.002kg

Change in Temp. = 2.4 CV = $\mathbf{2400}\ \boldsymbol{cal/gm}$

TYPE –V [Baggase (80%) + Molasses (20%)]

(High Compacting Pressure)

Weight of Water = 2kg

Mass of Sample Used = 0.002kg

Change in Temp. = 2.4 CV= $\mathbf{2700}\ \boldsymbol{cal/gm}$

Figure 6. Samples of Briquettes

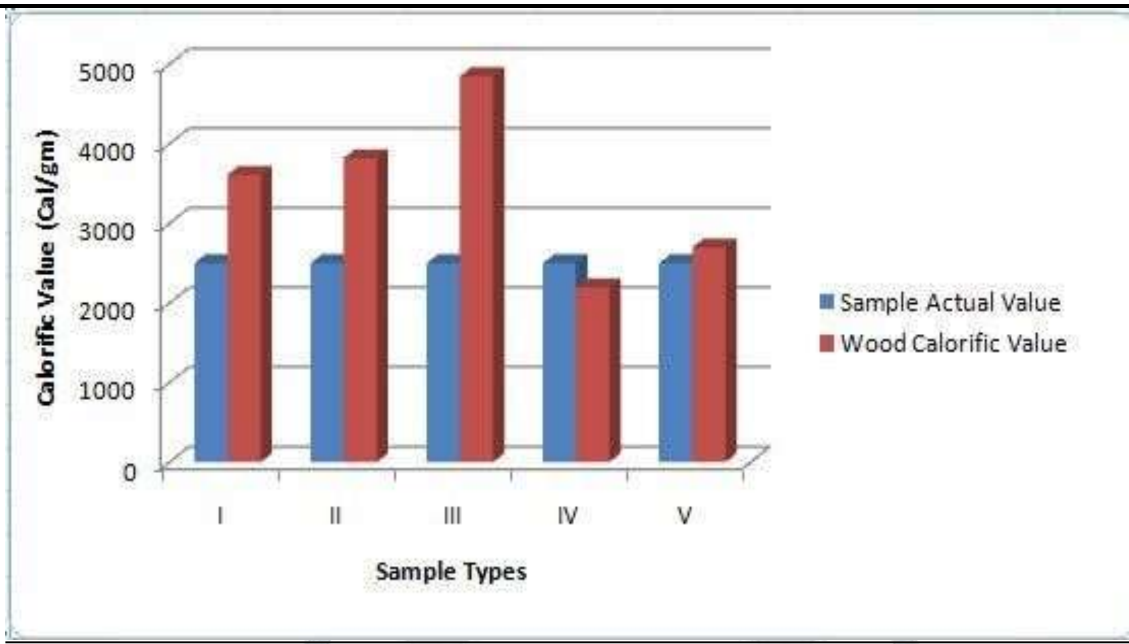

Figure 6. Comparative study of Calorific Value

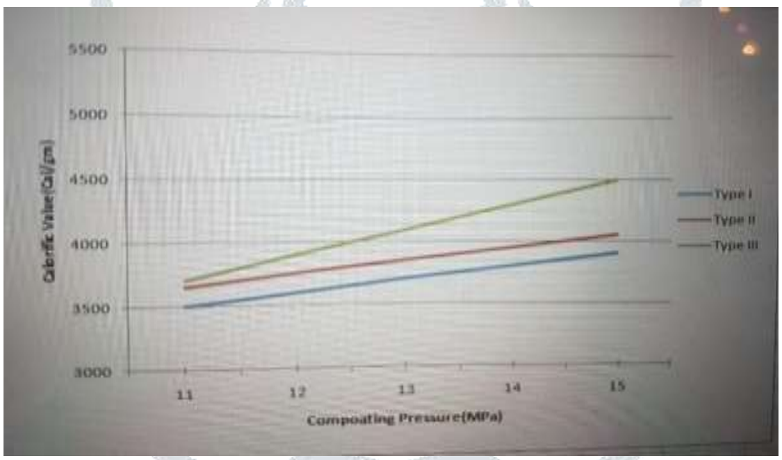

Figure 7. Compacting pressure vs calorific value

4. Conclusion

Briquettes were developed using waste products, which are collected from local areas of Punjab. Bagasse and organic waste being a pain to the farmers for disposing them results in a huge source of raw material. The fabricated briquettes were tested for calorific values and it was found that the results were very close to the values obtained from commercial coal. The samples with high in coal and bagasse content results in comparatively high calorific values. The developed briquettes may find their application in industries which are using small boilers. They give enough calorific values to fulfill the requirements to fire the boilers.

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