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Comparative Study on the Development of Composite Briquette as Alternative Fuel using Rice and Maize Husk

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Abstract

In this study, the development of briquettes from agricultural waste mainly rice and maize husk is presented. A 0.12 kg of each sample with a combination ratio of 1:1 was used in the build-up. The results obtained shows that, rice husk, maize husk and the combination of rice and maize husk have calorific value of 15.27 kJ/kg, 17.13 kJ/kg and 16.20 kJ/kg, moisture contents of 78.8 %, 86.8 % and 79.1 %, ash contents of 39.74 %, 18.07 % and 13.39 % and densities of 1084.3 kg/m^3, 1011.5 kg/m^3 and 1012.4 kg/m^3 respectively. The research shows that briquette made from maize husk has the highest calorific value that can meet domestic use as an alternative fuel compared to briquttes from rice husk and the combination of rice and maize husk.

Keywords: Biomass; rice husk; maize husk; briquette; calorific value; moisture content; ash content.

I. Introduction

The situation of energy in Nigeria can perhaps be described as terrible especially in rural areas. There is shortage of electricity in most of the communities in rural areas and the charges of the electricity also to the communities is very high. Looking at the current rising of population inside and outside the rural communities with diminishing forest resources, there is an urgency to create difference method of utilizing biomass as a renewable and sustainable source of energy.

Briquetting is a process of binding together crumbly materials (such as rice husk, coconut shell, millet cob, maize husk, wheat husk and other combustible material.) into a tight strong block of cramped materials under pressure, usually with the help of a binder such as corn starch. [1] Briquetting grants the conversion of waste materials or plant residues in elegant compacted fuel for large inventory or formation of energy as an alternative source of heat for household cooking and other related energy demanding industrial activities [2].

Rice is one of the large-scale crops grown in West Africa and processing of rice produce a large amount of by product like rice husk and stalk. Maize is another cereal crop that is generally cultivated all over the world with large amount of maize each year than any other grain [3]. Maize is usually the most consumed grain in developing countries like Nigeria. Maize cob and maize husk residues can be used as a source of domestic heating fuel as a substitute of wood [2]. The rice and maize husk are always being bulked and burned in landfill which is hazardous to environment [4].

Furthermore, there is also a need to perform a physic-mechanical characterization of briquette made from biomass residues and their amalgam to ascertain their fitness and appropriateness for production of compacted solid fuels which can comparatively replace charcoal and wood whose use is leading to deforestation and erosion. This study is aimed at making comparison between briquettes built from rice husk and maize husk in terms of their potential for better calorific value when used differently and when the two are mixed together in equal proportion using starch as binder.

II. MATERIALS AND METHODS

A. Materials

Materials used in this study include Rice and Maize husk, Cassava starch, mortar, pestle, milling machine, sieves, basin weighing balance and bomb calorimeter.

B. Method

The biomass residues (maize husk and rice husk) were collected from Government technical college Malali, Kaduna while the cassava starch was obtained from Kakuri market, Kaduna, Kaduna state, Nigeria.

The size of the collected maize husk and rice husk were reduced using a mortar and pestle before drying it for one week to reduce the moisture content. Thereafter, it was grounded into fine particles with the aid of an electric powered machine and three composite samples were produced which were weighed at the same proportion of 0.12 kg: 100% maize husk residues, 100% rice husk residues and a combination of 50:50% maize and rice husk residues.

The samples were carefully combined with 0.025 kg of a locally formed cassava starch (the binder), hot boiling water was added and stirred through to make a semi-solid paste, the cassava starch was selected because is cheap and relatively available. The mixed residues were packed into a basin and manually compacted. The briquettes were sun dried for one week and finally packaged.

III. ANALYSIS OF PRODUCED SAMPLES

A. Moisture content determination

All the samples were weighed before and after the sun dried. The moisture content was determined on the wet bases using (1).

$$M_c = \frac{m_1 - m_2}{m_1} \times 10 \quad (1)$$

Where, m_c = moisture content, m_1 = weight of briquette before drying. And m_2 = weight of briquette after drying.

B. Ash content Determination

The samples were burnt on a burner after weighing them and left it for some time on the burner. The determination of the ash content was based on the dry basis using (2).

$$A_c = \frac{m_a - m_1}{m_2 - m_1} \times 100 \quad (2)$$

Where, A_c = Ash content, m_1= weight of container, m_2 = weight of the sample + container and m_a=weight of the container + ash.

C. Calorific Value Determination

The calorific value is the amount of heat energy present in a material, and is determined by the entire combustion of specified quantity at constant pressure under normal conditions (temperature and pressure).

The calorific values of the samples were determined using a bomb calorimeter. Powdered samples were placed in a glass container and placed in the combustion chamber, while temperature increment within the calorimeter was measured and the calorific value calculated.

A. Density Determination

An electronic balance was used to measure the weight, while the relative density is estimated using (3).

$$R.D = \frac{m_1}{m_2} \quad (3)$$

Where, R.D = Relative density, m_1 = mass of substance and m_2 = mass of equal volume of water

IV. RESULTS AND DISCUSSION

A. Moisture content

The moisture content is critical in the performance of the briquette with regards to its resistance to mechanical deviation, density, calorific value and burning efficiency [5]. The maize husk sample briquette has the highest percentage of moisture content with a value of 86.60 %, followed by the combination of rice and Maize husk of 79.10 %, then the rice husk sample briquette which has the lowest percentage of moisture content of 78.80 % (See Fig. 1).

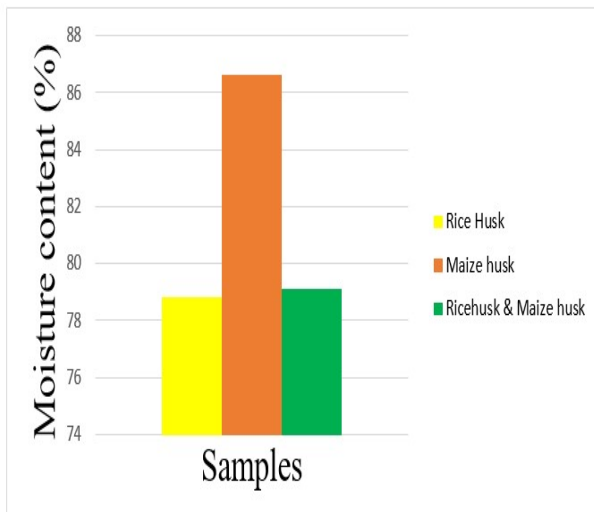

Fig. 1 Moisture content of samples

B. Ash Content

The combination of rice & maize husk Sample briquette has the lowest ash content of 13.39 %, followed by maize husk sample with a value of 18.07 %, then the highest ash content was noticed in rice husk sample of 39.74 % (see Fig. 2). This is important in their ignition and burning time. Insight of the ash content reveal the duration of clogging up of the burning medium. Low ash content increases the burning rate and enhance the heating value of fuel [6].

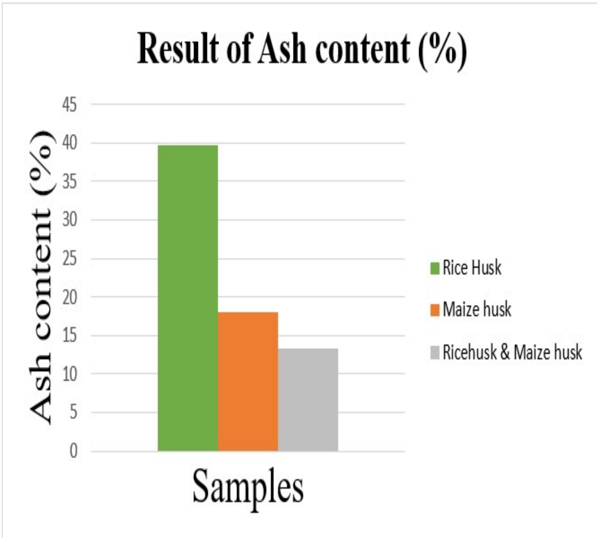

Fig. 2 Ash content of samples

C. Density

Reference [7] reported that density of biomass briquettes depends on density of the original biomass. Densities of all sample's briquettes obtained are illustrated in Fig. 3. It was apparent that densities were in the range of $1011.5 - 1084.3\ kg/m^3$. Comparison between the briquette indicated that rice husk sample briquette had the highest density of $1084.3\ kg/cm^3$ followed by the combination of rice & maize husk sample with $1012.4\ kg/m^3$ then maize husk sample briquettes which has the lowest value of $1011.5\ kg/m^3$ respectively.

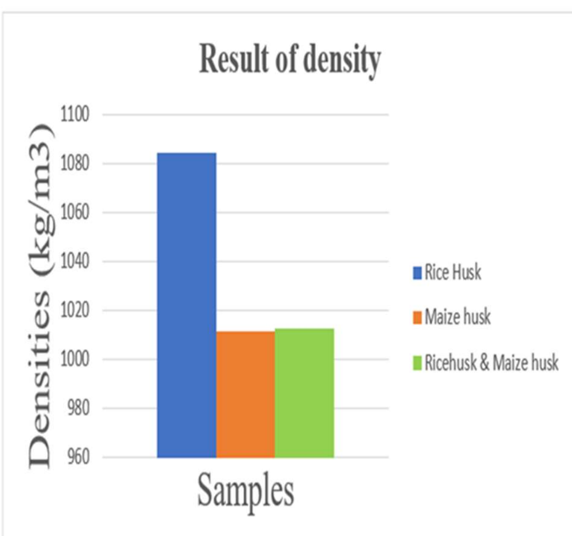

Fig. 3 Densities of samples

D. Calorific Value

Results obtained indicates that the maize husk sample briquette has the highest calorific value of $17.134\ kJ/kg$, followed by the combination of rice and maize husk sample briquette with calorific value of $16.201\ kJ/kg$ and the rice husk sample briquette with calorific value of $15.270\ kJ/kg$ (see Fig. 4).

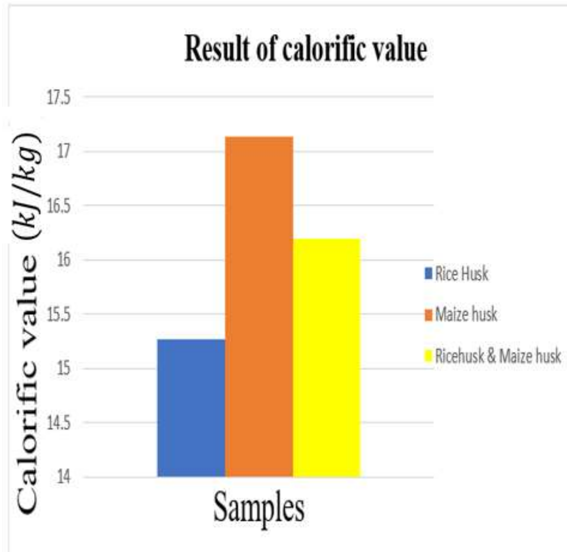

Fig. 4 Calorific value of samples

A summary of results obtained is presented in Table I.

Table I. Summary of the results obtained.

S/N	Samples	Moisture content (%)	Ash content (%)	Density (kg/m^3)	Calorific value (kJ/kg)
1	Rice husk	78.80	39.74	1084.3	15.270
2	Maize husk	86.60	18.07	1011.5	17.134
3	Rice and Maize Husk	79.10	13.39	1012.4	16.201

V. Conclusion

Briquettes were manually produced using Rice husk, Maize husks and a combination of both in a ratio of 1:1. Tests such as moisture content, ash content, density and calorific value were carried out and results obtained shows that briquettes made from Rice husk, Maize husk and a combination of Rice and maize husk have calorific value of 15.27 kJ/kg, 17.13 kJ/kg and 16.20 kJ/kg; moisture contents of 78.8%, 86.8% and 79.1%; ash contents of 39.74%, 18.07% and 13.39%; and densities of 1084.3 kg/m^3, 1011.5 kg/m^3 and 1012.4 kg/m^3 respectively. The density, moisture and ash content results shows that more than 85% of all the samples can burn with high calorific values, with briquettes from maize husk having the highest calorific value that is capable of meeting domestic use as an alternative fuel compared to briquettes from rice husk and the combination of rice and maize husk.

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