Design and Fabrication of Automated Biomass Briquetting Machine

Prof. Swapnil Solanki[1], Dhruvil Kotadia[2], Priyam Shah[3], Sarthak Soni[4], Smit Shah[5]

[1]*Assistant Professor, Department of Mechanical Engineering, Indus Institute of Technology and Engineering, Ahmedabad, Gujarat, India*

[2,3,4,5]*UG Student, Department of Mechanical Engineering, Indus Institute of Technology and Engineering, Ahmedabad, Gujarat, India*

Abstract: *Globally, fossil fuels are the major source for production of energy. It takes millions of years for the formation of fossil fuels. So, it is said that the production is low in regard to the demand. Such fuels generate higher amount of air pollution which leads to environmental issues like global warming. Therefore, it is now necessary to switch over to the alternate energy sources. After coal and oil, biomass is the third largest primary energy resource in the world. The agricultural residues are increasing day by day due to the higher agricultural production. But, those residues are usually burnt directly which results into air pollution. So, for efficient use of biomass wastes, biomass briquettes can be formed. Biomass Briquetting is the densification of loose biomass available such as agricultural residues, municipal waste and paper waste, etc. Biomass wastes such as sawdust, coir pitch, coffee husk, rice husk, forest leaves, coconut shells, etc. can be used for production of biomass briquettes. This paper focuses on design and fabrication of automated biomass briquetting machine. The main aim to manufacture such a machine is to help waste management and also to use such waste in an efficient way. This machine is designed in a way that it remains highly efficient and low cost.*

Key Words: Agricultural residues, briquettes, hopper, AC motor, speed regulator, grinding and mixing Blades, sieve plate, cylinder.

Introduction:

Biomass is an organic matter which is obtained from agricultural waste such as plant leaves, wheat flour, etc. Biomass waste is available in a huge quantity all over the world as it is produced at any place where plant and animal waste is produced. So, if this waste is treated properly, it can be used as a bio fuel which can replace coal and charcoal. The loose waste is compacted by a briquetting machine which is called a briquette. India is using the briquetting technique since decades (Example: preparation of cow dung cakes and balls of coal have been in use since the ancient times). The briquette possess high density so it is easy to handle, transport and store. The briquetting process can take place with or without the binding agents. Different binding agents like starch, coffee husk, wheat flour, etc. On the basis of data collected from some papers, it was found that the calorific value of the briquettes with wheat flour as binding agent is higher than that of coffee husk [1]. Such briquettes do not create much pollution as the raw materials used are already a part of the carbon cycle. Thus, it helps in keeping the atmosphere clean which leads to prevention of global warming. As this briquettes have better calorific value, the improved combustion characteristics help in the charging of furnaces [2]. In comparison to coal, the biomass briquettes on average saved 30-40% of boiler fuel cost [3].

Need for Biomass Briquettes:

The energy demand is increasing with the rise in the population and so there is a significant growth in the consumption of fossil fuels. The net energy demand cannot be satisfied with few conventional energy resources. So, to overcome the problems which may occur in the future, it is now necessary to use biomass energy. Biomass briquette is a solid fuel which is the best alternative available. India produces around 350 million tones of agricultural waste every year. Sorting of such waste is itself a tough task but this can be easily done by making biomass briquettes. Also, it can be used to replace coal for some applications. The study shows the agricultural residue availability (kg) per tonne of gram produced [2].

Crop	Crop Residue	Residue to Crop ratio	Agricultural residue availability (kg) per tonne of grain produced
Groundnut	Groundnut shell	0.33	330
Wheat	Wheat straw	1.47	1470
Paddy	Rice husk	0.33	330
	Paddy straw	1.53	1530
Sugarcane	Bagasse	0.25	250
Cotton	Cotton stalk	3.00	3000
Arhar	Arhar stalk	1.32	1320
Corn	Corn cobs	0.30	300
	Corn stalks	1.56	1560
Jute	Jute sticks	2.30	2300
Mustard	Mustard stalks	1.85	1850

Table 1

Literature Survey:

Many people have worked on this topic so as to depend on the renewable resources. Some people failed due to the low efficiency and less output. Hereby, keeping in mind the past experiences from the people who have contributed to this biomass briquetting technique.

Vinay V. Ankolekar and Sourabh S. Kulkarni showed the data of agricultural residue availability (kg) per tonne of grain produced and its alternative uses. Hereby, they showed that , nowadays, there is a significant rise in the availability of such residues due to higher agricultural production. They have also stated the advantages of briquetting of biomass , which are as under: the ease of charging the furnaces, increase in calorific value, improvement of combustion characteristics, and reduction of entrained particulate emissions and uniformity of shape and size.

Manjunath K S, Omprakash M, Niranjan Pangeni and Biradar Hanumant has made a briquetting machine which can be used for making briquettes of solid waste. They have used coffee husk as the binding agent. Although, there results show that the wheat flour could be a better binding agent as it will provide a briquette which is more compact and has more calorific value than the previous used binding agent. They have also shown that the green house gas emission produced through those briquettes would be much lower as the materials used are already a part of carbon cycle.

Kishan B S, Kiran Kumar, Santhosh T J and Amith D Gangadhar stated that the agricultural residues are very difficult to handle, transport and store. So, usually people opt for an easy way which is burning. But, it is clearly observed that if these residues are burnt directly it results in very poor thermal efficiency and creates lot of air pollution. They have made a briquetting machine with a grinding unit, career unit and compressing unit.

Methodology:

The project is divided into two types: Design and Fabrication.

The design of this model is developed in such a way that it can withstand all the forces acting on it. We have manufactured a horizontal design so that it can be used for higher output. Although, the horizontal frame may take more space than the vertical one but it is necessary to have more output and higher efficiency. The components and their workings are stated below:

- **Grinding Unit:** This unit consists of a Hopper, Motor, Grinder Blade, Sieve plate. The blade grinder and sieve plate is placed inside the hopper.
- **Hopper:** It is a type of cylindrical cone wherein the raw material is first kept.
- **Sieve Plate:** The sieve plate of 12 mm is used. As the study shows that this size is best suitable for formational of briquettes.
- **Grinding Blade:** This acts as a grinding member, and is made up of stainless steel. Based on the power input from regulator the blade rotates at certain RPM and grinds the raw materials, which then passes through the sieve plate. The raw material size of 6-12 mm is the best [4].
- **Motor:** Here we have used an AC motor of 250Watts, 230 Volts and 1400 RPM (with no load). And we have used a regulator to control the speed of the blade which is connected to the motor, as required on the amount of raw material to be grinded inside the hopper. The

motor is placed beside the hopper fitted on stand.

- **Mixing Blades:** Mixing blades are used to mix crushed raw material and binders for proper compaction in the compressing unit and to increase the density of briquettes. Mixing blades made of stain less steel and it is placed inside the sieve box. This mixing blades are fitted with a sprocket and chain mechanism and the mixing blades are rotated manually.

- **Pushing Plate:** Pushing plate is used to send mixed material from sieve box to connecting pipe, which is connected to from sieve box to cylinder. This is also driven by sprocket and chain mechanism and it rotates inside the sieve box. In each rotation some materials will be sent to the connection pipe.

- **Belt pulley:** A belt and pulley system is characterized by two or more pulleys in common to a belt. This allows for mechanical power, torque, and speed to be transmitted across axles. If the pulleys are of differing diameters, a mechanical advantage is realized.

Now, we will show the procedure of how the raw material will turn into the finished product (i.e. biomass briquette) by the use of above components.

Firstly, the raw material would be collected and then it will be poured into the hopper. Thereafter, we will start the AC motor which will help us to rotate the grinding blades. The speed regulator will control the speed of AC motor so that we can get the required size of raw material. The grinding blades will start rotating and thus the material will be grinded to almost 6-12 mm. The material will then pass to the sieve plate so that only the desired sized material can pass to the cylinder. In the cylinder, the material will be compressed and then this material will pass through a die so that we can get our desired shape. The pushing plate will then push the briquette outside of the machine. Thus, as you can see this is a fully automated process. It will therefore, require minimum man power.

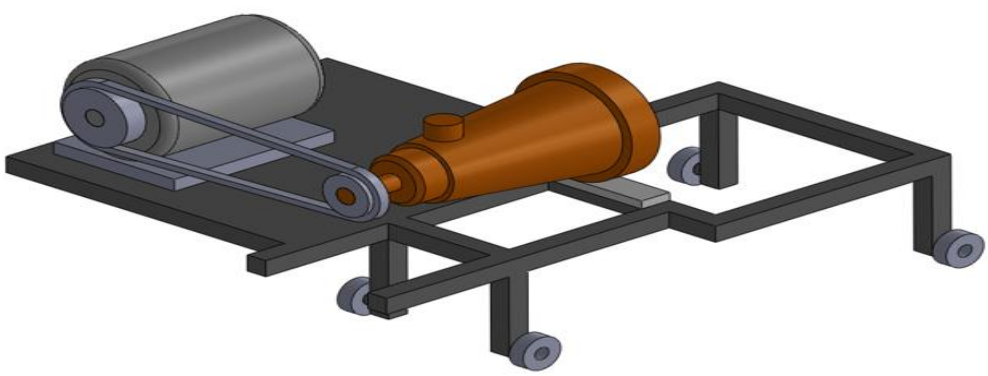
Material Specifications:

Table 2 shows the material selected for main components:

Sr. No.	Component	Material
1	AC Motor	1 HP
2	Wheel	Wood
3	Plate	Mild Steel
4	Frame	Mild Steel
5	Belt Pulley	MS Rubber

Table 2

3D Model:



Design Calculation [5] :

At an initial stage, we considered diameter as constant factor and so decided to produce the briquette of 7 cm diameter. Therefore, cylinder of 20 cm length and 3.5 cm radius was required. The thickness of the cylinder was considered at 1 cm as the cylinder will have to withstand high pressure. So, after the compression stage, we will get a briquette of 7 cm diameter and 7 cm height. On the basis of above data, we have carried out the calculations for hopper.

Volume calculation for hopper:

Volume of cylinder = $\pi \times r^2 \times h$

Volume of cylinder = $3.14 \times (3.5)^2 \times 200 = 769.69$cc

After the grinding of raw material takes place, the volume of grinded material will be equal to 1/3rd the volume of raw material (which was initially added to the hopper).

And since we are aiming to produce 5 briquettes for one completely filled hopper then again multiply volume by 5.

As our target is to produce 5 briquettes from one completely filled hopper, so we will again multiply the volume by 5.

So we get, Required Volume = $769300 \times 3 \times 5$

= 11545.35 cc

Actual Volume of hopper = $1/3 \times \pi(r1^2 + r1 \times r2 + r2^2) \times h$

= $1/3 \times 3.14 \times ((13.5)^2 + 135 \times 160 + (16)^2) \times 180$

= 12332.32 cc

So, by considering the hopper of dimension (r1 = 16 cm, r2 = 13.5 cm, h = 18 cm), the required volume of raw material can be grinded in the hopper and manufacturing of 4 to 5 briquettes can be easily done.

Conclusions and Future scope:

From this study, we can say that the agricultural residue can be easily handled at a very low cost. As this is an automated project, only the raw material is required to be poured. Therefore, we can say that the use of labours would be very much less. Also, more research and experiments should be carried out so that the biomass energy can also be used as liquid and gaseous fuels. Thus, Biomass energy is a boon to the world, so using it properly would definitely help in reducing the pollution and also it can be used as a substitute of coal for some applications.

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