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Development and Evaluation Analysis of a Briquetting Machine

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ABSTRACT: *The development of a briquetting machine tailored for the conversion of agricultural waste into briquettes marks a significant stride towards sustainable waste management and renewable energy production. This research delves into various facets of design and fabrication, refining and implementing processes to enhance efficiency. The study also investigates the effects of various machine factors on the performance of briquetting machines, focusing on the impact of briquetting temperature, mass of the substrate, and sample characteristics on several critical properties of the produced briquettes. Through a meticulous analysis, the intricate dynamics governing the drying process of Sample B are unveiled. Optimal results were achieved with a drying duration of 1.5 days at a briquetting temperature of 200°C, emphasizing the delicate balance crucial for effective drying. Sample B exhibits notable attributes, boasting a compression capacity of 4340 N, a mass of 9.03 g, and a volume of 23.98 ml. It showcases superior density and water resistance at 0.38 gml^{-1}, while Sample C demonstrates combustibility with a burning rate of 0.00615 gs^{-1}. Performance optimization factors yield a desirability level of 1.0, indicating the excellence of this research work. The study elucidates optimal parameters for maximizing desired outcomes, validating the efficacy of the experimental methodology employed. Furthermore, it underscores the potential applications of resin samples in industrial and laboratory briquetting research, showcasing their versatility and suitability for diverse purposes. This research underscores the importance of comprehensive methodologies in uncovering solutions that meet rigorous criteria for performance, desirability and reliability, thus contributing significantly to the advancement of briquetting processes and their practical applications.*

KEYWORDS: *Agricultural waste, briquetting machine, combustible, energy supply, renewable.*

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I. INTRODUCTION

In recent years, there has been a growing global emphasis on sustainability and efficient waste management due to increasing environmental concerns and the depletion of natural resources. One significant challenge is managing biomass and other organic waste materials, which often end up in landfills or are incinerated, contributing to pollution and greenhouse gas emissions. Briquetting machines offer a viable solution by converting these waste materials into high-density fuel briquettes, which can be used as a sustainable energy source. The importance of energy services to the socioeconomic development of a country has been extensively documented in literature [1]. Access to modern energy services is closely related to improvements in other facets of human development such as healthcare, water supply, education, environmental cleanliness, job creation, food security etc. [2]. In spite of this socio-economic importance, energy availability remains a huge problem in developing countries partly due to underdevelopment of the energy sector, poor infrastructural development, political instability and imbalance between increasing population and energy supply. World energy demand is expected to grow more than 50% in 2030 (16.3 billion tons of oil equivalents), of which two-thirds is derived from oil and natural gas [3]. Fossil fuels still represent the main energy supply worldwide, and oil is expected to remain the dominant energy source over the next decades. Developing countries, which feature relatively high population growth and accelerating economies, dominate as the biggest consumers in this projection, holding a share of more than two-thirds of this increasing amount [4].

Briquetting technology involves compressing materials such as agricultural residues, wood chips, and industrial by-products into compact forms, which can be easily handled, transported, and utilized as fuel. This technology not only helps in managing waste but also provides an alternative to conventional fossil fuels, which are depleting and contribute to environmental degradation. Briquette is a solid fuel of compressed combustible material suitable for heating. Briquetting is a mechanical treatment technique used to upgrade loose biomass material into higher density and uniform solid fuel via compaction [5]. This approach improves the physical characteristics of the briquette and enhances its combustion efficiency. It can be used as fuel for many heating purposes. It is a key strategy to make a clean, green and healthy environment [6]. Briquettes are a source of renewable energy from sawdust, oil palm residues, coconut shell, and rice husk, charcoal from low density wood, agro-forestry waste material and municipal waste. It is an affordable alternative to petroleum in view of the current fuel shortage and ever-rising prices. Briquettes of different shapes and sizes are made by applying pressure, heat and binding agent to biomass loose materials [3]. It can be made manually or by machines. Briquettes are widely used for many thermal applications which include steam generation in boilers, domestic heating purposes, flammable materials in brick kilns, paper mills, chemical units, dyeing houses, food processing units and oil mills [7]. Biomass densification, which is also known as briquetting of sawdust and other agro residues, has been practiced for many years in several countries [8]. Two main high pressure technologies: ram or piston press and screw extrusion machines, are used for briquetting. Historically, as reported by Kumar *et al.* [9] both technologies have their merits and demerits, it is universally accepted that the screw pressed briquettes are far superior to the ram pressed solid pellets in terms of their storability and combustibility. The decreasing availability of fuel wood, coupled with the ever-rising prices of kerosene and cooking gas in Nigeria, draw attention to the need to consider alternative sources of energy for domestic and cottage level industrial use in the country. Such energy sources should be renewable and should be accessible to the masses. Hence, the central problem addressed in this study is the need for a thorough understanding and evaluation of briquetting machines to optimize their performance, efficiency, and environmental benefits. Specifically, the research aimed at designing, fabricating and evaluating a briquetting machine to help in waste management by converting waste to energy through the production of briquettes from biomass waste.

II. MATERIALS AND METHODS

2.1 Design consideration

The materials to be used for the construction of the briquetting machine were selected based on the following factors that were considered.

i. Cost: Since this determines the cost at which the briquetting machine will be sold and its affordability. The cost of materials to be selected will be low without prejudice to the strength and quality of the machine.
ii. Strength: The materials to be selected will be of adequate strength and can offer high resistance to wear and not easily deformed.
iii. Appearance: The materials to be selected will possess a good finishing.
iv. Availability: The materials must be locally available so that if there is need of replacing any component, much time will not be wasted.

2.2 Components of the briquetting machine

i. **Hopper:** This is used for the temporary storage of materials. It was designed so that the stored material can be fed to briquetting machine easily.
ii. **Screw propeller:** This is a device consisting of a set of angled blades revolving around a hub to provide thrust. It was placed in the barrel to generate the required pressure and heat.
iii. **Barrel:** The extruder barrel is the housing that contains the screw propeller. The entire briquetting barrel was fabricated in two segmented for easy cleaning during maintenance.
iv. **Frame:** Machine frame carries the entire load of the machine; it also adds to the aesthetic of the machine however, it was bolted to the floor to provide added stability.
v. **Electric motor:** An electric motor is a device that turns electrical energy into mechanical energy. It produced the rotational motion for the machine also known as the prime mower

vi. **Band heater:** This uses electric heating elements (NiCr wire) to heat-up the external surface of the barrel for a gradual heat transfer to carbonize the sawdust and dries the briquette for rigidity.

vii. **Bearings:** These are mounted on the frame; they are used to provide load support for a rotating shaft, located at two different points on the shaft.

viii. **Thermocouple:** Thermocouple is a sensor for measuring temperature. This sensor consists of two dissimilar metal wires, joined at one end, and connected to a thermocouple thermometer at the other end.

ix. **Forming cylinder:** It is the second segment of the barrel, where the briquette takes it shape.

The research methodology involved the conceptualized design of the briquetting machine, proper material selection followed by detailed design calculations in accordance with engineering specifications with the relevant engineering drawings. Thereafter, the fabrication and development of the machine was carried out using locally sourced materials and lastly the preparation of the biomass wastes for the production of briquettes.

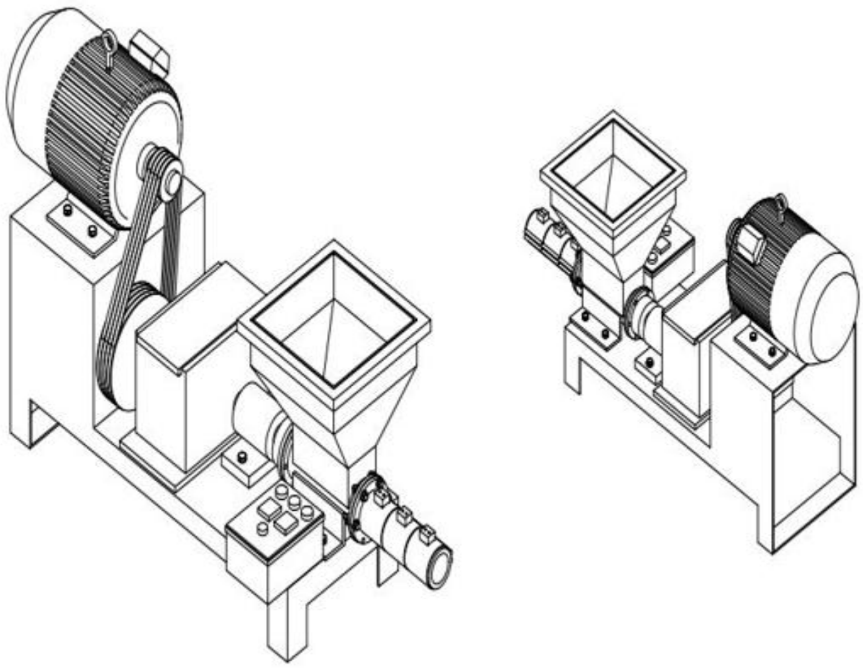


Fig. 1. Conceptual design of the briquetting machine

2.3 Design analysis of the briquetting machine

The essential components of the briquetting machine was analyzed, to determine the dimensions and stress on each element. The essential machine elements to be designed are hopper, barrel, screw, belt and pulley and shaft. The laboratory experiment on various physical properties of Gmelina sawdust was investigated, including the angle of inclination (θ), density (ρ), mass (m), and the volume of the container (V). These parameters were measured and analyzed to gain insights into the characteristics and behaviour of Gmelina sawdust under specific conditions. The experimental data obtained from these measurements contribute valuable information on the parameters required for the design of the hopper. The experimental results showed that θ is 31.2^0, m is 13.07 g ±0.5, and V is 0.001406 m^3.

The values 200 mm, 250 mm, and 100 mm were selected for a, b, h_o, and h_1 respectively. The value x was determined to be 150 mm and the inlet length of the hopper, b was determined to be 500 mm. The volume of the hopper, V_h is the sum of the volume of the frustum (V_a) and the volume of the cuboid (V_b). Mathematically;

$$V_h = V_a + V_b \quad (1)$$

The volume of the frustum, V_a is given as;

$$V_a = \frac{h}{3}\left(A_1 + A_2 + \sqrt{A_1 A_2}\right) \quad (2)$$

Where h is the height of hopper (m), A_1 is the area of the hopper inlet (m^2) and A_2 is the area of hopper outlet (m^2).

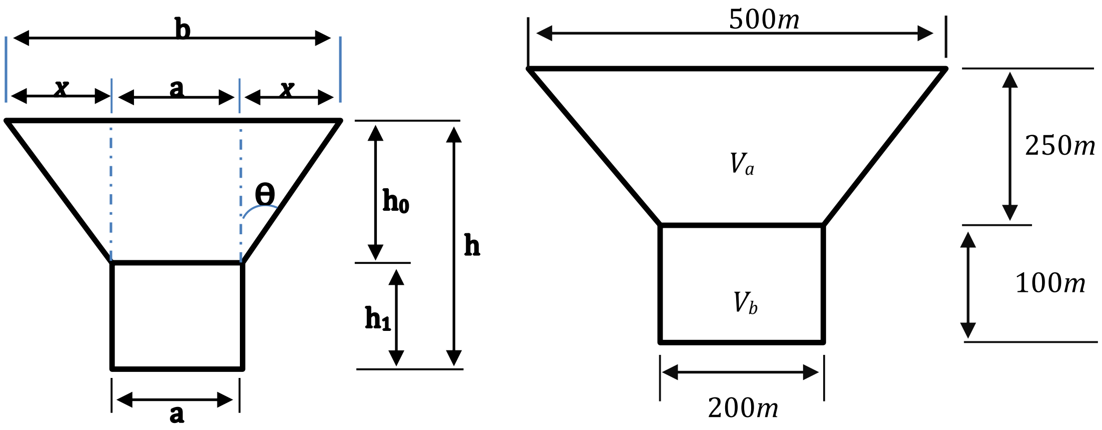


Fig. 2. The hopper configuration

The volume of the cuboid V_b was determined using;

$$V_b = A_2 \times h_2 \tag{3}$$

Where A_2 is the area of hopper outlet (m^2) and h_1 is the height of the hopper extension (m).
Therefore, the volume of the hopper, V_h was determined to be 0.0030 m^3. The density of Gmelina Saw dust was determined in the laboratory to be 9.74 kg/m^3, with a mass of 13.7 g which occupied a container of 1.4 x 10^{-3} m^3 in volume. The total weight of saw dust in the hopper was assumed to act directly on the peripheral of the rotating shaft.

$$\rho = \frac{mass}{volume} = \frac{m}{V} \tag{4}$$

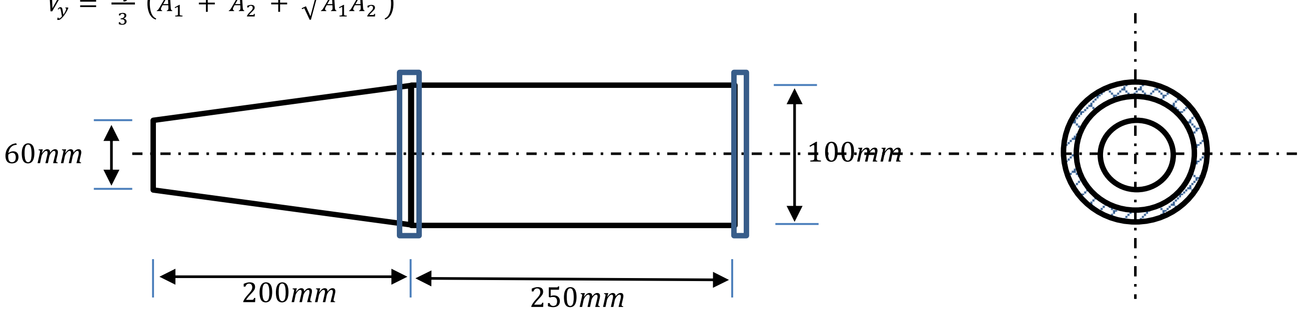
Where, m is the mass of saw dust occupied in the hopper (kg), v is the volume of the hopper (m^3) and ρ is the density of the saw dust (kg/m^3).
From the analysis, the hopper can accommodate Gmelina saw dust of 290 g per batch.

2.3.1 Barrel design

The barrel of the briquetting machine is cylindrical in shape. Also known as cylindrical shell. The volume of the barrel V_{barrel} is the sum total of straight barrel and tapered barrel.
∴ Volume of straight cylinder, V_x

$$V_x = A_x \times h_x \tag{5}$$

$$V_y = \frac{h_y}{3}\left(A_1 + A_2 + \sqrt{A_1 A_2}\right)$$



So, the volume of barrel is 0.00227 m^3.
The thickness of the barrel was determined using the following equations 6 [10]. Allowable stress (f) is given as;

$$f = 0.67 \times Re \tag{6}$$

$$Required\ wall\ thickness, D_r = \frac{P_d \times D_e}{2 \times Z \times f \times P_d} \tag{7}$$

Where Re is Yield stress for mild steel, De is the outside diameter, Z is strength reduction coefficient, and Pd is the Design Pressure. Yield stress of mild steel is 250 MPa, then;
Allowable stress, $f = 0.67 \times 250\ mPa = 1.67 \times 10^8\ mPa$
Again

$$D_r = \frac{P_d \times D_e}{2 \times z \times f + P_d} \; D_r = \frac{662.175 N/m^2 \times 0.1m}{2 \times 1 \times 1.675 \times 10^8 + 662.175 N/m^2} = 6.22\, mm$$

Considering a factor of safety of 0.5, the barrel thickness for the briquetting machine is

$$6.22 + 0.5 \cong 7\, mm$$

The selected barrel thickness was 8 *mm.*

2.3.2 Determination of power required to drive the screw

Power required by the screw anger to compress/densify the Gmelina saw dust was determined using the equation 8 proposed by Chen *et al.* [11].

$$E_p = 0.00053 \times M_{dot} \times C \times T \qquad (8)$$

Where E_p is the Briquetting Power, M_{dot} is the Mass flow rate per hour, C is the specific heat and T is the Temperature change within the barrel.

To determine the mass flow rate per hour of the briquetting machine (M_{dot});

$$\rho_0 = \frac{mass\ of\ briquett}{volume\ of\ briquett} = \frac{m}{V}$$

ρ_0 is the expected briquette density of Gmelina $(150\, kg/m^3)$, then the surface area of the briquette was determined as follows;

$$A_0 = A_{external} - A_{internal} = \frac{\pi {d_e}^2}{4} - \frac{\pi {d_i}^2}{4}$$

$$V_0 = A_0 \times h_0$$

Where A_0 the area of briquette and h_0 is the length of briquette

$$A_0\ and\ m_0\ were\ calculated\ to\ be\ 0.0025\, m^2\ and\ 37g\ respectively.$$

The mass flow rate per second is 37g

$$\therefore 37\, g/s \equiv 133.2 kg/h$$

During briquetting, there will be an increase in temperature. The change in temperature was determined using the equation 9 used by Ibitoye *et al.* (2023);

$$\Delta T = t_2 - t_1 \qquad (9)$$

Where ΔT is the change in temperature, t_1 is the initial temperature of saw dust and t_2 is the temperature of the forming cone.

The expected temperature of the briquette is 222°C, Specific Heat H_C = 0.2Kcal (kg°C) then;

$$E_p = 0.00053 \times M_{dot} \times H_C \times \Delta T = E_p = 3.13 hp = 2.33\, kW$$

2.3.3 Determination of torque

The torque on the shaft was calculated using equation 10 [12];

$$w = \frac{2\pi N_1}{60} \qquad (10)$$

Where N_1 is the speed of driven pulley.

According to Mwamlima *et al.* [13] the maximum speed of extruder shaft is 352 rpm.

$$w = \frac{2 \times 3.142 \times 352\, rpm}{60} = 36.87\, rps$$

$$\therefore Torque = \frac{P}{w} = \frac{2330}{36.87} = 63.20\, Nm$$

The torque of the driven shaft is 63.2 Nm

2.3.4 Shaft design

Using the standard equation 11 from Soyoye [14] diameter of screw anger shaft was determined thus:

$$d^3 = \frac{16}{\pi\tau}\sqrt{(M_b \times K_b)^2 + (M_t \times K_t)^2} \qquad (11)$$

Where M_b is the maximum bending moment, M_t is the maximum torsional moment, K_b is the combined shock and fatigue factor for bending, K_t is the combined shock and fatigue factor for torsion, d is the Diameter of shaft and τ is the maximum permissible shear stress.

The weight of the saw dust in the barrel and hopper at full capacity and weight of the warm were directly acting on the shaft. The shaft is suspended on two supports that kept it balanced.
The reacting force to keep the shaft balanced was determined as follows;

The warm has been designed with the thickness of 15 mm and 250 mm long. Density of mild steel, ρ_m is 7860 kg/m^3.
Area of shielded portion, A_w;

$$A_w = \frac{\pi {d_1}^2}{4} - \frac{\pi {d_2}^2}{4} = \frac{3.142 \times (0.06^2 - 0.03^2)}{4} = 0.00212\, m^2$$

The volume of the warm screw, V_w

$$= A_w \times h = 0.00212 \times 0.25 = 0.00053\, m^3$$

Knowing that $\rho = \frac{m}{v}$

$$m = \rho v = 7860 \times 0.00053 = 4.167\, kg$$

$$Weight\ (W_{warm}) = mg = 4.167 \times 9.81 = 40.88 \text{ N}$$

A rod of 12 mm was coiled to the warm.

$$A_{rod} = \frac{\pi\, 0.012^2}{4} = 0.0001131\, m^2$$

$Volume\ the\ rod\ used\ is\ 1.13 \times 10^{-4}\, m^3$
Mass of rod, $m = \rho \times v = 7860kg/m^3 \times 1.13 \times 10^{-4} m^3 = 0.89\, kg$

$$Weight\ (W_{rod}) = 0.89 \times 9.81 = 8.72 \text{ N}$$

The total weight of the warm screw is;

$$W_{warm\ scew} = W_{warm} + W_{rod} = 40.88\text{N} + 8.72\text{N} = 49.6\text{N}$$

Where; A is the weight of warm, B is the weight of saw dust in the hopper, C is the weight of densified saw dust in the barrel, R_1 is the first reaction and R_2 is the second reaction (bearing).
Determination of shear force
Taking the moment at R_1
Clockwise reaction = Anti-clockwise reaction

$$R_2 \times 0.15 = -55.78 \times 0.205$$
$$R_2 = -76.23\text{N}$$

Upward Forces = Downward forces

$$R_1 = R_2 + 55.78 = 132.1\text{N}$$

Determination of the Bending Moment
Starting from point A
Point A; -55.78 x 0 = 0 N*m*
B; -55.78 x 0.205 = -11.435 N*m*
C; -55.78 x 0.335 + 132.01 x 0.15 = 1.1 N*m*
The maximum bending moment is 11.435 N
Then,

$$d^3 = \frac{16}{3.142 \times 42 \times 10^6}\sqrt{(11.44 \times 2.0)^2 + (63.2 \times 2.0)^2}$$
$$d = \sqrt[3]{0.0000154} = 0.0248m = 24.8mm$$

Let the factor of safety for Screw press shaft be 2.0
The diameter of shaft, d= 2 x 24.8 *mm* = 49.6 *mm*
From the standard table, 50 mm shaft was selected.

III. RESULTS AND DISCUSSION

Experimental results and interpretation of results on the effect of machine factors like temperature, mass of substrate, samples etc. on the performance of the machine and responses of briquette formed to drying time, density and water resistance, compression capacity, burning rate, ash content were carried out in this research work and discussed in detailed, with the inclusion of fabrication procedure.

3.1 Effect of briquetting temperature and mass feed rate on the drying time

The drying process is a critical step in briquette development, food processing, agriculture and manufacturing. It was observe that higher temperatures generally accelerate the drying process due to increased evaporation rates. When the temperature of extrusion of briquette was 60℃ the drying time extends to 5 days. This relatively lengthy duration suggests that the rate of moisture removal from the material is relatively slow. Despite the moderate heat, other factors such as material composition, thickness, and moisture content may hinder efficient evaporation. Francis and Francis-Akilaki [15] corroborate this in their research on briquetting machine. Additionally, the low thermal energy might not provide sufficient kinetic energy to overcome the intermolecular forces holding water within the material, inconsequence; the drying process was prolonged. When temperature increased to 100°C during extrusion of briquette a significant reduction in drying time was experienced, reducing the drying time to 4 days. The higher thermal energy at this temperature accelerates the evaporation rate by providing the necessary kinetic energy to water molecules, overcoming intermolecular forces more effectively. Bahadır [16] was in consonance with this observation. Consequently, moisture was expelled from the material at a faster rate, leading to a shorter overall drying time. However, despite the improvement, the drying time remains relatively long, suggesting that other factors may still contribute to the overall efficiency of the process. Integration of the temperature to higher temperature of 200°C remarkably reduces the drying time to 1.5 days of sun drying. When this elevated temperature was attained thermal energy was significantly increased, resulting in a much more rapid evaporation rate. Water molecules within the material gain sufficient kinetic energy to break free from the material's structure, leading to efficient moisture removal. Kobilov [8] made similar report in his research on binding efficiency on the briquettes production. Additionally, the increased temperature may enhance airflow and promote better moisture diffusion, further expediting the drying process. Consequently, the drying time is substantially reduced compared to lower temperatures. This suggests that the observed differences in drying times among the various temperature and mass feed rate combinations are unlikely to occur by chance alone. Instead, they are likely influenced by the specific conditions employed during the drying process. Figure 3 showed that 200ºC and mass of 88.73 g has the highest performance in terms of sun drying time of 1.5 days while 60ºC and mass of 63.65 g was the lowest in terms of drying time.

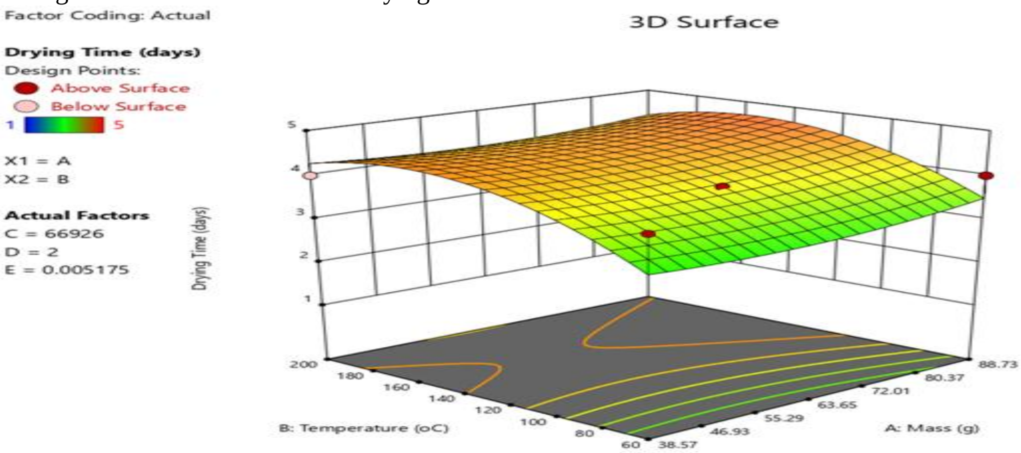


Fig. 3. Effect of briquetting temperature and mass feed rate on the drying time

3.2 Effect of mass and volume of water on the density and water resistance capacity

The relationship between mass, volume, density and water resistance capacity is crucial in understanding the physical properties and behaviour of materials used for briquettes production, particularly in substances like liquids [2]. This research enables us to corroborate, that when the mass of a substance increases while the volume remains constant, the density also increases. Conversely, if the volume increases while the mass remains constant, the density decreases. All samples of briquettes were soaked in water for 5 min. Sample A with mass of 6.29 g occupies a volume of 23.50 ml resulting in a density and water resistance capacity of 0.27 gml^{-1}. Vaish *et al.* [17] was in consonance with this observation in densification of briquette. Relatively lower density was observed compared to Samples B and C. This suggests that Sample A has a lower mass-to-volume ratio compared to the other samples, indicating that its particles are less tightly packed and its compression rate is low. Sample B have a mass of 9.03 g occupying a volume of 23.98 ml, resulting in a density and water resistance capacity of 0.38 gml^{-1}. Unlike Sample A, Sample B exhibits a higher density. This implies that Sample B has a greater mass-to-volume ratio, indicating that its particles are more tightly packed compared to Sample A. Sample C has a mass of 7.55 g occupying a volume of 20.55 ml, resulting in a density and water resistance capacity of 0.37 gml^{-1}. Similar to Sample B, Sample C demonstrates a higher density and water resistance. This suggests that Sample C, like Sample B, has a greater mass-to-volume ratio compared to Sample A. Comparing the three samples we can draw inference, there is a clear correlation between mass, volume, and density and water resistance capacity. If the mass increases while the volume remains relatively constant or decreases at a lower rate, the density tends to increase, as observed in Samples B and C. contrarily, when the volume increases at a relatively higher rate compared to the increase in mass, the density tends to decrease, as seen in Sample A, Sunday *et al*. [18] made similar resolution in it research on characterization of charcoal briquettes from butter seed shell. The differences in density among the samples can also have implications for their water resistance capacity. Higher density generally indicates a greater resistance to water penetration. Therefore, Samples B and C, with higher densities and water resistance compared to Sample A will exhibit better water resistance capacity. Figure 4 illustrates the relation between Samples A, B and C, mass, volume relative to density and water resistance.

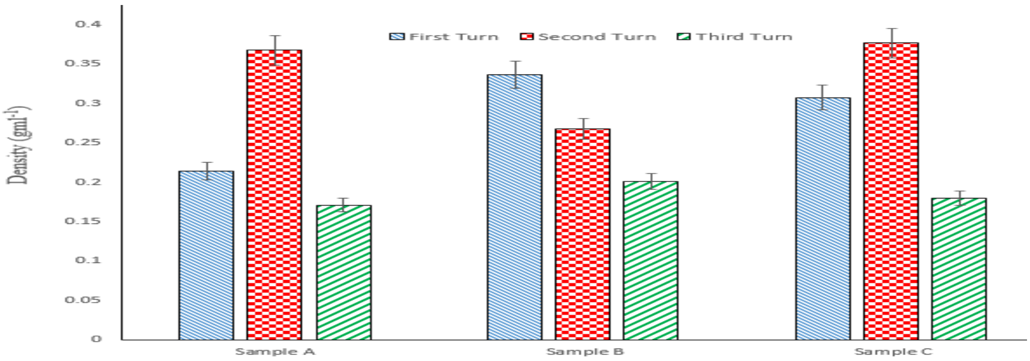


Fig. 4. Effect of mass and volume of water on the density and water resistance capacity

3.3 Impact of volume on the compressional strength

The relationship between volume and compressional strength is a critical aspect of material science, influencing the structural integrity and performance of various substances under pressure [12]. Three samples labeled A, B, and C, each were subjected to varying levels of force and possessing different volumes. Sample A, with a volume of 71095.22 mm^3, endured a force of 1482.00 N. Sample B, with a slightly larger volume of 72484.36 mm^3, faced a higher force of 4340.00 N. Sample C with the largest volume among the three at 87231.0 mm^3 experienced a force of 3830.00N. Onwugbuta *et al*. [19] was in consonance with this observation in their research on conversion of waste to briquettes. In Sample A, it was observed that despite experiencing the lowest force among the samples, it possesses the smallest volume. This suggests that within the confines of its smaller volume, the material demonstrated notable compressional strength, resisting the applied force to a considerable extent. The relationship between volume and strength becomes evident here; a smaller volume may imply a denser material or a more tightly packed structure, leading to enhanced strength properties. Ajith *et al.* [20] made such observation in is comparative research work of briquette from biomass and charcoal. Sample B with a moderately larger volume, faced a substantially higher force. The increase in volume appears to coincide with a corresponding increase in the force applied. This indicates that while the material within Sample B may possess inherent strength, its ability to withstand forces is somewhat compromised due to its larger volume. The effect of volume on compressional strength is apparent, as the material's capacity to resist deformation or failure diminishes with increasing volume (Figure 5). Sample C provides further insights into this relationship, featuring the largest volume among the three samples. Despite experiencing a force comparable to Sample B, Sample C's larger volume likely contributed to its relatively lower compressional strength. The expansive volume necessitates a larger surface area for the force to act upon, potentially leading to greater deformation or structural failure. Thus, while Sample C may still exhibit notable strength properties, its performance under pressure is somewhat hindered by its voluminous nature.

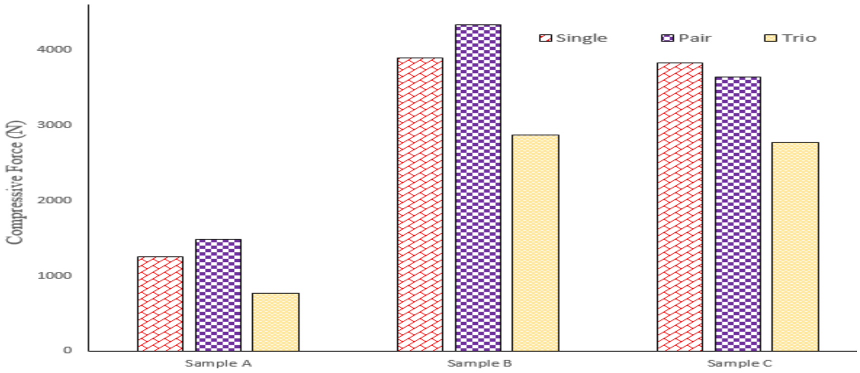


Fig. 5. Impact of volume on the compressional strength of the briquette produced

3.4 Effect of briquette mass and burning time on the burning rate

The research investigated the effect of different sample compositions on burning rate, specifically comparing Sample A, Sample B, and Sample C, each sample was allowed to burn differently for duration of 600 s to 840 s with measured masses and burning rates. Sample A has a mass of 3.68 g and a burning rate of 0.00613 gs^{-1}, Sample B has a mass of 3.72 g and a burning rate of 0.00620 gs^{-1} and Sample C has a mass of 3.69 g and a burning rate of 0.00615gs^{-1} as their highest rate of burning among all the five replicates (Figure 6). These observed differences in burning rates could be attributed to various factors, including differences in chemical composition, physical structure, or environmental conditions during the burning process. For instance, slight variations in the composition of the samples, such as impurities or additives, could influence their combustion properties [21]. Similarly, differences in the density or porosity of the samples could affect how readily they burn and the rate at which they consume fuel [22]. Environmental factors such as temperature, humidity, and airflow can also impact burning rates. Small fluctuations in these variables could contribute to differences in combustion behavior between the samples. Variations in the ignition process or the geometry of the burning surface could affect the observed burning rates. Also; Yusuf *et al.* [23] have same resolution on briquette charcoal from rice.

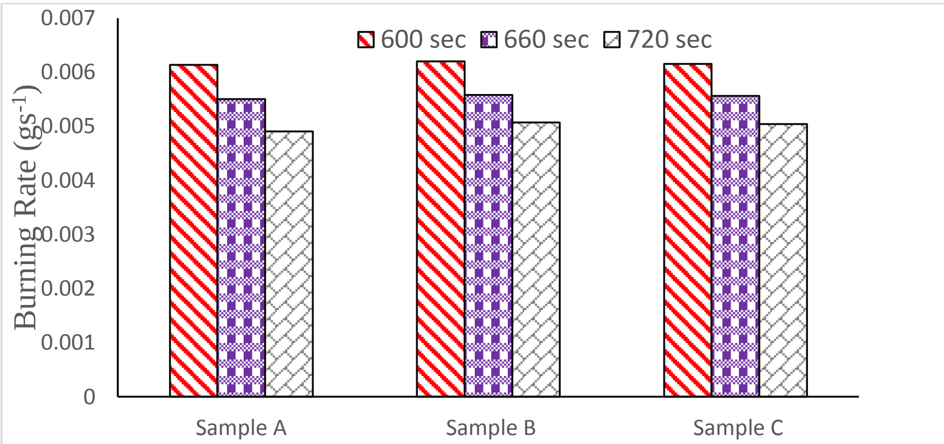


Fig. 6. Effect of briquette mass and burning time on the burning rate

IV. CONCLUSION

The design and fabrication of a briquetting machine for the production of briquettes from agricultural wastes represent a significant step towards sustainable waste management and renewable energy generation. Throughout this research work various aspects have been explored, refined, and implemented to achieve an efficient and effective briquetting process. The comprehensive analysis conducted in this study sheds light on the intricate relationships between various parameters in the drying process of sample B. The observation revealed that a drying time of 1.5 days at briquetting temperature of 200°C resulted in optimal outcomes, showcasing the intricate balance required for efficient drying. Sample B exhibited remarkable characteristics, including a high compression capacity of 4340 N, a mass of 9.03 g and a volume of 23.98 ml, coupled with the highest density and water resistance of 0.38 gml^{-1}. The burning rate of sample C was found to be 0.00615 gs^{-1}, demonstrating its combustibility. This research successfully elucidated the ideal parameters for maximizing the desired outcomes, thereby highlighting the efficacy of the experimental methodology employed. The findings of this study not only contribute to advancing our understanding of briquetting processes, but; also underscore the potential applications of samples of resin in various industrial and laboratory briquetting research, showcasing its versatility and suitability for diverse applications. The research demonstrates that machine factors such as briquetting temperature, substrate mass, and sample volume significantly impact the performance of briquetting machines and the properties of the produced briquettes. Optimal temperature settings can significantly reduce drying time, while higher mass and density improve water resistance. The relationship between volume and compressional strength highlights the need for careful consideration of briquette dimensions in design. Variations in burning rate underscore the influence of material composition and environmental factors. These findings provide valuable insights for optimizing briquetting processes and improving the quality and efficiency of briquette production.

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