Computing, Information Systems, Development Informatics & Allied Research Journal
Vol. 7 No. 2.June, 2016 - www.cisdijournal.net

Characterization of Briquettes Produced From Corn Cobs and Corn Stalks

[1]Oladeji, J.T., [2]Balogun, A. O., & [3]Adetola, S. O
[1, 3] Department of Mechanical Engineering Ladoke Akintola University of Technology, Ogbomoso
[2]Department of Mechanical, Automotive and Production Engineering Elizade University, Ilara-Mokin
[1]Correspondence Author: jtoladeji@lautech.edu.ng

ABSTRACT

Agro-residues can ameliorate some of the problems of energy shortage that are facing the whole world. Therefore, this work is based on the briquetting of two residues from corn. The corn cobs and stalks were prepared via chopping, drying, grinding, and sieving to form granules. An existing briquetting machine was used to produce the briquettes by compressing the blend of the feed stocks and cassava starch gel. The maximum and relaxed densities of the corn stalk were 951.29 kg/m3 and 851.17 kg/m3 respectively, while those of corn cob were 842.7 kg/m3 and 742.60 kg/m3 respectively. Compaction ratio of 6.14 and 5.44 were obtained for briquettes from cornstalk and corncob respectively, while for the relaxation ratio, values of 1.12 and 1.13 were obtained for briquettes from cornstalk and corncob respectively. The higher heating value of 21,345kJ/kg was obtained for briquette produced from cornstalk, while the corresponding value for briquette from corncob was 20,890kJ/kg. The two residues would make good biomass energy; however, corn stalk briquette has higher stability than that of corn cob as it has the lower relaxation ratio and higher relaxed density as well as higher energy value.

Keywords: Agro residue, Biomass Energy, Briquettes, Corn, Corn cob, Corn stalk.

CISDI Journal Reference Format
Oladeji, J.T., Balogun, A. O., & Adetola, S. O (2016): Characterization of Briquettes Produced From Corn Cobs and Corn Stalks. Computing, Information Systems, Development Informatics & Allied Research Journal. Vol 7 No 2. Pp 65-72 Available online at www.cisdijournal.met

1. INTRODUCTION

Energy is an integral part of a society and it plays a vital role in social and economical development by raising the standard of living and the quality of life (El-Saeidy, 2004). It is the key to the progress and social development of any society (Aremu and Agarry, 2013). The source of energy which the world depended on is fossil fuels. They were derived from the organic remains of pre-historical animals and plants. According to Kaygusaz and Turker, (2002), 86% of energy being consumed all over the world is from fossil fuels. It has brought about the industrial revolution and helped to turn the Western World into what it is today. However, it is becoming increasingly obvious that heavy reliance on fossil fuels is causing hazard to both human and ecology as there is environmental damage in getting the fossil fuels out of the ground as well as when they are burnt as a fuel (Aremu and Agarry, 2013). There is the need to generate alternative form of energy, which is renewable and environmentally friendly and in this regard, biomass can play a very significant role.

Biomass can be defined as all renewable organic matter including plant materials, whether grown on land or in water, animal products and manure, food processing and forestry by-products, and urban wastes (Purohit, et al., 2006). Biomass for energy purposes can be obtained from dedicated energy crops and/or from agricultural residues. Maize is a cereal crop that is grown widely throughout the world and generally consumed by Nigerians than any other grains (IITA, 2009). According to Food and Agricultural Organization (FAO, 2007) data, 589 million tons of maize was produced world-wide in the year 2005. The United States of America was the largest maize producer having 43% of world production. Africa produced 7% of the world's maize (Adesanya and Raheem, 2009). Nigeria was the second producer of maize in Africa in the year 2006 with 7.5 million tons [FOS, 2006]. South Africa has the highest production of 11.04 million tons (Adesanya and Raheem, 2009). In Nigeria, twenty eight different food items can be prepared from maize (BCOS, 2010). It can be eaten after cooking or smoking and can also be converted into animal feeds. The residues of maize, which are left behind after harvest include the husks, chaffs, stalks and the leaves (Oseni and Ekperigin, 2007). Cobs (Plate1) and stalks (Plate 2) are among the prominent residues associated with maize.

These disposed maize residues have some positive and negative effects on the environment (Oladeji and Olafimihan, 2008). The maize residues just like any other agro-based residues are indiscriminately left on the farm to be mineralized and used by other crops (Eze and Ojike, 2012). However, accumulation of these biomass residues especially in non-farming areas poses a serious threat to both human and ecology (Oladeji, 2012). Briquetting of these residues would reduce the use of fossil-fuel-derived energy and reduce environmental impact as well as demand for wood and charcoal for cooking (Mshandele and Parawira, 2009).

It will also lead to decrease in deforestation, which is a very big problem in developing countries (Salunkhe, *et al*., 2012). Briquetting, according to Wilaipon (2008) is defined as the process of compaction of residues into a product of higher density than the original raw materials, while Kaliyan and Morey (2009) described it as a densification process. The agro-residues that are used in biomass briquetting are of wide varieties and the most appropriate energy conversion technologies and handling processes vary from type to type (Oladeji, 2011). The broad aim of this project was to characterize briquettes produced from two biomass residues generated from cultivation of maize (i.e. Cornstalk and corncob). This was with a view to determining their energy potentials through briquetting and which of them is superior in term of energy generation.

Plate1:- Corn stalks

Plate 2:- Samples of Corn cob

2. MATERIALS AND METHODS

Cornstalk and corncob were obtained from the Lautech University farm dump, where they are usually left as waste products. The two agro-residues obtained were chopped into smaller sizes and sun-dried to reduce their moisture contents and ensure homogeneity. The two residues were subjected to process of sieving and a particle size of 2.00 mm was selected. To facilitate proper agglomeration and since a low pressure technique was employed, a cassava starch gel was used as a binder. An existing briquetting machine (Plate1 and Fig. 1), which has a capacity to produce four briquettes per batch and specifically designed and fabricated for compaction of agro-residues was used for briquettes production.

Plate 3:- A Prototype Briquetting Machine

The mixture of the residue and the binder was fed into the moulds of the briquetting machine and compressed and after the dwell (holding) time which was 90 seconds was observed, the briquettes (Plates 4 and 5) were ejected and left open in the sun to dry. However, the dimensions of the briquettes were measured before and after drying so as to obtain density related parameters**.**

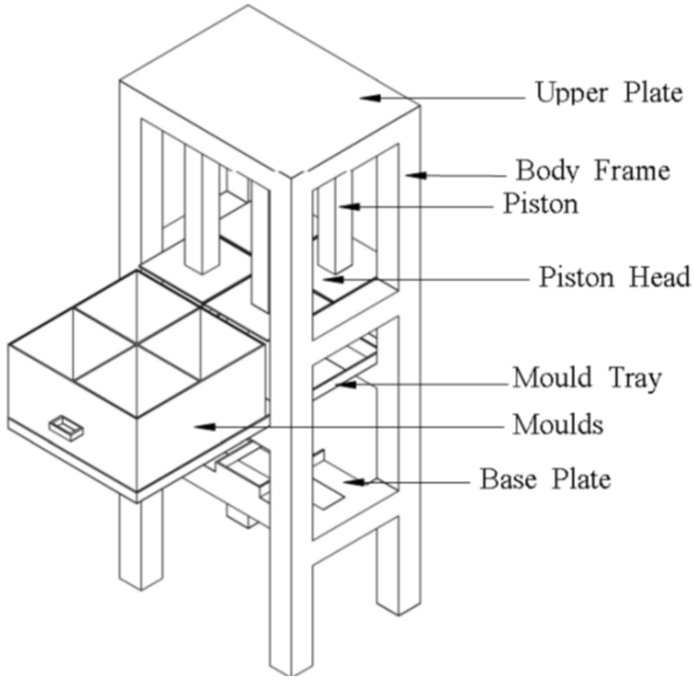

Fig.1:- Isometric View of an Experimental Briquetting Machine

Plate 4:- Briquettes produced from Corn Stalk

Plate 5. Briquettes from corncob residue

2.1 Determination of Physical and Combustion Characteristic of the Briquette produced

The density of the briquette from the residue was determined immediately after removing the briquette from the mould and this was calculated from the ratio of mass to volume of the briquette. The mass was obtained using weighing scale, while the volume of the briquette was obtained by taking the dimensions (length, breadth and height) of the briquette by means of ruler or vernier calliper. The relaxed density of the briquette produced from the residue was calculated as a ratio of briquette's weight to the new volume. Relaxed density is defined as the density of briquette obtained after the briquette has become stable i.e. when the briquette maintains its stability. It is also regarded as the spring-back density. Density ratio is the ratio of relaxed density to the maximum density i.e. Density ratio = Relaxed density/Maximum density. Maximum density is the compressed density of the briquette immediately after ejection from the briquetting machine. Relaxation ratio was calculated as the ratio of maximum density to the relaxed density i.e. Relaxation ratio = Maximum density/Relaxed density. The energy values for the briquettes produced from the two biomass residues were determined using Gallen Kamp bomb calorimeter.

3. RESULTS

The results of briquetting operation are presented in Tables 1 to 3, while Fig. 2 depicts the graph showing comparison between briquettes produced from cornstalk and corncob.

Table 1:- Briquetting Parameters for Corn Stalk and Corn Cob

Parameter	Unit	Value	
		Corn Stalk	Corn Cob
Mass	kg	8	8
Initial Length	m	0.16	0.153
Relaxed Length	m	0.167	0.159
Initial Breadth	m	0.146	0.14
Relaxed Breadth	m	0.149	0.145
Initial Height	m	0.09	0.083
Relaxed Height	m	0.095	0.088

Table 2:-. Density Related Properties of Corn Stalk and Cob

Parameter	Unit	Residue	
		Cornstalk	Corncob
Maximum density	kg/m^3	951.29	842.7
Relaxed density	kg/m^3	851.16	742.6
Density ratio	-	0.89	0.881
Relaxation ratio	-	1.12	1.135
Compaction ratio	-	6.14	5.44

Table 3:- Energy Values of Briquettes produced from the two Biomass Residues

Biomass residue	Heating value (kJ/kg)
Cornstalk	21,345
Corncob	20,890

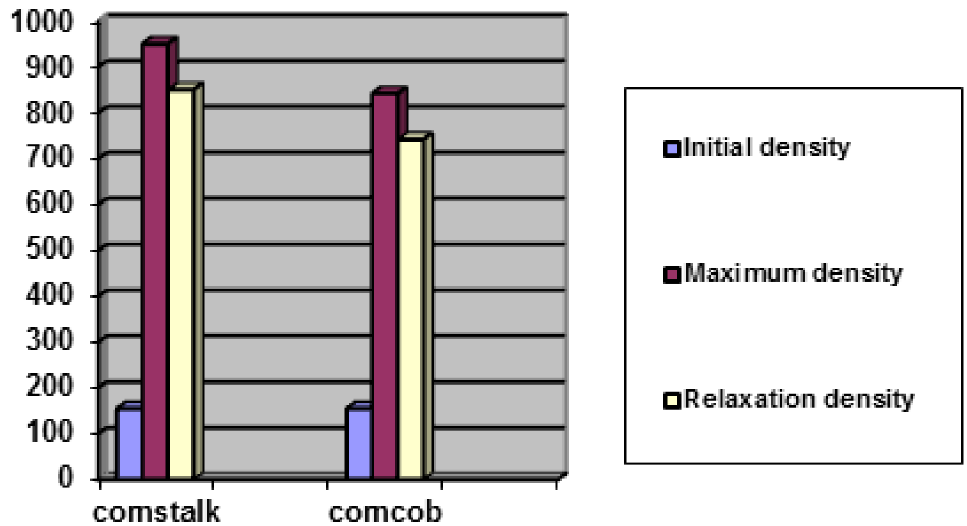

Fig: 2 Graph of Initial, Maximum and Relaxed Density of Corn Stalk and Corn Cob

The initial moisture content of the cornstalk and corncob were 17% and 16% respectively, while the corresponding final moisture contents were 14% and 15% respectively. The maximum and relaxed densities of the cornstalk were 951.29 $kg/m^3$and 851.165 kg/m^3 respectively, while those of corncob were 842.7 kg/m^3 and 742.6 kg/m^3 respectively.

4. DISCUSSION OF RESULTS

The densities obtained in this study appear better than densities of notable biomass fuels such as banana peel briquette-600kg/m^3 [Wilaipon, 2008]; rice husk briquette-534 kg/m^3 (Musa, 2007) and coconut husk briquette-630kg/m^3 (Olorunnisola, 2007). Comparing the maximum densities of the briquettes from the two maize residues, briquettes from cornstalks are better. The same thing could be said of their relaxed densities. The compaction ratios of 6.14 and 5.44 were obtained for cornstalks and corncobs respectively. The implication of this is that the higher value obtained for cornstalks is an indication that the cornstalks would lend themselves easily to process of densification than its corncob counterpart.

However, the values of compaction ratios for the two biomass residues are better and higher than those obtained by Oladeji (2012), where compaction ratios of 3.80, 3.93, 2.94 and 3.21 were obtained for groundnut shell, melon shell, cassava peel and yam peel respectively. The relaxation ratios obtained for the two biomass briquettes are good enough and deviate from the one obtained by Olorunnisola (2007), where a relaxation ratio of between 1.80 and 2.25 was achieved for briquetting of coconut husk. The implication of this is that briquettes produced in this work are far better than similar briquettes produced from coconut husks.

This is because the lower the value of relaxation ratio the more stable such a briquette is (Wilaipon, 2008). The energy values of 21,345kJ/kg and 20,890kJ/kg obtained in this study are good and sufficient enough for domestic cooking and industrial cottage applications. Furthermore, they compare well and even better than most biomass energies such as rice husk-11,900kJ/kg (Musa, 2007), cow pea-14,372.93kJ/kg and soy beans-12,953 kJ/kg (Enweremadu, *et al.,* 2004). The energy value of cornstalk briquette is higher than corncob briquette, which is an indication of superiority of the former over the latter.

5. CONCLUSION

From the results and findings of this study, the following conclusions were drawn: Briquettes from the two specimens examined in this study would make good biomass energy. Briquettes produced from the two residues would not crumble during transportation and storage because their relaxation ratios are low, which is an indication of stable and durable briquettes.
Briquettes from cornstalk are better than corncob briquettes going by the values of maximum and relaxed densities as well as relaxation ratio and energy values.

REFERENCES

[1] Adesanya, D. A., and Raheem, A. A., (2009): A study of the workability and compressive strength characteristics of corn cob ash blended cement concrete. Construction and Building Materials, 23:311-317.

[2] Aremu, M.O., and Agarry, S. E., (2013): Enhanced Biogas Production from Poultry Droppings using Corncob and Waste Paper as Co-substrate, International Journal of Engineering Science and Technology, 5(2), pp. 247-253

[3] BCOS, (2010), Uses of Corn-A Broadcasting Corporation of Oyo State Programme "Magazine" aired on 14th September, 2010

[4] El-Saeidy, E. A., (2004): Technological Fundamentals of Briquetting Cotton Stalks as a Biofuel, An Unpublished Ph.D Thesis, Faculty Agriculture and Horticulture, Humboldt University, Germany

[5] Enweremadu, C.C.: Ojediran, J.O.: Oladeji, J.T. and Afolabi, L.O., (2004): Evaluation of Energy Potential in Husks from Soy-bean and Cowpea, Science Focus 8:18-23.

[6] Eze, J. I., and Ojike, O. (2012): Anaerobic Production of Biogas from Maize Wastes, International Journal of the Physical Sciences, 7(6), pp. 982-987

[7] FAO, (2007). Agricultural Database, Available from http:/www.fao.org (accessed on June, 24, 2007)

[8] FOS, (2006). Federal Office of Statistics, Agricultural Survey, 2003/04, Federal Ministry of Agriculture (June, 2006)

[9] IITA, (2009). International Institute of Tropical Agriculture, *Zea may.* Available from http://www.iita.org/maize A technical article accessed on line 12- 09 -2012

[10] Kaliyan, N. and Morey, R. V. (2009): Factors affecting strength and durability of densified biomass products, Biomass and Bioenergy 33:337-359

[11] Musa, N.A., (2007): Comparative Fuel Characterization of Rice Husk and Groundnut Shell Briquettes, NJRED, 6(2). pp 23-26.

[12] Mshandele, A. M. and Parawira, W. (2009): Biogas technology research in selected sub-Saharan African countries- A review, African Journal of Bio-ethanol, 8(2), pp. 116-125

[13] Oladeji, J.T. (2012) Comparative Study of Briquetting of Few Selected Agro-Residues Commonly Found in Nigeria. Pacific Journal of Science and Technology 13(2):80-86

[14] Oladeji, J.T. (2011): The Effects of some processing Parameters on Physical and Combustion Characteristics of Corncob Briquettes An Unpublished Ph.D Thesis of Mechanical Engineering Department, Ladoke Akintola University of Technology, Ogbomoso

[15] Oladeji, J. T., and Olafimihan, E. O., (2008): Preliminary Evaluation of Energy Content of Corncob, Science Focus, Vol.13 No. 2, pp.52-55.

[16] Olorunnisola, A. O., (2007): Production of Fuel Briquettes from Waste Paper and Coconut Husk Admixture, Agricultural Engineering International: the CIGR E-journal. Manuscript EE 06 006 Vol. IX

[17] Oseni, O. A. And Ekperigin, M. (2007) Studies on biochemical changes in maize wastes fermented with Aspergillus niger, Biokemistri, 19 (2):75-79

[18] Purohit, P., Tripathi, A. K. And Kandpal, T.C., (2006): Energetic of coal substitution by briquettes of agricultural residues, Energy 31 1321-1331

[19] Salunkhe, D.B., Rai, R.K., and Borkar, R.P. (2012): Biogas Technology, International Journal of Engineering Science and Technology, 4(12), pp. 4934-4940

[20] Wilaipon, P., (2008) : The Effect of Briquetting Pressure on Banana-Peel Briquette and the Banana Waste in Northern Thailand, American Journal of Applied Sciences 6(1), pp. 167-171.