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Determination of Compresive Strength and Combustibility Potentials of Coal And Biomass Briquettes

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Abstract

Investigation on the compressive strength and combustibility proprieties of coal char and Biomass waste was carried out on five sets of briquette produced from three different sources of materials using a cassava starch as a binder, which were compacted in a wooden bar mould of length 2x2 cm^3 using El-burden berg compacting machine with model No El-31-34010 Using a tri-axial comprehensive machine, the comprehensive strength of the briquettes was determined as 611, 546.94, 281.26 928.29 and 584.64KN/m^2 units for rice husk, rice husk/coal char blend, sawdust, sawdust/coal char blend, and coal char briquettes respectively. A comparative water boiling test of the briquettes and firewood was carried out. 1kg of each set of briquettes and firewood was weighed. Rice husk briquette boiled 1.5 litres of water in 37 minutes, while firewood boiled the same quantity of water in 38 minutes 30 seconds. Sawdust briquette boiled that water in 25 minutes, while sawdust/coal char blend boiled the water in 20 minutes; coal char briquette boiled the water in 15 minutes 30 seconds. The results obtained revealed that such briquettes were of appreciable strength and could not crumble during combustion; they also resist abrasion during transportation and help keep the environment clean.

***Key Words**: Biomass, Briquette, Coal Char, Combustibility, Strength.*

1. Introduction

Human activity especially in the household requires a lot of energy our fossil fuels are exhaustible consequently the reserve concern us deeply particularly when both the population and per capital use of energy are expanding rapidly. However, it appears that coal will be the backbone of our energy system long after the reserve of petroleum and natural gas are depleted but the use and handling of it has serious problems Bala Thliza (2006).

Deforestation and rising oil prices have been a major challenge for the growing energy needs in countries. The development of renewable energy sources has the potential to decrease the dependence on increasingly scarce energy sources and contribute to the protection of vital ecosystems. Renewable energy offers possibilities to both reduce poverty and to allow sustainable development (Joseph *et al.*,2012).

The most common source of energy utilize for cooking in Nigeria have been a product of fossil fuel such as kerosene and natural gas. A survey of both rural and urban areas of Nigeria show that 70% of the household depends on fuel wood for cooking and heating room Oladeji (2010). In some homes electricity is also used even though pollution free the supply is erratic and unreliable. The need to offset some of this problem and the economic setback brought about by increasing fuel cost and over depending on fuel wood has compelled the world at large to supplement this other sources Raju *et al.*, (2014).

How do we then choose the best method of energy production ? The task is certainly not difficult. For instance blending agricultural waste in form of briquettes with a high calorific value coal with good combustion characteristics is investigated, Inegbenebor (2002). The technology for this process is readily available and the process is been used on a limited scale and is been investigated for use in the future Makumbi .T (2008) .The development of energy from agricultural waste is now generally favoured because it results in a cleaner environment and at the same time can provide the means of recycling wastes.

Briquettes are mostly use in the developing world where cooking fuel are not as easily available. The briquettes are cofired with coal in order to create the heat supply Aina, O. (2009) . Biomass briquettes mostly made of green waste and other organic materials are commonly use for electricity generation, heat and cooking fuel Prabir *et al.*,(2011). This compressed compounds contain various organic materials including Rice-husk, Groundnut-shells, Saw-dust , Municipal solid waste and Agricultural waste. The composition of the briquette varies by area due to the availability of raw materials. The raw materials are gathered and compressed into briquette in order to burn longer and make transportation of the goods easier. These briquettes do not have large concentration of carbonaceous substances and added materials compared to fossil fuels. The briquette produce low net total greenhouse gas emissions because the material use are already a part of the carbon cycle Yugo *et al.*, (2010).

2. MATERIALS AND METHOD

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2.1 Material

Materials used include: Coal, Rice husk, Sawdust and Cassava starch. The sample of coal was obtained from Raw material research and development council (RMRDC) Jos, Plateau State, Nigeria. Rice husk was collected from local rice mill in Yelwa Bauchi, the Sawdust was collected from Timber shed sawmill industry in Muda Lawal Bauchi, Bauchi State Nigeria and the cassava starch was purchased from Wunti market Bauchi. Two sets of 2x2cm interlocked square wooden mould was constructed in the structural laboratory of the Civil Engineering programme, Abubakar Tafawa Balewa University Bauchi (ATBU).

2.2 Methods

The coal sample was carbonized under low temperature carbonization, in the absence of air. Then pulverized using a hammer mill and sieve to pass through 21.20 mm sieve. The rice husk was dried at ambient temperature for a week to reduce the moisture content then sieve to pass through 2.0 mm sieve to ensure uniform size. The sawdust was sorted to remove impurities or foreign bodies in the material. It was then sieve to obtain an overall uniform particle size of 170 mm. The starch was made into a thick paste using hot water.

Five different briquettes were produced as follows: Starch paste and sieved Coal in the ratio of 2:8, Starch paste and sieved Rice-husk in the ratio of 2:8, Starch paste and Sawdust in the ratio of 2:8, Starch paste, Rice-Husk and Coal blended in the ratio of 2:4:4, Starch paste, Sawdust and Coal blended in the ratio of 2:4:4. The sample and starch paste were mixed thoroughly and loaded into the wooden mould, this was then compressed with Ele-burbenbegrs compacting model No. EL. 31-34010 in the structural laboratory of Civil Engineering programme ATBU Bauchi, the dandified briquette was extruded from the mould by intact, the procedure was repeated for the other samples. The briquettes were then air dried for two weeks, then Strength determination and combustibility test were carried out on them.

2.2.1 Strength Determination

The measurement of strength in terms of stress by means of triaxial compression was carried out on the square specimen (Head, K.H., 1992).

The specimen was centrally placed on the lower plates on the machine, the plate is winded by hand until a contact was made with the top plate, the strain dial guage on the pillar was adjusted to zero. The readings on the strain dials, and the load in the strain position under zero compressive load was recorded. Using stop clock, the first four reading of the load dial were recorded at every 0.2 mm of strain dial reading, while others at 0.4 mm interval was taken. Loading and taking readings continued until it was certain the failure has occurred for three consecutive readings of the load dial showed a decreases or a constant load. The machine is then stopped and the motor is allowed to stop completely and was put into reverse until the load is taken off. The machine plate was lower as to enable the specimen to be removed. The results are shown on Figure 1.

2.2.2 Combustibility Test

The materials for combustibility test included firewood, iron pots, thermometer, water, stop clock, weigh balance, locally fabricated stoves, measuring cylinder, and the produced briquettes.

1.0 kg of the briquettes and equivalent weight of firewood were weighed. 1.5 litre of water was measured and poured into each of the two pots. The initial temperature of the water was taken, and the pots were mounted on the stoves and were covered with their lids, with a hole specially bored in the lid with corks to support the thermometer, the stoves were placed close to each other packed with firewood, and the briquettes, small quantity of kerosene was sprinkle on both contents in the stove, and lighted at the same time to attain equal ignition points. A stop clock was started immediately to take the temperature reading after interval of 5 minutes until the water reach a boiling point. Figure 2 - 4 gave the values of temperature versus time reading of briquettes and firewood.

3. Results and Discussion

The results obtained from the compressive strength/stress test using the triaxial machine are shown on Figure 1. The results for combustibility test (water boiling) were carried out for the produced briquettes versus firewood. The results obtained are shown on Figure 2- 4 .

With the aid of a cassava starch which show a good performance and has a good binding properties, solid fuel briquette were produced from rice husk, sawdust, coal and their blends with coal as well, a line cracks on the side surface of the briquettes were observed, this could be as a result of the applied force up and below the mould without a corresponding application at the side during densification.

3.1 Compressive Strength / Stress of Briquettes

The results obtained from strength determination showed that the briquettes produced are of appreciable strength, and have compressive stress of rice husk 506.94, rice husk blend 616, sawdust

481.26, sawdust blend 728.29 and coal 584.64 all in KN/m^3 units.

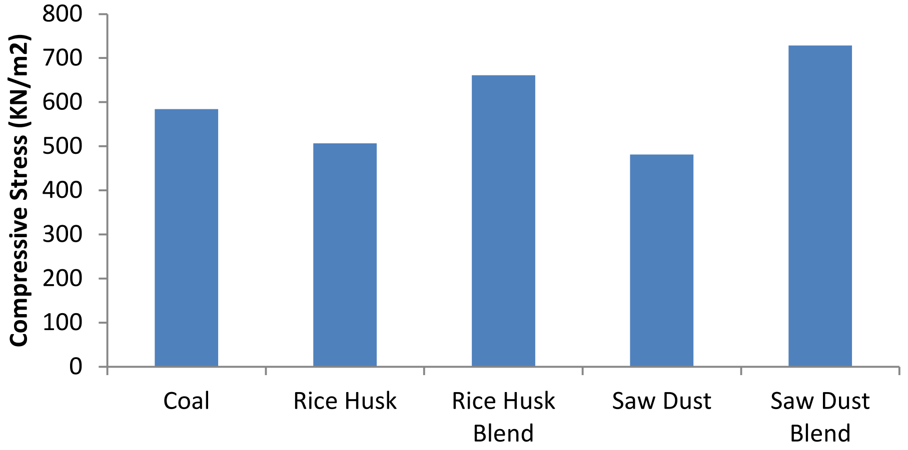

Figure 1: Compressive Stress / Strength Test

(The ratio of samples used are: Paste and Coal =2:8, Paste and Rice husk = 2:8, Paste and Saw dust = 2:8, Paste and Rice husk blend = 2:4:4, Paste and Saw dust Blend = 2:4:4.)

3.2 Combustibility Test (Water Boiling)

The performance of five sets of briquettes in water boiling test was compared to that of firewood; the results revealed that the produced briquettes burnt slowly ahead of firewood, with steady state flame stabilization and shapes maintained. This could be due to densities of the fuel as well as the chemical composition of the fuel, since the rate of combustion depends on it. It was also observed that firewood burn with more smoke than briquettes, having a non luminous flame but less intense than the briquettes.

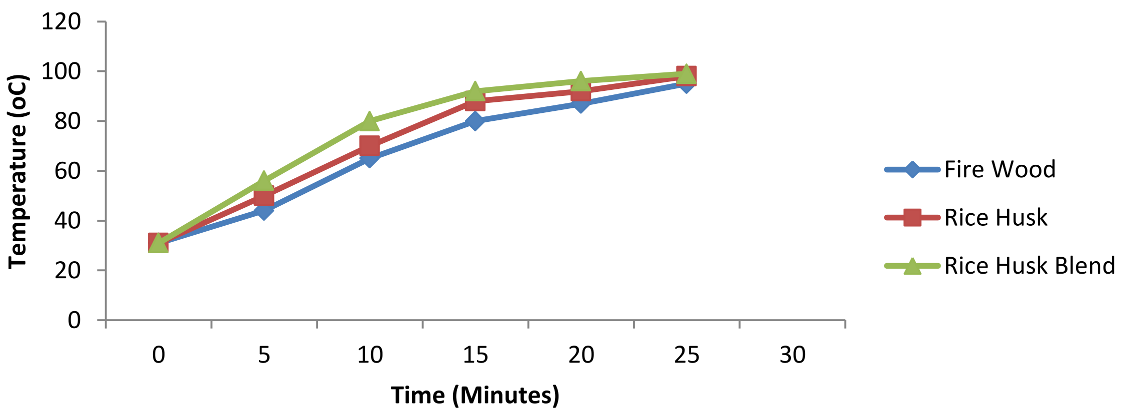

Fig 2: Water Boiling Test of Firewood, Rice husk and Rice husk Blend

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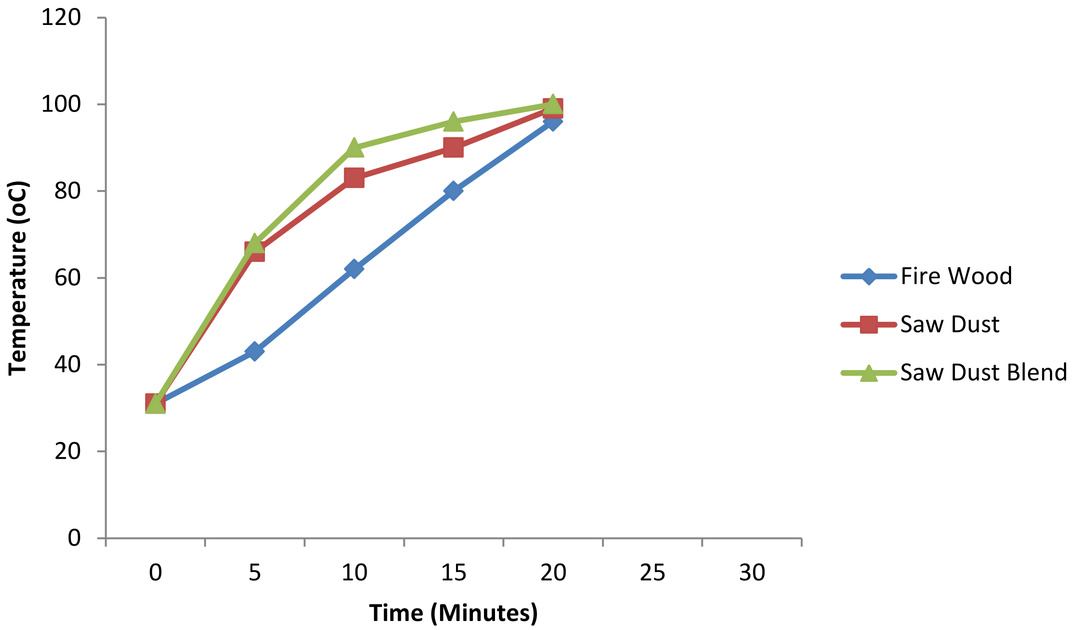

Fig 3: Water Boiling Test of Firewood, Sawdust and Sawdust Blend

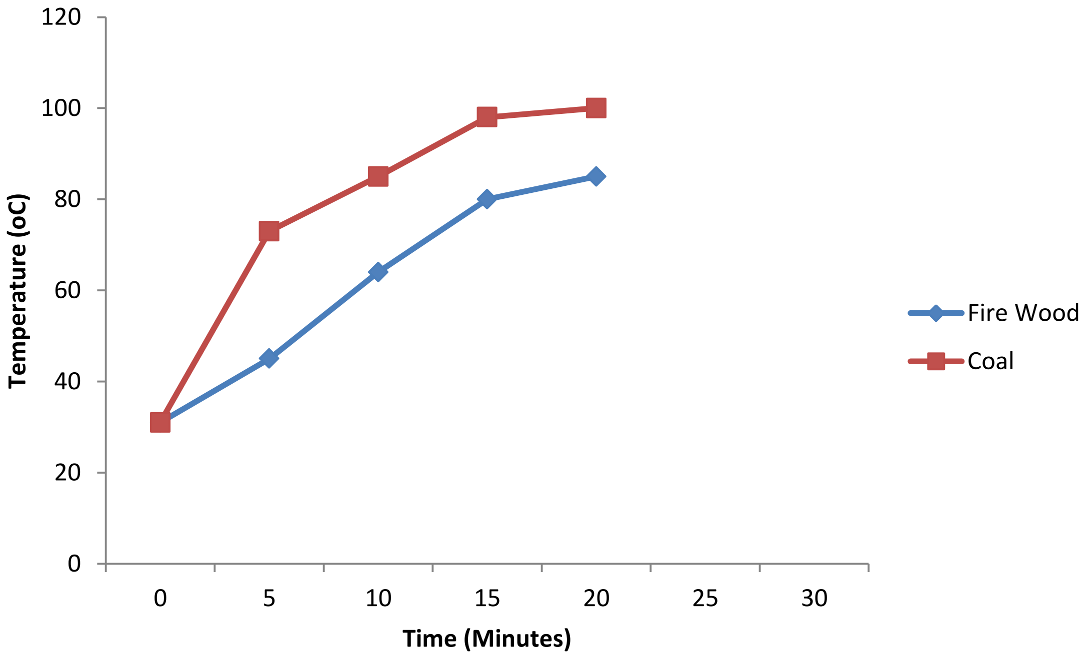

Fig 3: Water Boiling Test of Fire wood Vs Coal

3. Conclusion

From the research, the result obtained revealed that both rice husk, sawdust (a by-product of agricultural materials) and coal, can form a very good briquette to be used as fuel to substitute

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firewood and petroleum products such as kerosene and natural gas. The research is carried out to develop appropriate technology to meet future challenges by briquetting these agricultural by-product as suitable alternative means of energy for cooking. The briquettes also helps keeps environment clean.

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