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Blending coal char on the combustion profiles of fuel briquettes

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ABSTRACT

The right cost of kerosene and cooking gas plus the erratic electric power supply has necessitated the investigation into a cheap and affordable source of fuel. In study, five set of briquettes prepared from some agricultural wastes were studied. Sawdust blend briquette took twenty six (26) minutes to boil two litres of water while the non-blended sawdust briquettes took thirty (30) minutes. Blending with coal char generally decreased the moisture content of the briquettes and increased the ash content (from3:14 to 13.98%) and shear stress (from 76.0 to 265.0 KN/M^2) thereby increasing the residence time for combustibility.

Keywords: briquette, moisture, content, shear stress, ash, content, blending, combustion.

INTRODUCTION

The availability of energy is crucial pre-requisture of development in any society. The industrial revolution was largely a revolution of power availability [1]. About 80% of Nigerian's population live in rural areas and depend mostly on fuel wood for their energy need. This has a negative effect on the ecosystem by causing deforestation leading to soil erosion, desert encroachment, atmospheric pollution due to carbon dioxide build-up and loss of agricultural land. These rural dwellers and even urban dweller cannot afford to use electricity due to erratic supply and cooking gas due to its high cost. These rural and urban dwellers are left with no choice but of using fuel wood as their cheapest source of energy. These fuel wood popularly known as fire-wood have a low calorific value in addition to the ecological problems they cause. Massive tree exploitation recorded in most Nigerian forests in the past was a result of the fact that fire-wood which serves as the major source of energy were gotten from the massive volume of timber in the forest, [2]. The demand on wood is rapidly increasing due to a drastic increase in population which has driven many forest trees species into extinction thus, causing a lot of environment havoc. As a result of inefficient conversion and low biomass recovery on this trees in Nigerian forestry industries has lead to prevalence of sawdust around sawmills and constitutes a disposal problem [3].Obviously, most of the world's demand for energy is yet to be met by fossil fuel which provided about 80% of man's energy source but has failed to meet the huge demand of the teeming population which has kept increasing on daily basis while the volume of the fossil fuel kept on depreciating too. This has prompted a great world concern on other alternative sources of energy [4].

For most developing countries, biomass particularly agricultural wastes, has become one of the most promising energy sources. Biomass are organic matter in the original natural form, growing on the basis of photosynthesis, collecting and transforming solar energy in plants [5].

The idea of utilizing the residues from agricultural sectors has primary or secondary energy sources in attractive due to their availability, indigenous and also environmentally friendly. Examples like coconut shell, corncob and sawdust may be used as fuel without a suitable processing, since they have low energy content. All these issues any cause problems in transportation, handling, storage and entrained particulate emission control on direct combustion. Briquetting, overcomes these problem, improves the handling characteristics of raw materials and enhances the volumetric calorifies value of the biomass [6,7].

Briquetting has been in existence for quite some times in some parts of the world but began to gain more recognition in Nigeria in 1997 when Godson started the production of commercial scale of briquettes in a factory he set up in Okada, Edo State which fetch him a merit award in the 7^{th} Raw Material Research and Development Council (RMRDC) techno-expo between 12^{th}-15^{th} October, 2004 [7]

Briquettes is described as a substance made when small particulars of solid material are passed together to form a coherent shape of large size either with or without a binder [8]

In Malaysia, briquetting has been used to upgrade the properties of oil palm biomass [9]. Nasiru *et al* [10] reported increased energy content and reduced moisture content of 5 and 38% of palm biomass briquettes. Where a binder is used in briquettes making, the binder waste ration is important so as not to confer unnecessary material strength to the briquettes and effects the mechanical characteristics, such as compressive strength [11]

With the increasing use if biomass in Nigeria, some of which cannot be used as fuel directly, the effort of blending the wastes with coal char to produce briquettes with improved combustibility is the subject of this study.

MATERIALS AND METHODS

Sample Collection and Preparation

Samples of millet husk and sawdust wastes were collected from Aliero town, in Kebbi State while the coal samples were collected from the National Metallurgical Research and development Council (NMRDC) Jos Plateau State. Cassava starch was purchased at Sokoto Central Market.

The millet husk and sawdust were sun dired for three days to drive off moisture and serve with a B.S. test size of mesh of mesh size 80 to obtain a uniform size. The coal sample was pulverised to 75im in accordance with ASTM methods D410 and D492 [12] and then carbonized at 450^0using a phoenix furnace for thirty minutes. A rectangular mould of dimension 6 inches by 2inch internal diameter was constructed and a wooden bar was made, which just fitted into the mould to be used to exrude the briquettes as they formed

BRIQUETTING PROCESS: The wastes (millet husk and Sawdust) and starch as binder were weighed in the ratio of 6:1 respectively. A blend of the wastes, coal char and starch were weight in the ratio of 4:2:1 respectively. Slurries of the weighed starch were made for each of the five samples. Each of the five samples were mixed thoroughly with the slurries and loaded into the rectangular mould and compressed with a screw presser. The densified briquette was pushed out of the mould with the aid of the wooden bar. The procedure was repeated for the other samples. The prepared briquettes were air dried at room temperature for two weeks. The briquettes prepared includes: Coal chars (ii) Coal char + millet husk (iii) Millet husk only,

(iv)Sawdust only (v) Coal char + sawdust

Determination of moisture: Percent moisture was determined as difference in mass loss [13]

Percentage (%) moisture = $\frac{Wi-Wi}{Wi} X\ 100\%$ (1)

Wi = initial weight of briquette before burning,
Wi = Final weight of briquette after burring

Determination of ash: Percent ash in 5g of each sample was determined as difference in mass loss [14]

Percentage (%) ash contents $\frac{(Wa-Wc)-(Wb-Wc)}{Wa-Wc} X\ 100\%$ (2)

Where Wa = Weight of sample + crucible
Wc = Weight of crucible
Wb = Weight of ash + crucible

Procedure for Combustibility Test: 1kg of each briquette was loaded into an improved stove. The briquette was ignited with little kerosene and matches to initiate combustion and the fire was allowed to assume a steady combustion for 5minutues. Two litre of water in an aluminium pot was placed on top of the stove. A thermometer was inserted through the opening in the cover of the pot, which was previously drilled for this purpose. The water was heated to boiling and readings taken after two minutes interval and the corresponding temperature recorded until the water boiled at 100^0C

Determination of shear stress: Each sample of the briquettes was loaded into the ELE tritests 50 compressions machine, and a load 10kg was applied. The machine was set at gear one and at a strain rate 1.2mm per minute. The machine was switched on, clearing continued, deviator stress readings were taken at 0.5 strain interval until the maximum deviator stress (yield point) was obtained. The procedure was repeated for loads of 20kg and 40kg and corresponding readings taken. A plot of deviator stress (KN/M^2) against strain rate for the various sets of briquette and different loads were made. The maximum displacement multiplied by the stress factor gives the shear stress. The shear stress (KN/M^2) and the interrupt gave the shear stress of the briquette

RESULT AND DISCUSSION

Nature of the briquette: Strong and well formed briquette were obtained although some (sawdust and it's blend) suffered serious crack due to its elasticity. The cracks could be attributed to the pressure which was apply during compaction [15]

Physicochemical contents: The result of the physicochemical content of the briquette is shown on Table 1 below: result was presented as mean valves of triplicate analysis

Table 1: physiochemical characteristics of the fuel briquettes

Fuel Briquettes	Moisture (%)	Ash(%)
Coal char	9.95	10.25
Millet husk	13.50	7.65
Millet husk blend	10.75	13.98
Sawdust	11.18	3.14
Sawdust Blend	9.50	6.42

Combustibility test: The result by the combustibility test is shown on Table 2.

Table 2: Combustibility test of the fuel briquettes

Time (Mins)	TEMPERATURE MEASUREMENT (^{0}C) ATTAINED FOR:				
	Coal Char	Millet Husk	Millet Husk Blend	Sawdust	Sawdust Blend
0	34	34	34	34	34
2	38	42	41	44	44
4	40	46	49	56	53
6	43	50	54	63	61
8	49	55	58	70	69
10	53	64	78	73	76
12	55	74	78	74	81
14	58	70	81	76	86
16	63	76	84	78	89
18	70	80	85	80	92
20	80	83	86	90	94
22	84	86	88	92	95
24	92	88	91	94	97
26	96	94	94	96	100
28	100	97	95	98	-
30	-	100	98	100	-
32	-	-	100	-	-

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The moisture content varied from 9.50 (sawdust blend) to 13.50 (millet Husk). Briquetting generally reduces moisture content and increase energy content [10]. The combustibility of these fuels in enhanced

The coal blend briquettes are higher in percent ash (insert value) (13.98% & 6.42%) than their corresponding non-blend ones value (7.65% and 3.14%) respectively as shown in table 1. Both blends have their ash content increased by almost two fold than their non-blend counterparts. This expected because coals are rich in inorganic ([16] due to the depositional environment of the coal matrix [17].

The result of the combustibility test shown in Table 2 indicates that the sawdust blend took 26mintues to boil two litres of water while the non-blended sawdust took thirty minutes. This is expected as calorifies value are inversely dependent on moisture content [18]. This indicates that blending has decreased the time taken to boil the same quantity of water while improving the residence time for the briquettes to undergo complete combustion.

The discrepancy notice in this study is the case of the millet husk and it’s blend briquettes as shown in fig 1. It took thirty-two minutes fro the blend briquette to boil two litre of water while the non-blended briquette took thirty minutes. This could be as a result of the dense nature of the briquettes shown by their stress values and also their high ash content which impede combustion [19]

Shear Stress: The result of the shear stress is recorded in Table 3 as shown below

Table 3: results for normal stress against shear at maximum deviator stress and the maximum shear stress fro the fuel briquettes

Fuel briquette	Normal Stress (KN/m^2)	Shear Stress (KN/m^2)	Max. Shear (Mins) stress (KN/m^2)
Coal Char	121	414.2	265.0
Saw Dust	121	133.5	76.0
Sawdust blend	121	195.8	76.5
Millet husk	121	167.0	87.0
Millet husk blend	121	231.2	120.0

Table 3 results shows that blending with coal char has increased the shear stress value of the fuel briquettes. Blending the millet husk has blend may have been responsible for such properties as difficulty in ignition, propagation and stabilization, high burning rate and heat evolution. This help to keep the fuel compact and retains the heat capacity than the other fuel briquettes [20]

CONCLUSION

Blending of sawdust and millet husk with coal has greatly improved the combustion characteristic of these wastes and their residence time of combustion. It has also improved the shear stress of these fuels foe easy transportation and handling and the calorific value by decreasing their moisture content. Conclusively, efficient and affordable alternative sources of energy have been obtained from coal char, sawdust and millet husk blend briquettes.

REFERENCES

[1]. Jarret, H. R., A Geography of Manufacturing, 2nd Ed, MacDonald and Evans, Plymouth, **1979,** 20
[2]. FAO, Food and Agricultural Organization Wood Structure and Utility W.T. 102 FAO Working Document, Rome , **1990,** 35
[3]. Ogunsanwo, O.Y., Proceedings of the 27th Annual Conference of FAN Abuja FCT. **2001,** 225-234
[4]. Adegoke, O and Mohammed A ., Nigerian. *Journal of Renewable Energy*,**2002,** 4(1),67-69
[5]. Plastil D; Brozek. M; Molatak, J and Henamman. P., *RESAGS*, **2004**, 50 (4) Pp. 136-139
[6]. Demirbas, A ., *Energy Convers. Mgt*. **1999**, 40: 437-445
[7]. Etonihu, A.C, Akpabio, I.O and Sambo, *Int'l Jour. Chem. Sci*., **2008** , 1:55-60
[8]. Akande, J. A Proceeding of the 28th Animal Conference of FAN, Abuja, *F.C.T.* **2002**, 127-135 .
[9]. Kong, H. W., Processing of international Worship on Biomass Briquettes, Grover, P.D. and Mishra. S.K ., **1995**, 68-74
[10]. Nasrin, A. B; Ma, A. N; Choo, Y. M; Mohammad M. H; Rohaya, A. A and Zainab, Z ., *Am Jour. Applied. Sci.,* **2008**,5(3): 179-183
[11]. Wilaipon, P., *Am Jour Applied Sci*. **2008,** 6(1): 167-171
[12]. ASTM - American Society for testing Material Annual Book of ASTM Standard, Part 26, **1998**, 243-249, 253
[13]. ASTM , Annual Book of ASTM Standard: Petroleum Products, *Lubricants and Fossil Fuels*, **2009a,** 5 (5), 310-312
[14]. ASTM , American Society for Testing Material Annual Book of Standard: Petroleum Products, *Lubricants and Fossil Fuels*, **2009b,** 5(5); 310-312
[15]. Akapbio I.O and Illela, A., *Nigerian Journal of Renewable Energy* ,**1997**, 5(1, 2): 83-87
[16]. Barton, C.M; Gloe, C. S and Holgate, C.R , *Int Journal. Coal Geology*, **1993,** 23:193-213
[17]. Etonihu, A.C and Akpabio, I.O ., Processings of the Annual Int. Conf. Chem. Soc. of Nig., **2007,** 66
[18]. Gabriel, O.I., *Nigerian Journal of Technology*, **1993**, 6(4),76-79
[19]. Olorunnisola, A. O ., *Nigerian Journal of Renewable Energy*,**1998,** 7 (12): 13-34
[20]. Sambo, A. S; Etonihu, A.C and Akpabio, I.O ., *Int'l Jour Chem. Sci*.,**2008**, 1(2): 205 - 213