Sawdust as an Alternative Energy Source for Small Scale Cottage Industries in Nigeria

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Abstract— *The sawdust briquette and pallet were produce and the calorific values were obtained from an experiment performed on bomb calorimeter machine that gives the energy released by the fuel. Sample A (Afara) produce 16,197.4 J/g while sample B (Abora tree) gives 15,646.6J/g as the average energy realised which is a little more than the calorific value of wood (16,000J/g).Therefore, the briquette can be used as solid fuel in boiler, room heater, oven and furnaces as an alternative energy source. This can also lead to minimizing waste disposal in the sawmill industries.*

Keywords— Abora, Afara, briquette, energy, sawdust.

I. INTRODUCTION

Energy is essential in our everyday activities, there are different types of energy source, and sawdust is one of such, by using it as a solid fuel to produce heat during burning.

Afara tree is a large West Africa forest tree ranging in height from 15 to 46meters, the bowl is very straight with small buttresses and is sometimes also fluted. It can be branchless for up to 30 meters with diameter from 2 to 4.75 meters.

Mature trees are very flat topped with a wide horizontal canopy of evenly distributed foliage arising from the apex of the strength bole where Abora tree is of tropical west Africa from which a soft pale wood is obtain that is used for light construction, the height of the tree attains 30 to 40 meters with a diameter of 1.0 to 1.2 metres at maturity stage. Afara and Abora tree are used in the wood industries. The disposal of the waste is a big challenge for the industries, sawdust as alternative source of energy will solve the problem of waste from wood industries.

Waste to energy is the process of generating energy in the form of electric heat from the incineration of waste. It is a form of energy recovering from waste product (sawdust), this process produce heat through the combustion of the waste. With the high growth in populations, there is increased use of sawmill and with a lot of wood waste which can be converted to energy resources for cooking, heating, mechanical power and lighting which are basic requirement of life .

Traditionally wood in a form of fuel, twigs and charcoal has been the major source of renewable energy in Nigeria. The decreasing availability of fuel wood, coupled with the ever rising prices of kerosene and cooking gas in Nigeria, draw attention to the need to consider alternative sources of energy for domestic and cottage industrial in the country, such energy sources should be renewable and be accessible to the rural communities. An energy source that meets such sustainability requirements is fuel briquette.

The main idea is to get sawdust briquette out of wood waste which can be used in industries as solid fuel and for domestic use for cooking and heating.

II. BRIQUETTING PROCESS

A briquette is a block of compressed sawdust, coal, biomass or charcoal dust that is used as fuel to start and maintain fire (Grainger et al, 1981).

Biomass is an organic material available on renewable bans, which are produced directly or indirectly from living organisms or efficient biomass include forest and mill residue, agricultural crops and wastes, wood and wood wastes, animal waste, livestock operation residue, aquatic plants fast growing trees and plants municipal and industrial waste.

Biomass power, also called bio-power, is electricity produced from biomass fuels;itconsists of plant materials and animal products which include residue from food production and processing, trees and grasses grown specifically as energy crops, and gaseous fuels produced from solid biomass and waste (Brain, et al 1998).

Briquetting is a mechanical compaction process for increasing the density of bulky materials. This process is used for forming fine particles into a designed shape. It can be regarded as a waste control measure of production from agricultural waste. However, depending on the material of

interest, briquetting can be used to provide fuel source as a preventive measure to many ecological problems. Briquetting is a high pressure process which can be done at elevated temperature (zhanbin, 2003) or at ambient temperature (Mohammed, 2005) depending on the technology one wants to employs.

During this process, fine materialsare compacted into regular shape and size which does not separate during transportation, Storage or combustion.

In some briquetting techniques, the materials are simply compressed without addition of adhesive (binder less briquettes) (Mangena and Cann, 2007) while in some, adhesive materialsare added to assist in holding the particles of the materials together.

III. SAWDUST AVAILABITY IN NIGERIA

Sawdust comes from the saw milling activities and activities of wood based industries Arends and Doker shoot-shooq (1985) have stated that enormous quantities of sawdust are produced annually all over the world similarly Owonubi and Badejo (2000), have also stated that the volume of wood waste generated in Nigeria increases yearly and that the volume of sawdust created disposal problems which are of concern to all world industries and government Badejo and Giwa (1985) gave the estimated volume of sawdust in 1981 to be 1.72 million m^3.Owonubi and Badejo (2000) however, reported that sawdust accounts for about 10-20% of wood waste estimates.

The study conducted by Raw materials research and Development council (RMRDC) (1997), Established that Nigeria had 1,252 sawmill industries in existence by 1996. In a later study RMRDC (2003), further re-established that by the year 2003 Nigeria had 1,325 sawmills located in different parts of the country. Theyfurther asserted that sawdust was in commercial quantity and can be used for production of building materials.

Investigation from other countries have also show abundance of sawdust Harkin (1969) attested that a planner mill in America produces about 600 pounds of dry residues per a thousand board feet, which gives the total amount of air dry wood fines originating from U.S.A industries alone to exceed 15 million tons a year.

IV. APPLICATION OF SAWDUST BRIQUETTE

Application on Boiler

Some of the companies which use boiler for some production processing like paper mills, sugar mills Dyeing house, food processing unit solvent extraction plant etc.have switched from furnace oil to solid fuel to save cost. Sawdust briquette can be used in any solid fuel furnace boiler, this briquette have a high thermal efficiency comes with low moisture content and delivers smokeless usage. It can be used to provide heat to boiler for solid fuel boiler effectively.

Residential Heating

Wood is a natural product which can be highly compacted as a briquetted fuel. Almost take, on the burning behavior of coal owing to their greater density, wood briquettes has a higher calorific value than the same quantity of fire wood. They can be used instead of firewood, coal or wood in domestic solid fuel home appliances such as room heater, and house hold kitchen appliances.

As people are becoming more and more conscious about their individual impact on the environment and looking into greener more efficient energy sources, the briquetted fuel which is environmental friendly because it generated smokeless flame when used due to the low moisture content can be considered as one of such energy sources.

Furnace and Foundries

Agro wastes briquetted are best alternative to coal and charcoal. The sawdust briquette are made from agricultural and forest waste (sawdust) which have high specific density compared to loose biomass andhigher thermal efficiency than the loose type.Thus its briquette can be used in the furnace or foundries for metal heating and melting where melting point is less than 1000℃ .

V. PREPARATION OF MATERIALS SAMPLE AND FORMATION OF BRIQUETTE

Sawdust collected was sieved and dried. 22.5g of starch and 400g of sawdust were weighed out and 250ml of water are required, the water was heated to dissolve the starch and poured into the sawdust and mixed in the mold before preheating the mold for perfect solidification. Hence, the briquette is carefully removed from the mold and dry.

TABLE.1:Formulation of Sawdust Briquette

Materials	Quantity	Unit
Starch	22.5	Grams
Sawdust	300- 400	Grams
Water	250	Mil

VI. CALORIFIC VALUE OF THE BRIQUETTES

The specific sample was weighed out and placed into the crucible of the bomb calorimeter, and the crucible is place inside the decomposition vessel with wood thread connected from the ignition wire to the briquetted fuel

inside the crucible, the decomposition vessel is closed and placed into the bomb calorimeterwhich is then activated. After accepting all the operating condition of the system, filling of oxygen gas into the decomposition vessel and water inside the vacuum surrounding the decomposition vessel etc., energy release by the fuel is display on the visual screen.

Fig.1: Sawdust Briquette

VII. ENERGY RELEASED (Calorific value)

Bomb Calorimeter

Bomb Calorimeter IKA C2000 Basic with a Refrigerating unit IKA KV600 is a digital apparatus for the measuring the energy in joules per gram of the sample. It is used for bombing or burning fuel after all necessary requirements have been satisfied. The readings are automatically stored in the system and can be printed out via a dot matrix printer. Tables 2.0 and 3.0 shows the result of energy release for ten (10) samples each for the Afara and Abora sawdust briquettes respectively.

Table .2:Result of energy release (calorific valve) by awdust from Afara treesawdust briquette

S/N	DATE	SAMPLE WEIGHT (g)	TEMPERATURE RISE (k)	ENERGY RELEASE (J/g)
1.	08/31/2O15	0.40	0.7388	16,100
2.	09/02/2015	0.50	0.9407	16,465
3.	09/03/2015	0.60	1.1271	16,479
4.	09/03/2015	0.70	1.3475	16,921
5.	09/03/2015	0.60	1.1455	16,751
6.	09/04/2015	0.40	0.7714	16,823
7.	09/04/2015	0.50	0.8813	15,410
8.	09/04/2015	0.70	1.3047	16,378
9.	09/04/2015	0.90	1.592	14,952
10	09/04/2015	0.80	1.4276	15,695
			Total	16,197.4

The mean = $\frac{161,974}{10}$ = $\underline{16,197.4}\,J/g$

Table 3.0 Result of energy release (calorific valve) by the sawdust from Abora sawdust briquette

DATE	MASS OF SAMPLE (g)	TEPERATURE RISE(k)	ENERGY RELEASE(J/g)
09/02/2015	0.40	0.7045	15,338
09/03/2015	0.40	1.0806	15,646
09/03/2015	0.60	1.0875	15,893
09/03/2015	0.40	0.7249	15,791
09/03/2015	0.30	0.5062	14,582
09/03/2015	0.50	0.9076	15,877
09/03/2015	0.70	1.2478	15,656
09/03/2015	0.60	1.0913	15,949
09/03/2015	0.90	1.5971	15,623
09/03/2015	0.80	1.4651	16,111
		TOTAL	156,466

The mean = $\frac{156,466}{10}$ = 15,646.6 J/g

VIII. CONCLUSION

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Waste to energy is the process of generating energy in the form of electric heat from the incineration of waste. It is a form of energy recovering from waste product (sawdust), this process produce heat through the combustion of the waste. With the high growth in populations, there is increased use of sawmill and with a lot of wood waste which can be converted to energy resources for cooking, heating, mechanical power and lighting which are basic requirement of life.

Analysis conduction on two major sources of sawdust (Afara tree) produces 16,197.4 J/g and (Abora tree) gives 15,646.6J/g as the average energy realised which is a little more than the calorific value of wood (16,000J/g).

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