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RICE HUSK BRIQUETTE PRODUCTION AN ALTERNATIVE RENEWABLE FUEL ENERGY SOURCE IN EBONYI STATE- NIGERIA

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ABSTRACT

Global warming, caused by CO_2 and other pollutants has become an international concern in recent times. Consumption of wood fuels, such as firewood and charcoal is an urgent and serious issue in developing countries like Nigeria. The development of a substitute fuel for charcoal is a necessity. Rice husk which is a large portion of biomass produced in the rice mills, has been laying waste at the rice mills in most parts of the State, constituting huge environmental and health hazards. Beside, rural households and individuals who could not avail the gas or grid connections are in dare need of alternative fuel energy and could use rice husk briquette, as an alternative fuel source. These concerns informed the researchers to go into rice husk briquette production and briquetting technology as an alternative renewable energy source in Ebonyi State. It was investigated as a source of solid fuel. Two sets of solid fuel briquettes were produced from rice husk using paper mash and clay as binders. The briquetting was carried out mechanically using locally fabricated briquetting machines. Good and strong briquettes were produced. Two different designs of briquetting stoves were also produced for the performance evaluation. Water boiling tests were carried out which showed that 1kg of rice husk-paper mash briquette and rice husk-clay briquette took 15 minutes respectively to boil 2 liters of water where as it took 1.5kg of firewood and 20 minutes to boil the same quantity of water. Flame test also show a pale yellow to pale blue for rice husk-clay briquette and rice husk –paper mesh briquette respectively. These indicate the superiority of briquette over firewood or charcoal in terms of combustion characteristics and quantity respectively. The result also indicates the advantage of briquette in terms of ease of handling and transportation including cost benefit advantage over firewood, charcoal or gas.

Keywords: Biomass, Briquette, Agricultural wastes, Solid fuel, cooking Stove.

1. INTRODUCTION

Fuel briquette technology appears to have attracted the attention of most African researchers and innovators in recent times, coming at a time when global energy costs tend to be rising beyond affordability limits for homes and industrial uses in most developing countries.

Briquetting is a technology which uses either a dry or a wet process to compress solid waste (rice husk) into different shapes. The invaluable benefit of this technology is that it can lead to the production of low cost, locally made solid fuel for cooking or heating purposes as well as serving an alternative to firewood or charcoal, and even coal and cooking gas.

Briquette fuels are fuels made from compacted organic matter or biomass. Briquette was introduced and its use as domestic fuel is gradually taking over the conventional use of firewood and charcoal as it is more economical, made from waste products of processed biomaterials and it is environmental friendly as most briquettes produced emits less poisonous gasses like carbon monoxide compared to firewood, (Erikson and Prior, 2015).

Raw materials for making fuel briquette include agricultural and commercial residues such as rice husks, sawdust, scrap papers, weeds and leaves. Rice husk which is a large portion of biomass produced in the rice growing areas of Abakaliki in Ebonyi state has been lying waste at the rice mills in most parts of the state. This has led to environmental problems such as pollution, resulting into heaps on our streets, drainage system and water ways, resulting into flooding due to the blockage of the waterways. If these agricultural waste products can be properly recycled, into useful product, more goods will be made available to our society, environmental pollution and other disease attack would be greatly reduced. Eneh (2011), asserted that Pollutants from agricultural wastes in developing countries including Nigeria substantially constitute avoidable source of air pollution as well as widespread hazards of fire. Agricultural air pollution in Nigeria could come from contemporary practices, which include clearing, felling and burning of natural vegetation (Francis, and Peter' 2002)

The main reason prompting research into alternative energy source is that fire wood has been reducing alarmingly in most forests. While briquette is smokeless and provide higher temperature more quickly than coal and

wood. The households who could not avail the gas or grid connection could use rice husk briquette as an alternative fuel source. Briquetting of biomass can be considered for its economic, reliability and ease of operation. Hence briquetting of rice husk for solid fuel is used for heating in cooking stoves, fire place, and furnace.

According to Yahaya and Ibrahim (2012), solid fuel briquettes also have the advantage of cleanliness, ease of handling, produce a small volume of smoke and its ash content is rich in potash and phosphate. This ash can be used as fertilizer on an unfertile soil. With briquetting of rice husk a new fuel source is found which will help in reducing wild dumping of rice husk in the rice growing regions. This will drastically reduce the cutting of trees for fuel wood which in the long run will cause desertification.

Rice husk is a typical dry or membranous outer covering of the rice. When compared to other agro residues have higher ash content (20- 22.4%) higher potash content, 1.0% crude protein, 0.3% crude fat and 30% carbohydrate (yahayaand Ibrahim 2012). However, rice husk is an exceptional biomass, it has good flow ability, normally available with 10-12% moisture and the ash contain fewer alkaline materials. Infect, Francis and Peters (1965), noted that rice husk makes an excellent fuel although its calorific value is less than wood and other agro residues. Presently solid fuel briquette technology has not gained any appreciable popularity and use in Nigeria notwithstanding the abundance of raw materials (agro residues) for its production. Ebonyi State is the leading rice producing States in the south-Eastern Nigeria with pyramids of rice husks scattered in the three Agricultural zones. These wastes could be turned into wealth by utilizing the husks to produce solid fuel briquette.

2. METHODOLOGY

a. Materials and instrumentation

Raw materials—Rice huskswere collected from the rice mills located in Abakaliki and other parts of Ebonyi State. The raw materials used are shown in table 1 with their sources and characteristics

Table 1: RAW MATERIALS USED.

Raw materials	Sources	Characteristic
Rice husk	Rice mill at Abakaliki rice milling industries Abakaliki L.G.A Ebonyi State.	Dried with 8-10% moisture content.
Clay soil	Clay excavation site/pit at Ngbo, ohaukwu L.G.A, Ebonyi State.	Wet with 10-15% moisture content
Paper mash	Locally sourced from paper wastes in TVE depts. Ebonyi State University Abakaliki.	Shredded/grinded into near powdered state

b. Equipment used and their manufacturers

The equipment used, their type and the manufacturers are indicated in table 2

Table 2: EQUIPMENT USED.

Equipment	Model	Manufacturers
Power engine	GX200	TIGMAX
grinding machine	Nil	Locally fabricated
Weighing balances	1005k	Waymaster, England
Pressing machine	Nil	Locally fabricated
Measuring jug.	Graduated plastic cup	Innoson, Nig.
Mould	Nil	Locally fabricated
Stop watch	4528-2	Joerex, Japan
Briquette stove	Nil	Locally fabricated
Hydraulic jack	20 ton	China
Pressing sticks	Nil	Locally made
Digital thermometer	06563329	Homecare, China

c. Rice Husk Briquetting Procedure

The rice husk solid fuel briquette production process consists ofthe mixture of well grinded rice husks with binder of clay and paper mash.The use of a binder allows lower pressure to be used. The binders selected are available in the area of study and are not expensive and provide a strong bond.

The binder and water were mixed with the rice husk to form a paste, which was put into a cylindrical mould using mechanical compression. Finally, the briquettes were produced and dried directly in the sun.The skills needed to operate the equipment were easy to learn.

d. Binder's selection

A binder is defined as something that sticks things; a substance capable of holding materials together by surface attachment or a substance added to form dry ingredients into a solid mass or to maintain an even consistency throughout a liquid or semi liquid substance. The term binder is considered to be a general term that includes other materials, not limited to cement, glue, starch, and paste (Yahaya and Ibrahim, 2012). Although all these terms are used loosely interchangeably, binder is becoming most widely used and it is considered the most acceptable general term for all bonding agent.

The two binders used in the cause of this research project were clay and paper mash. The reasons were because they are readily available, cheap and have higher binding effect with less smoke.

e. Briquetting Process

In briquetting rice husk, the rice husk is grounded to a semi fine powdered form with the help of a grinding machine using 2 different binders (clay and paper mash). Two sets of briquettes were produced at the ratio 2:1 (rice husk/clay paste and rice husk/paper mash respectively. These mixtures were loaded into a fabricated mould and compressed by weight to the mould for 30 minutes and sun-dried. The drying process was continued for proper drying to be achieved prior to the boiling water test using the fabricated briquette stove by the researchers.

f. The Water Boiling Test

The water boiling test is a well-known test which has been used previously by researchers. It measures the time it takes a given quantity of fuel to heat and boil a given quantity of water. In this case a known quantity each of both briquette and firewood were measured.

g. Test 1

The first sample (Rice husk- clay briquettes were stacked in a fabricated stove while the firewood/charcoal was stacked in a different stove. Two aluminum pots containing two liters of water each were seated/mounted on the stoves. The stoves were ignited and as soon as the flames were stabilized for 2-5 minutes, a stop watch was activated. The initial temperatures of the water were taken using digital thermometer and thereafter readings were recorded at 5 minutes interval using a digital thermometer. The readings were stopped after recording boiling point and the weight of the residual was noted after discarding the ash. Similarly, a known quantity of the second sample (Rice husk-paper mash briquettes) were then stacked in the stove while firewood /charcoal was stacked in the second stove and the procedure was repeated.

3. RESULTS

a. Nature and appearance of the briquette

The briquettes obtained from the mould after drying were clean, strong and well formed. There were noticeable hair like small cracks on both the rice husk- clay and rice husk-paper mash briquette. This may be due to low compressive force applied. It could also be due to unequal distribution of pressures which was restricted at the top of the mould. This error can be remedied by the use of a compaction machine or higher pressure jack. The compressive strength is a criterion of briquette durability (Richard, 1990).

b. Stove Testing

The testing procedures developed are in accordance with the international standard for testing of wood burning cook stoves. The efficiency of stove is defined as the ratio of the energy transferred to the water, divided by

the energy liberated by the burning fuel. The result obtained from the water-boiling test for rice husk-clay, rice husk-paper mash and firewood are shown in Table 3 & 4 below:

Table 3: Rice husk-clay binder versus firewood

Rice Husk-Clay		Firewood	
Time (min)	**Temperature (^{0}c)**	**Time (min)**	**Temperature (0c)**
0	27	0	27
5	65	5	45
10	88	10	65
15	100	15	80
20		20	100

Table 4: Rice husk paper mash versus firewood

Rice Husk-Paper Mash		Firewood	
Time (min)	**Temperature (^{0}c)**	**Time (min)**	**Temperature (0c)**
0	27	0	27
5	45	5	35
10	75	10	55
15	100	15	80
20		20	100

Table 5: Ash content of the fuel used

	Fuel briquettes	**Weight of fuel (g)**	**Weight of ash (g)**	**% ash content**
1.	Rice husk-clay binder	1000	100	15
2.	Rice husk-paper mash	1000	150	18
3.	Firewood	1500	300	30

4. DISCUSSION

From the result, table 3 shows the variation of temperature with time for both rice husk-clay briquette and firewood. It is observed from this table that rice husk-clay briquette attained a temperature of 65^{0}c in 5 minutes while fire wood attained 45^{0}c at the same interval of time (both from initial temperature of 27^{0}c.

In 10 minutes, the rice husk –clay paste rose to 88^{0}c followed by 100^{0}c in 15 minutes. This shows a better combustion characteristic compared to firewood, which burns slowly from 45^{0}c in 5 minutes through 65^{0}c, 80^{0}c, and 100^{0}c in 5, 10, 15 and 20 minutes. The water heated by rice husk-clay paste took 15 minutes to boil compared to that of firewood that took 20 minutes to boil the same quantity of water.

Similarly, table 4 shows that variation of temperature with time for both rice husk-paper mash briquette and firewood from initial temperature of 27^{0}c.It is seen from the table that rice husk- paper mash briquette attained a temperature of 45^{0}c in 5 minutes while firewood attained a temperature of 35^{0}c at the same time interval. In 10 minutes, the temperature of water for rice husk-paper mash rose to 75^{0}c followed by 100^{0}c in 15 minutes; Compared to firewood which burns slowly from 35^{0}c in 5 minutes, 55^{0}c in 10 minutes 80^{0}c in 15 minutes and finally 100^{0}c in 20 minutes. From the result obtained, it can be seen that the water heated with rice husk-paper mash took 15 minutes to boil 2 litres of water compared to firewood that took 20 minutes to boil the same quantity of water.

The rapid combustion observed could be attributed to porous nature of the rice husk briquettes compared to the relatives dense firewood. The porosity in the rice husk briquette enables the volatiles to leave more readily and be consumed rapidly in the flame.

The nature of flame colour of a burning fuel gives an indication of the quality of heat and the cleanliness of the flame. For example a blue flame indicates a clean and high quality heat. On the other hand, yellow flame indicates a low quality heat with soot deposits. During the water boiling test the colour of the flame for rice husk-paper mash paste was pale yellow with lesser smoke and for rice husk-clay briquette, the colour of the flame was pale yellow initially but when stabilized, the colour became pale blue which signifies complete combustion and high heating efficiency while for firewood, the colour of the flame was pale yellow throughout with high smoke content. From the results obtained, it was noted that for all the fuel samples, clean cooking pots did not completely emerge when used for cooking applications. For this reason, further research was needed to be carried out on the design, construction and performance evaluation of briquetting stove.

5. CONCLUSION

The following conclusions were drawn from this research work.

I. The conversion of rice husk into solid fuel does not only provide renewable fuel source but also keep the environment clean, helps to check deforestation by felling of tress for fuel wood.
II. In the application of rice husk as solid fuels, forming briquettes facilitate handling, storage and transportation.
III. The briquettes will serve as substitute for fuel wood since it shows superior combustion characteristics over fuel wood and the materials is readily available.
IV. The briquetting process is economically, cheap and affordable to the rural and low-income urban dwellers. Besides, the binders do not contain harmful agents.

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