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Estimation of the moisture content, volatile matter, ash content, fixed carbon and calorific values of saw dust briquettes

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ABSTRACT

Briquetting is one way of making efficient use of existing resources. It involves collecting combustible waste materials due to lack of density, and compressing them into solid fuels of convenient shape that can be burnt like wood or charcoal". "Biomass briquette is one of the proven ways of generating energy from waste". "The excessive use of fossil fuels, wood fuels and natural gas has led to serious environmental issues and deforestation". "This work focused on estimating the heating values of sawdust briquettes to ascertain its suitability for domestic use and small-scale industrial cottage application". The calorific value of the briquettes was determined using a bomb calorimeter. "The following heating values of sawdust briquettes were obtained: average percentage moisture content 5.04%, average percentage volatile matter 10.80%, average percentage ash content 3.85%, average percentage fixed carbon 80.95% and average percentage calorific value 26918.02KCal/Kg. These results indicate that the briquettes made from sawdust have high heating values enough for domestic use and small-scale industrial cottage applications

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1 Introduction

"The primary source of energy for such vital activities as cooking and space heating is burning wood, charcoal and other agricultural products". "An increasing population using dwindling resource of combustible materials (fossil and wood fuels) for cooking and heating purposes will eventually result in the shortage of those materials unless urgent steps are taken to reverse the trend". "One way of making efficient use of existing resources is briquetting". "Briquetting involves collecting combustible waste materials that are not usable due to lack of density, compressing them into solid fuels of convenient shape that can burn like wood or charcoal" [3].

Biomass briquetting is the densification of loose agro residues with or without binding agents to produce compact solids with the application of pressure". "A briquette is the product formed from the physic-mechanical conversion of dry, loose and tiny particle size material with or without the addition of an additive into a solid state characterized by a regular shape". "Briquettes are mainly used for heat applications (steam generation, melting metals, space heating, brick kilns, tea curing, etc) and power generation through gasification of biomass briquettes and for domestic uses" [4].

Developing countries are faced with the huge problem of waste management of agro residues". "Agro and sawmill residues are usually burnt on roadside or dump yards, which results in environmental pollution. "These residues are very difficult to handle, store and if they are burnt directly results in very poor thermal efficiency and create lots of air pollution". "These problems can be avoided by briquetting these wastes into usable energy generating fuel." [1]
"Biomass briquettes are a proven way of generating energy from waste". "Different types of waste have been utilized to develop biomass briquettes". "It has been revealed that the fabrication of biomass briquettes derived from municipal waste stream could result in feasible on–site fuel production [6]". "In another report, briquettes have been produced from sawdust, date palm trunk and different plastic wastes, without the use of external binding agent" [7].

"It has been reported that briquettes were prepared using cow dung, wheat flour and paper pulp as binding agents". "These briquettes were tested for calorific value and compressive strength by varying percentage by volume of binders. The minimum energy costs for production of these briquettes were also calculated." [2]. "In an effort to substitute briquettes for firewood in the rural households in Nigeria Bio briquettes were prepared from elephant grass, spear grass and bio coal at moderate pressure and temperature". "Proximate analysis was carried out on these briquettes and results were compared with wood samples". [8]

"In this research paper, I estimated the heating values of briquettes produced from sawdust".

2. Materials and methods

2.1. Determination of moisture content of the briquettes

"The percentage moisture content (PMC) was determined by weighing 1.5g of the briquette sample in a crucible of known mass and placed in an oven set at 105°C ± 5°C for 1 hour". "The crucible and its content were removed from the oven allowed to cool to room temperature and reweighed". "This process was repeated until the weight after cooling became constant and the value was recorded as the final weight". This process was repeated using three (3) different samples of the briquettes and results are tabulated in Table 1. "The sample's moisture content was determined using equation (1)".

$$PMC = \frac{W_1 - W_2}{W_2} \times 100\% \quad (1)$$

"Where, W_1 is the initial weight of briquette sample and W_2 is the final weight of briquette sample".

2.2. Determination of volatile matter of the briquettes

"The percentage volatile matter (PVM) was determined by placing 1.5g of the briquettes sample in a crucible and kept in a furnace for 8 minutes, at temperature of 550ºC ± 5°C and weighted after cooling". This process was repeated using three (3) different samples of the briquettes and results are tabulated in Table 2. "The percentage volatile matter of the sample was determined using equation (2)"

$$PVM = \frac{W_2 - W_3}{W_3} \times 100\% \quad (2)$$

"Where, W_2 is the weight of the oven-dried sample in grams; W_3 is the weight of the sample after 8 min in the furnace at 550 °C in grams"

2.3. Determination of ash content of the briquettes

"1.5g of the briquettes samples was placed in a closed furnace and burnt completely". "The weight of the residue was taken with an electronic balance". This process was repeated using three (3) different samples of the briquettes and results are tabulated in Table 3. "The percentage weight of residue gives the ash contained in the sample and its determined using equation (3)".

$$PAC = \frac{W_4}{W_2} \times 100\% \quad (3)$$

2.4. Determination of fixed carbon of the briquettes

The percentage fixed carbon (PFC) is given by equation (4) [9] and results are tabulated in Table 4.

$$PFC = 100\% - (PMC + PVM + PAC) \quad (4)$$

2.5. Determination of calorific value of the briquettes

"The calorific value of the briquettes were determined using a bomb calorimeter". "1.5g of the briquettes sample was burnt completely in oxides of oxygen". "The liberated heat was absorbed by the water and calorimeter". "The heat lost by burning briquette was the heat gained by water and calorimeter". "The calorific value (CV) of three (3) different samples of the fuel was calculated from the measured data [5] using equation (5)" and results are tabulated in Table 5.

$$CV = \frac{BFx\ \Delta t - 2.3\ length\ of\ wire}{W} \quad (5)$$

"Where: BF = Burn Factor; Δt = Change of temperature $(t_2 - t_1)$ºC; t_2 = final temperature; t_1 = initial temperature; W = mass of the sample used and BF = constant = 13,257.32"

3. Results and discussion

"The physico-chemical properties of the briquettes produced from sawdust were limited to determination of the percentage moisture content, percentage volatile matter, percentage ash content, percentage fixed carbon and calorific value".

Table 1. *Percentage values of moisture content for sawdust briquettes*

Sample	PMC (%)
1	5.10
2	5.09
3	4.92
Average	**5.04**

"Table 1, showed the average percentage moisture content for the sawdust briquette produced as 5.04%". "Moisture content of briquette increased with increase in binder concentration and decreased with increase in compaction pressure for all briquettes [10]". "Results obtained agreed with the recommendation of 5% – 10% moisture content for quality briquettes [11]". "When moisture content is low, briquettes will easily ignite, and higher calorific values are expected from the briquette [9]". The moisture content obtained indicates that the briquettes produced can easily ignite; higher calorific values are expected and are of high quality.

Table 2. *Percentage values of volatile matter for sawdust briquettes*

Sample	PVM (%)
1	10.95
2	10.56
3	10.88
Average	**10.80**

"Table 2, showed the average percentage volatile matter for the sawdust briquette produced as 10.80%". "High volatile matter indicates ease of ignition, rapid burning and proportionate increase in flame length but low heating values". "The sawdust briquette produced has a percentage volatile matter that falls within the range 10% to 25% for good quality briquettes [10]". This indicates that the briquette produced can easily ignite, burns rapidly and has proportionate increase in flame lenght.

"**Table 3**. *Percentage values of ash content for sawdust briquettes*

Sample	PAC (%)
1	4.15
2	3.81
3	3.60
Average	**3.85**

"Ash content of briquettes tells the extent of clogging up of the burning medium". "Table 3, showed the average percentage ash content for the sawdust briquette produced as 3.85%". "Low ash content offers higher heating value for briquettes but high ash content results in dust emissions that lead to air pollution [5]". "High ash content lower calorific value which affects combustion volume and efficiency [12]". Since the ash content of the briquette produced is low, it will offer higher heating value.

Table 4. *Percentage values of fixed carbon for sawdust briquettes*

Sample	PFC (%)
1	80.50
2	81.24
3	81.10
Average	**80.95**

"Table 4, showed the average percentage fixed carbon for the sawdust briquette produced as 80.95%". "This result agrees with the reported suitability of briquettes with fixed carbon as 80.5% for domestic applications [11]". "The higher the fixed carbon of a fuel, the greater the calorific value, the smaller the volatile matter, the lower the ash and moisture content and the better the quality of the fuel [13]". The percentage fixed cardon obtained from the briquette produced is indicative of the fact that the briquette has high calorific value, lower volatile matter, lower ash and moisture content.

Table 5. *Calorific values for sawdust briquettes*

Sample	CV (KCal/Kg)
1	26,914.98
2	26,926.21
3	26,912.88
Average	**26,918.02**

"The calorific value determines the amount of heat energy present in a material". "Results from Table 5, showed that the average percentage calorific value for the sawdust briquette produced is 26918.02KCal/Kg". "The briquette samples produced were of high heating value enough for domestic use and small-scale industrial cottage applications".

4. Conclusion

"Fossil fuels and wood fuels are the major source for energy in Nigeria today". "The excess use of these fuels will lead to serious environmental issues like global warming, air pollution and deforestation". "It is high time we convert biomass wastes to useful briquettes, which will be the substitute for these fuels". "Using Crucible furnace and the bomb calorimeter were used to perform the various experiments, this work focused on estimating the heating values of sawdust briquettes to ascertain its suitability for domestic use and small-scale industrial cottage application". "Results obtained indicate that the briquettes made from sawdust have high heating value enough for domestic use and small-scale industrial cottage applications".

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