Measurement of Energy Value on different Grain sizes of Sawdust Briquettes.

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Abstract. Biomass and other industrial wastes is on the increase and is causing a lot of problem especially the effect on our environment. In developing countries like Nigeria, there are no adequate majors of disposing these wastes, hence, converting them to other useful products such as briquettes for domestic fuel is desirable. In this research, the energy values of briquettes made from sawdust using two binders were assessed. The sawdust briquettes was produced using sawdust mixture of different grain sizes (0.05cm and 0.1cm, 0.3cm and 0.5cm respectively) and two different types of binders (clay and starch) in percentage compositions of 75:25, 80:20, 85:15, 90:10 and 95:05, respectively. The briquettes were subjected to energy evaluation test using a Calorimeter. The mean bulk densities of the briquettes produced from sawdust mixture of different particle sizes was determined. We also obtained results of the average energy values of the briquettes produced using both binders respectively. The results indicate that briquettes produced from sawdust of grain size (0.05cm and 0.1cm) using starch gave the highest energy value while those obtained from sawdust of particle size (0.3cm and 0.5cm) using clay gave the lowest calorific value. The briquette from sawdust of particle sizes (0.05cm and 0.1cm) is therefore more suitable for starting and maintaining fire for cooking and other domestic heating. The effective utilization of these agricultural by-products as high grade solid fuel can reduce environmental pollution resulting from the wastes and also help in minimizing the energy crisis resulting from non - renewable energy sources like petroleum products as domestic fuel.

Keywords: binding materials, sawdust briquettes, energy values, domestic fuel.

1. INTRODUCTION

Biomass waste is a general term given to all organic waste and dry plant materials and is characterized with a variety of conversion and end use. It has found its way as one of the favorable means of creating a cleaner environment, waste recycling to valuable products, renewable energy and inexpensive energy conversion etc. Examples of these include; sawdust, rice husk, palm kernel shell, groundnut shell, sugarcane bagasse etc.

Again, the uses of biomass fuel such as composite sawdust briquette have been found to be a good source of renewable energy for domestic cooking (O. N. Aina, et. al, 2009). In seventeenth century, the rural poor often burn dried cow dung because of the acute shortage of wood fuel and wide spread deforestation. The conversion of Agricultural by products, wood waste and coal dust to high energy value briquettes for cooking and drying have been investigated and found to be feasible.

However, the importance of sawdust as a source of fuel cannot be over-emphasized as it is readily available and cheap. Most often, it is usually dumped or burnt off at sawmill sites in Nigeria thus a lot of energy is being wasted and uncontrolled heat generated. Over the years, sawdust has been used for the production of heat and power in gasification of plant and for domestic cooking (kurstdet, 1981). This possibly raises the issue of how best to utilize this economical waste. Moreover, the production of biomass briquette contributes to income generation of micro enterprise or any entrepreneur who produces them and sells them. In this ways, more money stays within the community rather than being exported for foreign fuels.

Furthermore, briquetting can be defined as a way of converting loose biomass residue such as sawdust, straw or rice husk into high density solid blocks that can be used as a fuel. Briquetting can be of two types - high pressure briquetting and low pressure briquetting. High pressure briquetting uses a power-driven press to raise the pressure of dry, powdered biomass to about 1500bar (150Mpa).This will raise the temperature of the biomass and as a result melts the lignin in the woody (sawdust) material. Low pressure briquetting can be used for materials with a low amount of lignin, such as paper and charcoal dust. In this process, the powdered biomass is mixed into a paste with a binder such as starch or clay, and water. A press is used to push the paste into a mould or through an extruder or can simply be shaped by hand. The best materials for high pressure briquetting are sawdust and woody residues, because they contain a high proportion of lignin. However, most dry agricultural residues can be used if they are ground into a coarse powder. Some do not make good briquette on their own (e.g. grain straw and dried grasses) but work well when mixed with woody materials to provide the lignin.

Thus, this work investigate the energy values on different grain sizes of sawdust briquettes using a bomb calorimeter. But before measuring the energy values of the sawdust briquette, binders for different briquettes will be reviewed.

1.1 Research Problem

Biomass and other industrial wastes is on the increase and is causing a lot of problem especially the effect on our environment. In developing countries like Nigeria, there are no adequate majors of disposing these wastes, hence, converting them to other useful products such as briquettes for domestic fuel is desirable.

1.2 Aim and Objectives of the work

The purpose of this project is to measure the energy values on different grain sizes of sawdust briquettes. To achieve this, there are two main tasks in the project work, which are;

- Making briquettes from sawdust of different texture and two different types of binders (clay and starch) on different compressions.
- Investigate the energy content of the briquettes using a bomb calorimeter and based my conclusion on the data gotten from the research work.

2.0 MATERIAL AND METHODS

This study was developed by using the facilities and materials laboratory at the Scientific Equipment Development Institute, Enugu State – Nigeria.

2.1 Raw Material Preparation

The sawdust used was a mixture of different grain sizes (0.05cm & 0.1cm and 0.3cm & 0.5cm respectively) constituting two major samples for the experiment. The mixture of the different grain sizes for each sample was in the ratio of 50:50 and 70:30. Each of the grain sizes sample was gotten from two different sawmills located in Aba and Enugu (Eastern part of the country, Nigeria). The moisture content (MC) of each sample before briquetting was 15% and 20% respectively. Finally, we designated the finer grain samples as Group A, then the coarse sample as Group B.

2.2 Briquette Production and Quality Evaluation

The sawdust was poured into a flash dryer which automatically reduce the moisture content to 5% at 80 - 100^{0}C for 60 minutes for both samples.

Group A: The sawdust mixture of finer grains was fed into a bowl and mixed with two different types of binders (clay and starch) in percentage compositions of 75:25, 80:20, 85:15, 90:10 and 95:05, respectively. The agitating process was done in a mixer to enhance proper blending prior compaction. A steel cylindrical crucible (die) of dimension 14.3mm height and 49.3mm in diameter was used for this project. The die was freely filled with known amount of weight (charge) of each sample mixture and be positioned in the briquetting press machine for compression. The piston was actuated manually for 10, 12, 14, 16 and 18 respective oscillation counts of hammer head with respect to piston movement to compress the samples. Compacted pressure ranged from 3.0 – 9.0MPa. After pressure was applied at a time to the material in the die, the briquette formed was extruded.

Prior the release of applied pressure, each briquette was replicated five times according to the level of process variables. The briquettes produced were allowed to dry in the sun for two days and then assessed for their energy.

Group B: Again, the sawdust mixture of coarse grains was fed into a bowl and mixed with two different types of binders (clay and starch) in percentage compositions of 75:25, 80:20, 85:15, 90:10 and 95:05, respectively. The same procedure for Group A was utilized for Group B in making the briquettes.

2.3 Data Collection

The length, mass, diameters of the briquettes were determined. These measurements were used to compute the volume and density of each of the One Hundred and Fifty samples of briquettes produced.

NB: We used the value we obtained from the average of the five samples for each sample in the table. This was done to get a more accurate value for the research

Data were also collected on the physical properties of briquettes produced from the sawdust. The methods and formulas used are given below.

Density: The weights of briquettes were determined on the balanced in the laboratory. Then, the volumes of briquettes were determined by a simple calculation based on the direct measurement of length and diameter of the briquettes.

The Formula:

D (kg/m^3 or g/cm^3) = M/V;

Where; D = Density

M = Mass

V = Volume.

2.4 Measurement of the Energy content of the briquettes produced

To measure the energy content of the briquettes produced from different compressions, a bomb calorimeter was used.

Heat Value: The heat value of both samples was determined using a Bomb calorimeter. Each samples of the briquette from each Group was weighed. And placed in the crucible before covering it tightly. The bomb was closed and charged in with oxygen up to 30 atm. The bomb was fired up by depressing the ignite switch to burn the sample in an excess of oxygen. The maximum temperature rise in the bomb was measured with the thermocouple and galvanometer system

Formula:

G.E. (Kcal/g) = (G.meter deflection x Calibration)/ (Weight of sample.)

3.0 RESULTS AND DISCUSSIONS

3.1 Physical Characteristics of the Briquettes

The briquettes were produced using a screw press briquetting machine. The outer surface of the briquettes was carbonized and solid with no holes at the center. The average weight of the briquettes is approximately 651g, while the average length and diameter are 15.5cm and 5.1cm respectively. The average volume is 609m3 while the briquettes from the both samples of the sawdust assumed a brown coloration.

Table 1: Showing the % constituent for Group A samples

S/N	Sample	Starch %	Clay %	Sawdust % *(Finer Mixture)*
1.	A1	25	-	75
2.	A2	-	25	75
3.	B1	20	-	80
4.	B2	-	20	80
5.	C1	15	-	85
6.	C2	-	15	85
7.	DI	10	-	90
8	D2	-	10	90
9.	E1	5	-	95
10.	E2	-	5	95

Table 2: Showing the % constituent for Group B samples

S/N	Sample	Starch %	Clay %	Sawdust % *(Coarse Mixture)*
1.	A1	25	-	75
2.	A2	-	25	75
3.	B1	20	-	80
4.	B3	-	20	80
5.	C1	15	-	85
6.	C2	-	15	85
7.	DI	10	-	90
8	D2	-	10	90
9.	E1	5	-	95
10.	E2	-	5	95

Table 3: Comparative Assessment of Energy values of the briquettes.

Sample	Starch %	Clay %	Sawdust %	Vol. before Briquetting (cm^3)	Bulk Density Before briquetting (g/cm^3)	Vol. after Briquetting (cm^3)	Bulk Density after briquetting (g/cm^3)	Mean
A1	25	-	75	52.314	0.956	96.599	0.518	
A2	-	25	75	52.314	0.956	90.849	0.550	0.534
B1	20	-	80	52.314	0.956	119.599	0.418	
B2	-	20	80	52.314	0.956	97.749	0.512	0.465
C1	15	-	85	52.314	0.956	100.433	0.498	
C2	-	15	85	52.314	0.956	96.312	0.519	0.509
DI	10	-	90	52.314	0.956	119.216	0.419	
D2	-	10	90	52.314	0.956	116.149	0.430	0.425
E1	5	-	95	52.314	0.956	115.766	0.432	
E2	-	5	95	52.314	0.956	123.816	0.404	0.418

Table 5: Mean calorific values of briquettes

Sample	Briquette	Calibration Constant	Galvanometer deflection	GE (Kcal/g)
A1	Sawdust and Starch	0.7872	2.39	4.421
A2	Sawdust and Clay	0.7872	2.20	3.976
B1	Sawdust and Starch	0.7872	2.40	4.553
B2	Sawdust and Clay	0.7872	2.30	3.911
C1	Sawdust and Starch	0.7872	2.60	4.652
C2	Sawdust and Clay	0.7872	2.44	4.009
D1	Sawdust and Starch	0.7872	2.85	4.701
D2	Sawdust and Clay	0.7872	2.50	4.011
E1	Sawdust and Starch	0.7872	3.0	4.723
E2	Sawdust and Clay	0.7872	2.55	4.014

3.2 Discussion

The lignocellulose waste (sawdust) used for the production of briquettes was randomly collected from sawmills located in Aba and Enugu (Eastern part of the country, Nigeria). The moisture content (MC) of each sample before briquetting was 15% and 20% respectively. They were flash dried to reduce the moisture content automatically to 5% at a temperature of 250^0C – 300^0C for 50 minutes.

The quality of briquette is determined by the moisture content of the sawdust used as the input material. The higher the moisture content of the sawdust, the higher the loss of energy required for water evaporation during combustion at the expense of the calorific value of the briquette. The dried sawdust was freely fed into the cylindrical crucible and positioned in the briquetting press for compression. The piston was actuated manually for 10, 12, 14, 16 and 18 respective oscillation counts of hammer head with respect to piston movement to compress the samples. Compacted pressure ranged from 3.0 – 9.0MPa. After pressure was applied at a time to the material in the die, the briquette formed was extruded.

In determining the calorific value of the briquettes, the Bomb Calorimeter was used. First, the samples of the briquettes produced was allowed to dry naturally in the sun for a period of 2 days. After which the average mass of the group sample was gotten. The bomb's body was placed and tightly screwed in position. The thermocouple wire was plugged into the bomb until the pressure rose to 25 bars. The light spot index was set to zero using the galvanometer zero knob ensuring a stable temperature before the firing knob was depressed and released to fire the bomb. Heat is released and the maximum deflection of the galvanometer scale was recorded after which the burnt gases were released from the apparatus with the aid of the pressure release valve.

The maximum deflection obtained in the galvanometer was converted to energy value of the briquette material by comparing the rise in galvanometer deflection with that obtained when a sample of known calorific 5.1cm 15.5cm value of benzoic acid is combusted. The process is repeated to determine the energy value of the different compressions. The energy values of all the samples burnt were recorded.

4.0 CONCLUSIONS

In this study, a comparative assessment of the calorific values of briquettes produced from different grain sizes of sawdust biomass materials was carried out in terms of different binders (starch and clay) and below are the following conclusions.

- That briquettes produced from sawdust of grain size (0.05cm and 0.1cm) using starch gave the highest energy value while those obtained from sawdust of particle size (0.3cm and 0.5cm) using clay gave the lowest calorific value.
- Again, the briquette from sawdust of particle sizes (0.05cm and 0.1cm) is therefore more suitable for starting and maintaining fire for cooking and other domestic heating.
- Finally, the effective utilization of these agricultural by-products as high grade solid fuel can reduce environmental pollution resulting from the wastes and also help in minimizing the energy crisis resulting from non - renewable energy sources like petroleum products as domestic fuel.

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