Design And Fabrication Of Low Cost Briquetting Machine

Prof. Vishalsingh Rajput
Assitant Proff.
Dept.of Mechanical Engineering
NMIET
Talegaon Dabhade,India

Rakesh Rajesh Chavan
Student
Dept.of Mechanical Engineering
NMIET
Talegaon Dabhade,India

Nilesh Shantaram Desai
Student
Dept.of Mechanical Engineering
NMIET
Talegaon Dabhade,India

Sahil Dhanaji Nimbalkar
Student
Dept.of Mechanical Engineering
NMIET
Talegaon Dabhade,India

Ayush Rajendra Patil
Student
Dept.of Mechanical Engineering
NMIET
Talegaon Dabhade,India

Abstract— *Enormous amounts of biomass waste can be utilized as an elective method for fulfilling the energy need by briquetting. Biomass waste for instance: - Rice Husk, saw dust, nut shell, and so on, can become powerful and effective for clean energy usage in provincial regions when compacted as briquettes. This course of pressure and compaction is called as briquetting. To pack and conservative the Biomass squander in strong fuel a briquetting machine was created in this review. An electric motor of 0.5 hp and 1440 rpm was utilized to drive the machine.*

Watchwords: - Biomass waste, Briquettes, Briquetting machine, Rice husk, saw dust, Nut shell.

I. Introduction

Briquettes are utilized as an elective wellspring of energy. Briquette produced using waste material, for example, rice husk, groundnut shells, cotton stalks and husk of soya bean and rural waste has less fossil fuel byproduct. In India as well as unfamiliar nations a significant number of organizations changed from petroleum products to briquettes machine undertaking to get ecofriendly bio fuel and furthermore to save our current circumstance from contamination and CO2 emanation. The unrefined substance is joined and compacted into briquette to consume longer and makes the transportation of merchandise more straightforward.[1]

Briquettes are cheap than coal. There is no fly debris while consuming briquettes and have high consuming effectiveness. It is sustainable power source that improve our environmental factors or climate.[2]

In many non-industrial nations with expanding populace how much rural wastage additionally expanded. These wastages get decay and consumed because of this the smoke of the wastage cause air contamination. Along these lines, to keep away from this issue biomass briquette is one more approach to utilizing horticultural waste. It isn't legitimate method for consuming biomass squander straightforwardly in homegrown (cooking, warming) as well as industry applications (agro enterprises, food handling). There is likewise an issue of taking care of, stockpiling and transportation in regards to with it. To deal with the biomass, squander the proficient way is to deliver it as briquettes.[3]

Biomass is a natural matter which is gotten from agrarian waste, for example, plant leaves, wheat flour, and so on. Biomass squander is accessible in a gigantic amount all around the world as it is created where plant and creature squander is delivered. Thus, in the event that this waste is dealt with appropriately, it tends to be utilized as a bio fuel which can supplant coal and charcoal. The free waste is compacted by a briquetting machine which is known as a briquette. India is utilizing the briquetting strategy since many years (Model: planning of cow compost cakes and chunks of coal have been being used since the antiquated times). The briquette has high thickness so it is not difficult to deal with, transport and store. The briquetting system can happen regardless of the limiting specialists. Different restricting specialists like starch, espresso husk, wheat flour, and so forth. Based on information gathered from certain papers, it was found that the calorific worth of the briquettes with wheat flour as restricting specialist is higher than that of espresso husk. [1]

Briquettes are conservative blocks of compacted biomass materials, for example, sawdust, wood chips, rural buildups, or charcoal residue. These blocks are made by compacting the unrefined substances under high tension without the utilization of any folios or added substances. The course of pressure lessens the volume of the material as well as makes it simpler to deal with, transport, and store. Briquettes act as an eco-accommodating option in contrast to conventional fills like coal and kindling. They are broadly utilized for warming, cooking, and modern purposes. The development of briquettes is harmless to the ecosystem as it frequently uses squander materials that sounds disposed of, truly. Briquettes have arisen as a promising eco-accommodating arrangement in the domain of feasible energy. These little, minimized blocks of packed biomass materials have gotten some forward movement as an option in contrast to conventional powers like coal, kindling, and, surprisingly, melted oil gas (LPG). The most common way of making briquettes includes compacting different natural materials, for example, sawdust, wood chips, rural deposits, or charcoal residue, under high tension, without the requirement for covers or added substances. This pressure decreases the volume of the materials as well as changes them into a helpful and effective fuel source. [4]

II. Problem Definition

By and large, for crushing of biowastes, separate pulverized machines are utilized.

* The machines which are existing now are costly.

* A minimal expense briquetting machine, which changes over effectively accessible biomass waste into briquettes at higher proficiency can be made.

The utilization of briquettes as a wellspring of energy faces difficulties when contrasted with LPG gas, a generally utilized and helpful fuel choice. While briquettes offer eco-friendly and practical advantages.

III. METHODOLOGY

1. Define the Purpose and Objectives: -

Distinguish the particular reason for your briquetting machine, for example, delivering fuel briquettes from biomass buildups, and set clear targets for the task, including cost constraints

2. Research and Gather Information: -

Research existing plans and briquetting procedures to figure out the standards and best practices.

Assemble data on materials accessible for the task and their expenses.

3. **Determine the Machine Specifications: -**

Characterize the key determinations, like the kind of briquettes (e.g., shape and size), wanted creation limit, and manual or mechanical activity.

Decide the vital parts, including the edge, screw press, form, and handle.

4. Design the Briquetting Machine: -

Make a point-by-point configuration, including portrayals and computer aided design drawings, that integrates the determinations and goals.

5. Fabricate the Machine: -

Obtain the expected materials, like metal plates, lines, and poles, in view of your plan.

Use welding and metal working procedures to develop the casing, screw press, shape, and other machine parts.

Guarantee that the machine is solid and stable, taking into account security during activity.

6. Cost Analysis: -

Work out the absolute expense of materials, devices, and work utilized in the creation cycle.

Contrast the last expense with your predefined spending plan to guarantee that it stays inside the minimal expense range

7. Documentation for Replication: -

Make client manuals and gathering guidelines assuming that you intend to impart your plan to others keen on imitating your minimal expense briquetting machine

IV. Experimental test setup

- **Components used**

1. Frame

The frame is usually made of mild steel. It is strong enough to withstand all types of loads in working condition. All other parts are fitted to the frame. Frame is helping the supporting of the various light load support.

2. Shaft

A shaft is rotating machine element which is used to transmit power from one place to another. In order to transfer the power from one shaft to another, the various members such as pulleys, gears etc., are mounted on it.

3. Sheet

Sheet metal is metal that is formed into thin, flat pieces. Sheet metal is generally produced in sheets less than 6 mm. It is one of the fundamental forms used in metalworking and can be cut and bent into a variety of different shapes. Thicknesses can vary significantly.

4. Pneumatic Cylinder

A pneumatic cylinder is a mechanical device that uses compressed air to produce linear or rotary motion. It's a vital component in various applications, from manufacturing and automation to construction and transportation. Pneumatic cylinders operate on the principle of converting the energy stored in compressed air into mechanical motion.

5. Arduino

ATmega328P is a high performance yet low power consumption 8-bit AVR microcontroller that's able to achieve the most single clock cycle execution of 131 powerful instructions thanks to its advanced RISC architecture. It can commonly be found as a processor in Arduino boards such as Arduino Fio and Arduino Uno.

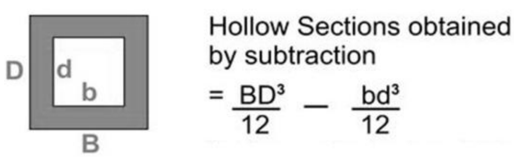
6. IR Sensor

IR sensor is an electronic device, that emits the light in order to sense some object of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation.

V. Calculations

1. To Calculate Total Load Developed On Frame:-

- Load On Frame Is 18 Kg = 18*9.81 = 176.58 N
- Maximum Distance From Neutral Axis Y = D/2 = 25/2 = 12.5 mm.
- D = 25 mm, B = 25 mm, T= 2 mm
- d = 21 mm, b = 21 mm



- Total Length Of Frame = L = 900 Mm
- Moment Of Inertia In X Direction
- I = 16345.33 mm^4

$$Mb = \frac{WL}{4} = \frac{176.58 \text{ X } 900}{4} = 39730.5 \text{ N-Mm}$$

W – Load Applied
L – Total Length

- Bending Stress Of Pipe

$$\frac{Mb}{I} = \frac{\sigma b}{y}$$

σb – Bending Stress
Mb – Bending Moment
I – Moment Of Inertia
Y – Maximum Dist. From Neutral Axis

$$\sigma b = \frac{39730.5 \text{ X } 12.5}{16345.33} = 30.383 \text{ N/Mm}^2$$

- Theoretical Bending Stress

$$\sigma b(th) = \frac{Syt}{f.s} = \frac{310}{1} = 310 \text{ N/Mm}^2$$

S_{yt} = Yield Tensile Strenth
F.S = Factor of Safety

$$\sigma b < \sigma b(th)$$

Hence Design Is Safe.

2. The Belt Drive Design:

➢ Design Parameter.

- Rated Power = 746 W (Range 746-1130 W)
- Belt material - Rubber belt
- Pully material – Cast Iron Pulley
- Drive motor Power - 0.5 HP. 240V 1400 RPM.
- Speed of drive Pulley i.e. motor N_1 = 1400 RPM
- Speed of driven Pulley N_2 = 900 RPM.

μ= 0.3, α=34^0, K_1= 1.3[Assumption (From design data book)]
Where,
μ= Coefficient of Friction
α= angle of the Belt

- Operating Condition = 8 hrs/ day
- Design Power (Pd) = Pr x K = 746 x 1.3 = 1000 W

On the basis of design Power, we Select V belt and the values are obtained from design data book is
Width of belt (W_b) = 13mm, Thickness of belt (t_b) = 8mm,
Dia of Pulley (Dp_1) = 75 mm

Belt velocity = $V_b = \frac{\pi \times Dp1 \times N1}{6000} = \frac{\pi \times 75 \times 1400}{6000} = 5.49$ m/s

Belt velocity (V_b) = 5.49 m/s
Speed ratio $\frac{N1}{N2}$ = 1.55 (From design data book)
$Dp_2 = Dp_1$ x Speed ratio = 75×1.55 = 117 mm
Minimum Centre Distance (Cmin) = $Dp_1 + Dp_2$ = 117+75 = 192 mm.
Cmin = 192mm (For analysis we are Consider 600 mm).

Angle of wrap (θ) = $\pi - \frac{Dp2-}{2C} = \pi - \frac{117-}{2\times600} = 3.106$ rad

3. Tension on tight Side and Slack side is

$$\frac{F1}{F2} = e^{\frac{\mu\theta}{\sin(\frac{\alpha}{2})}}$$

And,

$$Pd = (F1 - F2)Vp$$

From above eq^n we can Find out F_1 & F_2

$$Pd = (F2 \times e^{\frac{\mu\theta}{\sin(\frac{\alpha}{2})}} - F2)\,Vp$$

$$F2 = \frac{Pd}{(e^{\frac{0.3\times3.106}{\sin(\frac{34}{2})}} - 1) \times 5.49}$$

F_2 = 7.8456 N
F_1 = 189.99 N
Working load (Fw) = $w^2 = 13^2$ = 169 N
Centrifugal load (Fc) = $Kc \times (\frac{Vp}{5})^2 = 2.52 \times (\frac{5.49}{5})^2$
Centrifugal load = 3.038 N

Bending load (F_b)= $\frac{Kb}{Dp1} = \frac{17.6\times10^3}{75} = 234.66\ N$

Bending load = 234.66 N

Resultant load (Fr) = $\sqrt{(F1^2 + F2^2 - 2 \times F1 \times F2 \times cos\theta)}$

$=\sqrt{(190^2 + 7.845^2 - 2 \times 190 \times 7.845 \times cos 3.106}$

Resultant load = 197.84 N

4. Torque Transmitted by belt:

$$T = Fr \times \frac{Dp1}{2} = 197.84 \times \frac{75}{2} = 7419\ N.mm$$

weight of Pulley (W_p) = $\rho \times Vg \times N$

Volume (V) = $\pi \times r^2 \times w \times m^3$

$r = rp2 - t = 58.5 - 8 = 50.5\ mm = 0.0505\ m$

ρ =7850 kg/m³.

V = $\pi \times 0.0505^2 \times 0.013 = 1.0415\ m^3$

$Wp = 7850 \times 1.0415 \times 9.81 = 8.02\ N$

5. Calculations about Briquette

- **Amount of Energy Required to regular meal.**

Table No: - 1 Total energy needed and time Required

Sr. No.	Food	Total Energy Needed (Kcal/kg)	Time Required to cook per Kg (Min)
1.	Rice	79.3	15
2.	Meat	56.5	40
3.	Leafy Vegetables	74.5	20
4.	Water	72	8

Qn is the needed energy for cooking food.

This can be determined based on the amount of food to be cooked and/or water to be boiled and their corresponding specific heat energy. The amount of energy needed to cook food can be computed using the formula.[5]

$$Qn = \frac{Mf \times Es}{T}$$

Where:

Qn - energy needed, Kcal/hr

Mf - mass of food, kg

Es - specific energy, KCal/kg

T - cooking time, hr

A kilogram of rice has to be cooked within 15 minutes, what is the energy needed to cook the rice,

$$Qn = \frac{1x79.3x60}{15} = 317.2kcal/hr$$

Table No. 02 Energy Needed

Sr.No.	Food	Energy Needed (Kcal/Hr)
1.	Rice	317.2
2.	Meat	84.75
3	Leafy Vegetables	223.5
4.	Water	540

- **Heating Value Of Fuel (Hvf):-**

In the below table the list of different fuels is given with their respective heating value (calorific value) which will be used as raw biomass for burning.[5]

Table No. 03 Heating Value of Fuel

Sr. No.	Fuel	Fcr (Kg/Hr)
1.	Rice Husk	0.170
2.	Wood Chip	0.110
3	Coconut Husk	0.120
4.	Maize Stalk	0.139
5.	Coconut Shell	0.101
6.	Sugarcane	0.132
7.	Groundnut Shell	0.113
8.	Rice Straw	0.151
9.	Saw Dust + Cow Dung	0.135
10.	Wheat Straw	0.128

- **Fuel Consumption Rate (Fcr):**

This Refers to The Amount Of Energy Needed In Terms Of Fuel For Burning. This Can Be Computed Using the Formula,

$$Fcr = \frac{Qn}{HvF£}$$

Where:

Fcr - Fuel Consumption Rate (Kg/Hr)
Qn - Heat Energy Needed (Kcal/Hr)
Hvf - Heating Value of Fuel (Kcal/Kg)
Ξ - Efficiency of Briquette (%)

$$FCR = \frac{317.2}{3105*0.6} = 0.17\text{kg/Hr}$$

Table No. 04 Heating Value of Fuel

Sr. No.	Fuel	Hvf (Kcal/Hr)
1.	Rice Husk	3105
2.	Wood Chip	4785
3	Coconut Husk	4371
4.	Maize Stalk	3800
5.	Coconut Shell	5200
6.	Sugarcane	3996
7.	Groundnut Shell	4661
8.	Rice Straw	3500
9.	Saw Dust + Cow Dung	3898
10.	Wheat Straw	4100

VI. Design of Briquette Machine

- Briquette Machine:

Fig. No. 01: Briquette Machine

VII. Results

- Comparative analysis of Sawdust briquette

Table No. 05 Physical Properties of sawdust briquette

Sr. No.	Parameters	Unit	Observation	
			Calculated Values	Referred Values [6] [7]
1	Moisture	g/100g	4.02	5.04
2	Total Ash	g/100g	3.28	3.85
3	Calorific Value	kcal/100g	4427	3898

- Comparative analysis of soya husk briquette

Table No. 06 Physical Properties of soya husk briquette

Sr. No.	Parameters	Unit	Observation	
			Calculated Values	Referred Values [1]
1	Moisture	g/100g	5.27	-
2	Total Ash	g/100g	2.06	4.10
3	Calorific Value	kcal/100g	3946	4170

Results of this study show that in case of sawdust briquette the calorific values of calculated value is higher than referred value and the ash content and moisture content is low.
In case of soya husk briquette both calorific value and ash content is low compared to referred value.

VIII. Conclusion

Using Screw press technology & belt drive mechanism, we design and fabricated briquette machine. We tested our machine with two raw different material such as sawdust and soya husk. Calorific value of saw dust briquette was higher where as in case of soya husk briquette calorific value is lower compare to the referred value. Hence this prototype helps us to meet our objectives and to produce good quality briquettes with higher calorific values and with low ash and moisture content.

IX. References

[1] Nikhil J. Gajbhiye, Laukik P. Raut "Briquettes making machine for industrial and agricultural purpose" Volume: 05 Issue: 02 | Feb-2018

[2] Prof. Swapnil Solanki, Dhruvil Kotadia, Priyam Shah, Sarthak Soni "Design and Fabrication of Automated Biomass Briquetting Machine" Volume: 07 Issue: 04 | Apr 2020

[3] Francis Inegbediona and Tina Ishioma Francis- Akilaki "Design and Fabrication of a Briquetting Machine" 21 March 2022

[4] Study of Biomass Briquettes, Factors Affecting Its Performance and Technologies Based on Briquettes e-ISSN: 2319-2402, p- ISSN: 2319-2399.Volume 9, Issue 11 Ver. II (Nov. 2015), PP 37-44 Shreya Shukla1, Savita Vyas.

[5] Alexis T. Belonio," Rice Husk Gas Stove Handbook", (2005), Department of Agricultural Engineering and Environmental Management, College of Agriculture, Central Philippine University, pp no.1-155

[6] Physical and Combustible Properties of Briquettes Produced from a Combination of Groundnut Shell, Rice Husk, Sawdust and Wastepaper using Starch as a Binder Vol. 24 (1) 171-177 January 2020

[7] Francis Inegbedion estimation of the moisture content, volatile matter, ash content, fixed carbon and calorific values of saw dust briquettes Volume 10, Issue 1, (2022).