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The Effect of Storage on Some Properties of Groundnut Shell Biomass Briquettes

O. Ajani Oyelaran*

Department of Research and Development, Hydraulic Equipment Development Institute, Kano-Nigeria

P A P E R I N F O

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A B S T R A C T

The effect of storage time on some properties of groundnut shell briquette with 5, 10, 15 and 20% binder (cassava gel) was studied. The briquettes were prepared using a motorized briquetting machine. The moisture content, durability rating, water penetration, calorific value and the ash content were determined after every 30 days for 6 months. The results reveals that the moisture content of briquettes decreases during storage during the hot season, the result also reveals a decrease in the durability rating. However, there is an increase in the water penetration with storage time. There is also an increase in the ash content with storage, and this is believed to be responsible for the decrease in the calorific value of the briquettes with storage. However, briquettes with 15 and 20% binder remained relatively stable after 6 months of storage.

1. INTRODUCTION

Biomass is defined as the biological degradable fraction of products, waste and residues from agriculture (including animal and vegetable materials), forestry and the biological degradable fraction of industrial and household waste [1]. The usual way of getting rid of residue of different crops in developing nations is by burning them in open fields causing air pollution. For resourceful management of agro – forest residue, it is essential to think of means of utilizing this residue for the advantage of humanity, hence the use of compaction to produce briquettes for heating and electricity generation. There is over exploitation of wood for burning due to high cost of fossil fuel and population growth. This exploitation of wood is one of the key drivers of deforestation and desertification. This has led to the depletion of large forest cover in many sub-Saharan countries and consequently leading to alteration and disturbance of the ecosystem thereby causing environmental crises. Use of agro-residues in raw form is still limited because of a number of problems such as low energy content per unit volume, low bulk density, high moisture content and high transportation cost. Transforming these loose biomasses into briquettes is an effective way to solve these problems, and to contribute towards alleviation of energy shortage and environmental degradation [2]. Agricultural waste which is produced in millions of tones per year is one of the most viable alternatives to replace wood as a source of energy. Some of the factors to be considered that affect briquetting are effects of particle size [3], pre-heating of biomass feedstock [4], pressure/density relationship [5] and effects of moisture content [6]. They all concluded that those aforementioned factors have one effect or the other not only on briquetting process, but on the quality of the briquettes as well as.

Briquetting can be done with or without a binder. Briquetting without the binder is more convenient but it requires sophisticated and costly presses and drying equipment which makes such processes unsuitable in a developing country like Nigeria [7].The materials chosen for this study is groundnut shell. This material was selected because it is available in abundance, and most often, these residues are dumped or flared resulting in wide spread fire hazards and environmental pollution. One point to note is that these agricultural wastes are seasonal, and therefore large amount will need to be stored to meet off-season periods. The aim

*Corresponding Author's Email: ajaniyelaran@gmail.com (O.Oyelaran)

of the present study is to evaluate the influence of organic binders and their concentration on thermal and storage characteristics of groundnut shell briquettes.

2. MATERIALS AND METHODS

The raw materials used for preparing briquettes were groundnut shell of 500 particle size with binder (cassava gel). Briquettes were made using a motorized briquetting machine which can exert a pressure of 10MPa with dwell time of 5 minutes. Four compositions of different binder percentages (5, 10, 15 and 20) with 5 replicated samples each were studied. The briquettes were prepared during summer period, having initial moisture content of 9.0% (dry basis) and kept in a plastic bag under atmospheric condition and stored for a period of 6 months at the prevailing room temperature. Measurements on moisture content, bulk density, durability rating, water penetration resistance, calorific value and ash content were taken at regular intervals of 30 days.

The air oven method was used to determine the moisture content of the briquetted material. The bulk density was determined by using stereometric methods as described by Rabier, [8]. Stereometric methods are based on the measurement of the dimensions such as diameter, length, width and height. In this experiment, the related dimensions are length, breath and thickness. The measurement was done using vernier caliper. The volume was estimated by calculating the volume of the cuboid shape. By knowing the volume and mass of the briquette, the bulk density was determined by geometric formulae. The density was calculated by dividing the mass of the briquette by its volume. The durability test (Shattering resistance) was carried out according to Al-Widyan et al., [9] method, where the briquettes were dropped four times_from a height of 1.85 m on a flat steel plate. The durability (%) was calculated as the ratio of the final weight of the briquette retained after four drops to the weight of the initial_briquette.

Resistance to water penetration was considered as the percentage water absorbed by a briquette when immersed in water. Each briquette was immersed in water at 27°C for 30 seconds. The weight of briquette before and after immersion was then recorded[10].Leco AC-350 Oxygen Bomb Calorimeter interfaced with a microcomputer was used to assess the heat values of the produced briquettes. Two grams of the briquette was weighed and the screw mold bracket was used to re-mold the briquette to the appropriate calorimeter bucket size. Ten (10) ml distilled water was poured into the bomb and the industrial oxygen cylinder was connected to the bomb and the valves opened and bomb filled slowly at pressure range of 2.5 – 3.0 Mpa for a minute. The bomb was placed inside a canister bracket containing the distilled water and its lid was covered. The switch was turned on and the microcomputer was set for data collection which automatically calibrates and measures the energy values and displays the values on the screen for recording after feeding the necessary data on the briquettes. The data and result of the experiment are displayed on computer screen [11]. The ash contents of briquettes were determined according to Wakchaure and Mani, [12] method, where ash remaining in the combustion of sample of briquettes taken during the determination of calorific value in crucible of bomb calorimeter are measured dividing by initial mass of that sample.

3. RESULTS AND DISCUSSION

3. 1. Effect of Storage Period on Moisture Contents of Biomass Briquettes The study showed that with increase in storage time, the moisture content decreased for all the briquettes at all proportions of binder. The mean change in moisture content with storage period is shown in Table 1 with standard deviation of between 0.4 and 0.6. During the 6 months of storage it was observed that the moisture content decreases between 14.33 and 24.67% with briquette with 20% binder are having the highest decrease and 5% binder having the least decrease of 14.33%.

3.2. Effect of Storage Period on Durability index of Briquettes Durability signifies the measure of shear and impact forces a briquette could withstand during handling, storage and transportation processes [13]. Durability index is an important parameter during transportation and storage of briquettes. The change in durability index with storage time is presented in Table 2 with standard deviation of between 2.3 and 3.1. During the 6 months of storage, it was observed that the durability rating decreases with increase in storage time for all briquettes compositions. The largest decrease in durability rating with storage period is observed with briquettes having 5% binder while the least is with the briquettes with 20% binder. This might be as a result of the good binding properties of starch gel.

3.3. Water penetration resistance Table 3 shows that water absorption increases with increase in storage time with standard deviation of between 1.9 and 3.5. The resistance to water penetration of briquettes increases in storage time of the briquettes. The lowest increase of resistance to water penetration was observed for briquettes made of 20%binder while the highest was observed for 5% binder during storage time. It can be concluded that briquettes with higher binder concentration are better briquettes in terms of resistance to water penetration during storage. This could be as a result of binder based briquettes absorbed less moisture due to higher bulk density of briquettes.

3.4 Effect of Storage Period on Calorific Value of Briquettes The calorific value of the briquettes is shown in Table 4 The calorific value of briquettes increases with increase in concentration of binders. This might be as a result of higher calorific values of cassava gel. The calorific values of briquettes however, decrease with increase in storage. After storing briquettes for 6 months, it was observed that the calorific value of briquettes produced decreases by 1.19, 2.97, 0.39 and 0.20 MJ/kg for briquettes having 5%, 10%, 15% and 20% binder respectively. Lois[14], and Schmidt and Walter[15] wrote that during the first days of storage, the temperature rises rapidly in the interior of the bales, which together with other conditions create fiber degradation processes, darkening, high fiber losses and other chemical-physical damages, as well. The results, where there is decrease in moisture content and decrease in calorific value instead of increase in calorific value might be due to intense chemical and microbiological processes taking place during storage.

TABLE 1. Moisture variation with time

	Storage period (days)						
Sample	**0**	**30**	**60**	**90**	**120**	**150**	**180**
B05	9.00	8.83	8.55	8.38	8.28	7.94	7.71
B10	9.00	8.72	8.40	8.20	8.00	7.60	7.31
B15	9.00	8.70	8.20	7.90	7.70	7.30	6.92
B20	9.00	8.62	8.10	7.70	7.10	6.95	6.69

TABLE 2. Durability rating variation with time

	Storage period (days)						
Sample	**0**	**30**	**60**	**90**	**120**	**150**	**180**
B05	69.86	70.11	69.32	68.91	68.11	67.97	67.40
B10	88.90	88.96	88.11	87.33	86.77	86.12	85.87
B15	91.55	92.10	90.95	90.63	90.23	90.18	90.12
B20	93.52	94.23	93.21	92.94	92.45	92.30	92.18

TABLE 3. Resistance to water penetration

	Storage period (days)						
Sample	**0**	**30**	**60**	**90**	**120**	**150**	**180**
B05	38.16	40.64	43.21	44.66	46.07	46.95	45.76
B10	25.36	26.53	27.98	29.80	30.95	31.87	32.43
B15	9.86	11.10	11.82	12.51	12.82	13.14	13.81
B20	8.53	9.27	9.41	10.14	10.61	10.97	11.41

TABLE 4. Resistance to water penetration

	Storage period (days)						
Sample	**0**	**30**	**60**	**90**	**120**	**150**	**180**
B05	18.22	18.05	17.84	17.58	17.33	17.07	17.00
B10	20.05	19.84	19.61	19.51	19.29	19.17	17.08
B15	21.36	21.31	21.28	21.23	21.15	21.15	20.97
B20	21.53	21.49	21.46	21.44	21.41	21.36	21.33

TABLE 5. Ash content variation with time

	Storage period (days)						
Sample	**0**	**30**	**60**	**90**	**120**	**150**	**180**
B05	3.60	3.89	4.27	4.66	4.85	5.10	5.49
B10	3.68	4.05	4.59	5.03	5.58	6.02	6.30
B15	3.72	4.14	4.71	5.42	6.05	6.63	7.05
B20	3.74	4.43	5.15	6.21	6.73	7.17	7.56

3.5 Effect of Storage Period on Ash content of Briquettes Ash content of briquettes is presented in Figure 4. After storing briquettes for 6 months, it was observed that the ash content of briquettes produced increases. It was also observed that the ash content of briquettes increased with increase in concentration of binding materials. The increase in ash content might be due to biological degradation and low evaporation of volatile matter from the biomass briquette[16].

4. CONCLUSIONS

The study reveals that moisture content and durability rating of briquettes decreases with storage especially during summer because this study was carried out during the hot season while the water penetration increases with storage. Calorific values increased with increase in concentration of binders while it decreases with increase in storage time of briquettes. Although the values do not show a linear relationship, the properties of the briquettes are affected by storage. However, all the briquettes remained stable after 6 months of storage. The high cost of fossil fuel and over exploitation of fuel wood in developing countries, with successful production of fuel briquettes from agricultural waste and waste product (starch) from dewatered cassava, fuel wood users specifically rural settlers can now have an alternative to fuel wood as sources of energy.

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