International Journal of Engineering Research and Reviews ISSN 2348-697X (Online)
Vol. 4, Issue 4, pp: (48-52), Month: October - December 2016, Available at: www.researchpublish.com

A COMPARATIVE EVALUATION OF THE MECHANICAL PROPERTIES OF BRIQUETTE PRODUCED FROM TICK AND *GMELINA* SAWDUST

[1]Taiwo I. Oyedemi, [2]David B. Oke, [3]Adewumi I. Abioye, [4]Emmanuel Ekundayo

[1,2,3,4]Department Mechanical Engineering, The Polytechnic, Ibadan, Ibadan, Oyo State, Nigeria.

Abstract: **Large quantities of mill residues which are generated annually in Nigeria constitute environment health hazard. Briquetting of these residues is a major way of converting them to a higher quality alternative solid fuel. The present study was undertaken to assess quality briquettes produced from *Gmelina* arborea sawdust and Tick sawdust from Sango Sawmill, Ibadan in Oyo State Nigeria. Briquetting of the mill residues was carried out by using a hydraulic press briquetting machine at a pressure compression level of 1.5MPa and starch binder concentration of 1.5Mpa and 1.18mm particle size of the sawdust feedstock. The mechanical properties assessed for both species of sawdust include bulk density, moisture content, durability, and compressive strength. Chemical properties such as carbon content and ash content were also assed using standard methods. Starch was used as a binder at 30% (w/w) concentration for *Gmelina* and Tick briquettes. The results showed that the briquettes produced from Tick sawdust has higher bulk density, ash content and higher percentage carbon content while that of *Gmelina* sawdust has higher moisture content, compressive strength, and durability. Starch was suitable for binder for the production of briquettes from Gmelina sawdust and Tick sawdust. However, *Gmelina arborea* sawdust briquettes were stronger and more durable than Tick sawdust briquettes. Therefore these two abundant and cheap mill residues can be used as an alternative energy source in Ibadan and Southwestern region of Nigeria in particular.**

Keywords: **Briquettes, Comparative Evaluation, *Gmelina* sawdust, Tick sawdust.**

I. INTRODUCTION

In developing countries, especially in Nigeria, wood residues account for between 15 and 60% by volume in sawmills, and between 40 and 70% by volume in plywood industries (Hakkila and Parikka (2002). Major concerns of wood industry are the disposal of sawdust accumulation which also created an environmental problem. Disposal of sawdust was done by burning or transporting the bulk to areas far from the saw mills which is very expensive. Most of the domestic cooking in developing countries is done with the use of non-renewable fossil fuels such as kerosene, which had become too expensive for the common masses. Composite sawdust briquette which is a source of biomass fuel is a good source of renewable energy for domestic cooking that had been proposed by researchers (Kuti and Adegoke 2008).

Various waste materials such as palm fruit fibre/sawdust composite, maize stock/sawdust composite briquettes; coconut husk/sawdust briquettes, wheat straw, hemp stalks, reed and reed composition with pear biomass and so on, had been used as composite briquettes (Sosu et al., (2011), Adegoke and Mohammed (1999), Maki et al., (2012), Ajuitse (2011), Kakitis et al., (2011) Kaliyan et al, (2009) and others.

II. MATERIALS AND METHOD

Sample and Sawdust briquette

Tick and *Gmelina* arborea woods are majorly used in Nigeria for various constructions and flooring operations. Sawdust of tick and *Gmelina* wood from Sango Sawmill, Ibadan in Oyo State were used as feedstock for this study. The sawdust species was sun dried to about 10% . One hundred gramme (100g) of dried uniformly-sieved sample was mixed with cassava starch until a uniform mixture was obtained. The sample-binder mixture was hand-fed into the steel mould for doughnut briquettes and covered at both ends with the disk. The sample-binder mix inside mould was then placed under the hydraulic press and compacted at the pressure 1.5 MPa and a dwell time of 5 minutes. At each level of binder, 15 replicates were produced. The diameter of the briquettes was thereafter taken at two different points with aid of digital calipers while the weight and thickness was recorded immediately.

Determination of Mechanical and Chemical Properties of briquettes

The following Mechanical and Chemical properties were determined using standard methods; durability, moisture content, carbon content, bulk density, compressibility, heating value, ash content and sieve analysis.

Moisture Content (% MC)

Percentage M.C(wet basis) was determined by measuring 2g of pulverized briquettes into a crucible (w_1). The content was dried in an oven at 110^0C -120^0C for 2hrs to obtain oven dry weight (w_2). Moisture Content was thereafter calculated according to Davies and Abolude (2013) as:

$$\textbf{\%MC} = \frac{\text{Initial weight } (w_1) - \text{Dry weight } (w_2)}{\text{Initial weight } (w_1)} \times \frac{100}{1}$$

Ash content

In determination of percentage ash, 2g of oven dried pulverized briquettes were weighed in a crucible (w_3), this was placed in the furnace for 3hrs at 600^0C to obtain the ash weight (w_4).

Percentage ash content was calculated as:

$$\textbf{\%Ash} = \frac{\text{Weight of ash } (w_4)}{\text{Dry weight } (w_3)} \times \frac{100}{1}$$

Carbon content (% CC)

This was calculated by subtracting the sum of % volatile matter and % ash content from 100.

$$\textbf{\% CC} = 100 - (\%\ Vm + \%\ Ash)$$

Compressive strength

The test was carried out by using Arey Tensile testing machine at the Strength of Materials Laboratory, The Polytechnic, Ibadan.

Sieve, Scale and Measuring tube

Sieve used for the study were into three layers, which are 2.60 grain size, 1.18 grain size and 0.60 grain size. Recast tube. Required amount of water was measured using the measuring tube. The balance was used to determine the weight of the grain size needed for specific percentage to be mould.

Briquetting machine

The equipment used in this study was a 20 mould cylindrical briquetting machine. The equipment functions with the hydraulic jack. The compression plunger has 3.2cm diameter and 8cm length which had 20 moulds holes and has removable solid base. The plunger was placed on the compression cylinder; and was together placed on the mount press, directly under the jack stopper. A pressure gauge incorporated into the machine was used to monitor the briquetting pressure.

Plate 1: Cylindrical briquettes made from Gmelina sawdust

III. RESULTS AND DISCUSSION

The results of the analyses were presented below:

Characterization of raw materials for the briquetting (Gmelina arborea sawdust and Tick sawdust)

Table I: ***sieve analysis of Gmelina sawdust***

Sieve Size	Weight Retained	Percentage Retained	Percentage Passing
10mm	2.0	1.3	98.7
5mm	5.5	3.7	95
2.36mm	5.5	3.7	91.3
1.18mm	78.5	52.3	39
600	33.0	22	17
300	10.5	6.7	10.3
150	5.5	3.7	6.6
150 passing	10	6.6	
TOTAL WEIGHT	150		

Table II: Sieve Analysis of Tick sawdust

Sieve Size	Weight Retained	Percentage Retained	Percentage Passing
10mm	3.0	1.5	98.5
5mm	6.0	3	95.5
2.36mm	11.0	5.5	90.0
1.18mm	38.0	19	71
600	70	35	36
300	51	25	25
150	15.5	7.7	2.8
150 passing	5.5	2.8	
TOTAL WEIGHT	200		

Table III: Physical and Chemical Properties of Raw Materials

Sawdust species	% Moisture	% Ash	Bulk Density (gcm^3)	% Carbon Content
Gmelina	11.96	4.81	0.1792	8.31
Tick	11.33	4.86	0.2223	24.54

Table IV: Mechanical Properties of the briquettes (Compressive test)

Samples	Compressive strength (N/m^2)	Compressive strength (W)
Gmelina sawdust cylindrical shaped 1.18mm size at 30% of concentration	181.9	16.90

Tick sawdust cylindrical shaped 1.18mm size at 30% of concentration	47.88	4.45

***Durability Index Test of Briquettes** at 1.5 MPa*

TABLE V: Gmelina cylindrical shaped 1.18mm size at 30% concentration

No of replicates	Initial weight	Final weight
First round	100	88
Second round	100	87
Third round	100	88

TABLE VI: Tick sawdust cylindrical shaped 1.18mm size at 30% concentration

No of replicants	Initial weight	Final weight
First round	100	84
Second round	100	84
Third round	100	86

Discussion of Results

From Table III, the bulk density of the Tick sawdust is $0.2223gcm^{-3}$ is observed to be greater than that of the Gmelina arborea sawdust which is $0.1792gcm^{-3}$. This implies that Gmelina sawdust is lighter in weight than that of the Tick sawdust. The percentage ash content of Tick sawdust (4.86%) is also seen to be higher than that of the Gmelina sawdust of 4.81%. The significance of this is on the combustion of the fuel such that the one with higher percentage may not burn effectively as those of lower percentage. However, the moisture content of Gmelina sawdust (11.96%) is higher than that of the Tick sawdust.

From the results shown on table IV, The compressive strength of Gmelina sawdust is $181.9N/m^2$ is greater than that of Tick sawdust having the compressive strength value of $47.88N/m^2$. This shows a greater compactbility on the side of Gmelina than the Tick sawdust. Tables V and VI show that, the average durability index or shelf life of Gmelina arborea sawdust is 84.67% while that of Tick sawdust is 84.67%. This simply means that the Gmelina arborea sawdust is more durable than the Tick sawdust.

IV. CONCLUSION

Briquettes produced from Tick sawdust had higher bulk density, ash content and percentage carbon content while those from Gmelina sawdust had higher moisture content, compressive strength and durability. Gmelina arborea briquettes possess better mechanical properties than Thick sawdust briquettes. This suggests that both wood species produces strong and durable briquettes. Gmaline sawdust is a better species for producing briquette fuel.

REFERENCES

[1] Adegoke, CO and Mohammed, TI (1999), "The effects of palm kernel shell on calorific value of sawdust briquettes". Journal of Applied Science. Vol 10, No 2 pp 25-37

[2] Ajuitse, ON (2012), "Investigation of sawdust briquette as high grade fuel" Ph.D Thesis, Department of Mechanical Engineering, the Federal University of Technology, Akure. (Unpublished).

[3] Akintunde M.A.: The Effects of Paper and Palm Kernel Shell on Mechanical Properties of Sawdust Briquettes. IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) ISSN: 2278-1684 Volume 4, Issue 4 (Nov-Dec. 2012), PP 11-16

[4] Kakitis, A; Nulle; I; and Ancans, D (2011), "Mechanical properties of composite biomass briquettes". Proceedings of the 8th International Scientific and Practical Conference, pp 175 – 183.

[5] Kaliyan, N; Morey, RV; White, MD and Doering, A (2009), "Roll press briquettes and pelleting of corn stover and switchgrass". Transaction of the ASABE. Vol. 52 No 2, pp 543 – 555.

[6] Kuti, O.A. and Adegoke, C.O. (2008). Comparative performance of composite sawdust briquette with kerosene fuel under domestic cooking conditions. AU J.T. 12: 57- 61.

[7] Maki, KC; Pelkman, CL; Finocchiaro, EI; Kelley, KM; Lawless, AL; Schid, AB and Rains, TM (2012), "Resistant Starch from High-Amylose Maize Increases Insulin Sensitivity in Over-weight and Obese Man". Journal of Nutrition, Vol. 142, No. 4, pp 717 -723.

[8] Sosu, EK; Hasford, F and Dadson, ABC (2011), "Study of mechanical properties of composite materials made from palm fruit fibre and sawdust". Research Journal of Applied Science, Engineering and Technology. Vol 3, No 12 pp 1441-1444.

[9] Tembe, E.T., Otache, P.O. and *Ekhuemelo, D.O.: Density, Shatter index, and Combustion properties of briquettes produced from groundnut shells, rice husk and saw dust of Daniellia oliveri. Journal of Applied Biosciences 82:7372 – 7378 ISSN 1997–5902

[10] Wachira, G. G , Gitau, A. N, Kimani, M. W, Njoroge, B. N. K: Mechanical Properties of Saw Dust Briquettes of Eucalyptus Tree Species of Different Binders and Press Machines International Journal of Emerging Technology and Advanced Engineering Volume 5, Issue 4, April 2015 (ISSN 2250-2459, ISO 9001:2008 Certified Journal).