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POTENTIAL IMPROVEMENT ON CALORIFIC VALUE OF BIODEGRADABLE RESIDUALS USING BRIQUETTING MACHINE

[1]Sojan Thomas T, [2]Parthiban V, [3]Vijay S, [4]Raja V, [5]Mohan S

[1,3,4,5]Student, [2]Associate Professor,

[1]Mechanical Engineering,

[1]Narasu's Sarathy Institute of Technology, Salem, Tamil Nadu, India

Abstract: Utilization of agricultural residues is often difficult due to their uneven and troublesome characteristics. The process of converting biodegradable residuals into a compressed block by compacting is known as briquetting. There are different machine available in market to compact residuals but those machine are bulky and are costly, hence here we designed a portable, economical briquetting machine, which uses scotch yoke mechanism to convert the biological waste into useful briquette. This study is based on production of such briquettes using biodegradable waste (rice husk) and to analysis its physical parameters (Total Solid, Calorific Value) and Proximate parameters (Percentage Moisture Content (PMC), Percentage volatile matter (PVM), Percentage ash content (PAC), Percentage fixed carbon (PFC)) of such briquettes and compared with standard coal briquette.

Index Terms **- Agro-residues, Briquette, Proximate Analysis, Densification, Scotch Yoke Mechanism.**

I. INTRODUCTION

Households in rural India are highly dependent on firewood as their main source of energy, because fuels tend to be expensive, and access to alternative fuel like coal, gas, kerosene and electricity for cooking and heating is limited. The fuels dominate the domestic sector are primarily used for cooking. The primary energy source for cooking used by rural households is wood (78%). In actual volumes of annual fuel consumption, fuel wood ranks first, at 252.1 million tonnes, followed by dung-cakes, at 106.9 million tonnes and agricultural residue, at 99.2 million tonnes of annual consumption. Similarly, the per capita consumption are also high for fuel wood at 250 kg, 50 kg for animal dung and 134 kg for crop residues This is further corroborated by the energy consumption estimation given by NCAER.

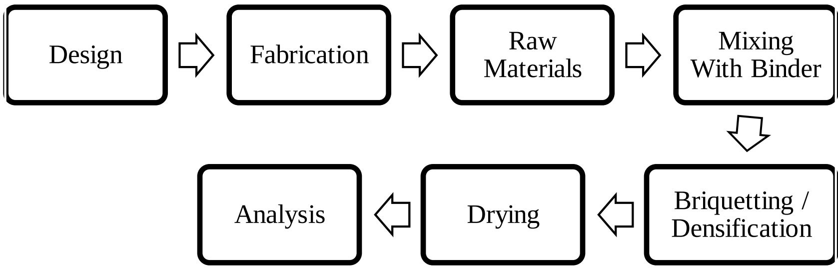
Various parts of our world produce large quantities of agro residues but they are burnout inefficiently. The major residues are rice husk, coffee husk, coir pith, jute sticks, groundnut shells, mustard stalks and cotton stalks. Apart from the problems of transportation, storage, and handling, the direct burning of loose biomass in conventional grates is associated with very low thermal efficiency and wide spread of air pollution.

The briquettes produced can be used for domestic purposes (cooking, heating) and industrial purposes (agro-industries, food processing) in both rural and urban areas. Thus Biomass briquetting is the process of densification of loose biomass material to produce compact solid composites of different sizes with the application of pressure.

II. OBJECTIVE

- ✓ To design and fabricate economical briquetting machine.
- ✓ To produce biomass briquettes with a lower ash content of around 10 to 25 % as compared to that of coal which is around 20-40 % by reducing quantity of binder used.
- ✓ To produce higher density biomass briquettes (4000 –4500 Kcal/m^3).
- ✓ To improve the Calorific Value of agro-residual by compacting.
- ✓ To analysis the output produced and compared to coal standard data.

III. WORK PLAN



IV. DESIGN:

In this project, the briquette will be made in cylindrical shape of size with 80mm inner diameter and 100mm length. For the required briquette dimension.

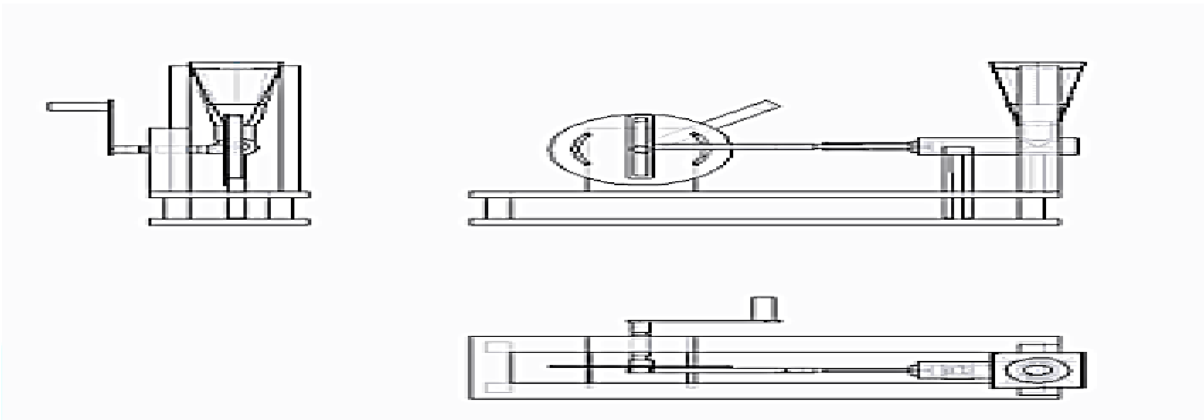


Fig 1: Line Diagram of Economical Briquette Machine.

Table No 4. 1: Design Specification	
PARTICULAR	**SPECIFICATION**
Hopper	Height = 20cm Length = 20cm Outer diameter = 2.5cm Inner diameter= 20cm
Frame	Length = 60cm Width = 30cm Height = 30cm
Cylinder	Inner diameter= 80mm Length= 100mm
Press (piston)	Diameter= 80mm

IV. ANALYSIS:

1. PHYSICAL PROPERTIES:

i. **Total Solid:** Total solid is a measure of Amount of solid particles present in briquette.

$$\text{Total Solid Content} = \frac{\text{Weight of Dried Briquette}}{\text{Weight of Wet Briquette}}$$

ii. **Bulk density:** The bulk density of material was determined as per the standard procedure. A cylindrically shaped container of 1000 ml (1000 cm3) volume was used for determination. The container was weighed empty to determine its mass and then it was filled with the sample and weighed once again. The bulk density was determined by dividing the mass of the material by the volume of the container. The bulk density was calculated by using the formula:

$$\text{Bulk Density} = \frac{\text{Mass of Briquette Sample,(Kg)}}{\text{Volume Of Mesuring Cylinder, }(m^3)}$$

iii. **Calorific Value:** Heat produce by the complete combustion of specified quantity. This was measured using bomb calorimeter experiment.

$$CV = \frac{(W+w)(T2\ -T1)}{WF}$$

Where,

W= Weight of Water in Calorimeter (Kg),
w= Weight Equivalent of Apparatus (Kg),
T_2= Final Temperature (°C),
T_1= Initial Temperature (°C),
W_f= Weight of fuel (kg)

2. PROXIMATE ANALYSIS:

i. **Percentage Moisture Content (PMC):** The moisture content of biomass was measured by natural dry method. Initially the wet sample was weighted. Then the dry sample weighed. The PMC can be calculated as follow,

$$PMC = \frac{\text{Weight of Wet Briquette}}{\text{Weight of Dried Briquette}}$$

ii. **Percentage Volatile Matter (PVM):** The percentage volatile matter (PVM) was determined by placing wet briquette sample in a crucible and heat until a constant weight was obtained. The briquette was kept in the furnace at the temperature of 550°C for 10 min and weighted after cooling. The PVM can be calculated as follow,

$$PVM = \frac{\text{Weight of Dried Sample} - \text{Weight of Ash}}{\text{Weight of Dried Sample}}$$

iii. **Percentage ash content (PAC):** The percentage ash content (PAC) was also determined by heating 2 g of the briquette sample in the furnace at a temperature of 550°C for 4 h and weighed after cooling in a dessicator to obtain the weight. The PAC can be calculated as follow,

$$PAC = \frac{\text{Weight of Ash}}{\text{Weight of Dried Sample}}$$

iv. **Percentage fixed carbon (PFC):** The percentage fixed carbon (PFC) was computed by subtracting the sum of PVM, PAC and PMC from 100. The PFC can be calculated as follow,

PFC= 100% - (PAC+ PMC+ PVM)

IV. RAW MATERIAL USED:

Table No 2 Raw Material Composition

MATERIAL	MIXTURE
Rice Husk	**70%**
Paper Pulp	**20%**
Corn Starch	**10%**

Fig 2: Briquette Made By Rice Husk

V. RESULT AND DISCUSSION

The briquettes prepared manually by low-cost briquetting machine was sown in the figure 2,and the were analysed for their Calorific Value, Moisture Content, Bulk Density, Volatile Matter, The Amount of Fixed Carbon, Total Solid Content, Ash Content etc. using standard methods of quality testing. The result are tabulated below.

Table No 3: Physical Characteristics

SAMPLE	CV	TSC	BD
Rice Husk + Paper Pulp + Starch	4300Kcal/ m^3	94.117%	1591.549Kg/m^3
COAL (standard)	3900 Kcal/ m^3	95%	1200 Kg/m^3

Table No 4: Proximate Characteristics

SAMPLE	PMC	PVM	PAC	PFC
Rice Husk + Paper Pulp + Starch	6.25%	79.75%	20.25%	6.25%
COAL (std)	6.23%	70.88%	30..2%	7.31%

This table shows that briquette produce by our economical briquette machine has higher calorific value than coal. The other properties are also having some significant lever of improvement than coal.

VI. SCOPE OF FUTURE WORK

The machine fabricated requires some human effort for compressing the raw material. The requirement of human effort can be eliminated by using a less capacity motor to actuate the slotted lever gradually for compressing the raw material. This increases the compression pressure which helps in obtaining the good quality briquettes. And also this high pressure causes raw material to bind stiffly and this may also lead to elimination of using binder. By using this mechanism fabrication cost can be reduced.

Any type of feed stock can be used apart from the saw dust, coffee husk, dry leaves and other biological and non-biological waste can be compacted to reduce waste management cost and facilitates the easy transportation of the same.

VII. ADVANTAGES/ DISADVANTAGE/ APPLICATION:

1. **Advantage:**
   - ✓ The output from the machine is uniform in Size
   - ✓ The bulk density is higher (1500 kg/m^3 against 1200 kg/m^3 for the die and punch technology).
   - ✓ The machine is very light due to the absence of reciprocating parts and flywheel.
   - ✓ They have low ash content value and nearly an average calorific value of 4,300 kcal/kg.
   - ✓ Densified product is easy to transport and store.
   - ✓ It uses man power and also electric power to produce the biomass briquettes

2. **Disadvantages:**
   - ✓ The power consumed by this equipment is high compared to other briquette production systems.
   - ✓ The wear rate of the screw is very high.
   - ✓ There is a limitation on the raw material that can be compacted.
3. **Application:**
   - ✓ Boilers.
   - ✓ Food processing industries.
   - ✓ Domestic.
   - ✓ Gasification.
   - ✓ Charcoal.
   - ✓ Cooking and water heating.
   - ✓ For steam generation.

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