

EFFECT OF PAPER PASTE ON THE CALORIFIC VALUE OF SAWDUST BRIQUETTE

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ABSTRACT

The problem constituting by waste paper is enormous. How to dispose this waste is becoming worrisome and it's generated every day. Although waste paper is used for various other things, there are still abundant of it. Since both paper and sawdust are wood products, as sawdust is used for briquettes, paper also can be used. This is one of the ways of reducing the nuisance constitute by these wastes. Mixing waste paper with sawdust briquettes could lead to better briquette performance and cost-effectiveness making this fuel more attractive to both producers and consumers. This leads to the investigation of the effect of paper paste on the calorific value of solid briquettes. In this work briquettes were produced out of the mixtures of sawdust from *Teak, Mazonia, Iroko and Afara* woods. This mixture of sawdust was sieved into three different grain sizes A (1.2 mm), B (1.15 mm) and C (0.75 mm). To these were added two grain sizes (1.18 mm and 1.70 mm) of palm kernel shell and paper pastes in various ratios. Sixteen samples were produced from each grain size of the sawdust; hence there are forty-eight different ratios of sawdust: palm kernel shell; paper paste. Five each of the samples were tested and average values recorded. The experimental results show that, as the percentage by weight of paper paste increases, both percentage fixed carbon and ash content reduce. Also both the volatile matters and the calorific values increase with increase percentage paper paste. However, it was noted that as the paper paste exceeded 25% there was a decrease in the calorific value. Hence for optimum performance and calorific value, the appropriate percentage paper paste should range between 20% and 25%.

Keywords: sawdust, briquettes, calorific value, performance, mixtures, paper paste.

1 INTRODUCTION

Biomass briquettes are made from agricultural waste and are replacements for fossil fuels such as oil or coal, and can be used to heat boilers in manufacturing plants. Biomass briquettes are renewable sources of energy and avoid adding fossil carbon to the atmosphere. Use of biomass briquettes can earn carbon credits for reducing emissions in the atmosphere. For instance Lanocess India and a few other large companies are supposedly using biomass briquettes for earning carbon credits by switching their boiler fuel. It also provides more calorific value/kg and saves around 30-40% of boiler fuel costs.

One of the popular biomass briquettes emerging in developed and developing countries is the sawdust briquettes. This involving compressing and extruding sawdust to make a reconstituted log that can replace firewood. There are no binders involved in this process. The natural lignin in the wood, binds the particles of wood together to form a solid. Burning a wood briquette is far more efficient than burning firewood. Moisture content of a briquette can be as low as 4%, whereas green firewood may be as high as 65%.

Sawdust briquettes have developed over time with two distinct types: those with holes through the centre, and those that are solid. A solid briquette is manufactured using a piston press that compresses sand witted layers of sawdust

together. Briquettes with a hole are produced with a screw press. The hole is from the screw thread passing through the centre but it also increases the surface area of the log and aids efficient combustion, (Osun, 2002 and Adekunle, 2004).

Starch or *amylum* is one of the popular binders used in briquetting. The word starch is derived from Middle English *sterchen*, meaning to stiffen, "*amylum*" is Latin for starch, from the Greek *αμυλον*, ("*amylon*") which means not ground at a mill. It consists of a large number of glucose units joined by glycosidic bonds. It is produced by all green plants as an energy store. As good as starch has been, it has to be replaced because, it is the most common carbohydrate in the human diet and is contained in large amounts in such staple foods as potatoes, wheat, maize, rice and cassava. In addition to starchy food and plants consumed directly, 66 million tones of starch were being produced per year world-wide in 2008. In the EU this was around 8.5 million tones with around 40% being used for industrial applications and 60% for food uses. This gives the reason why paper paste was employed in this work. The waste papers generated in companies and paracitatas are enormous. So instead of burning this waste it can be used as additive to solid briquettes.

A lot of research work had been done on the utilization of sawdust for domestic cooking using improved burning stove, Danshehu et al., (1992). While attempt had been made to densify the sawdust briquettes with appropriate equipment fabricated by the Raw Materials Research and Development Council in collaboration with the Abubakar Tafawa Balewa University, Bauchi State, Nigeria, Aliu (1996). There has been various research works at the Federal University of Technology, Akure on the suitability of utilizing sawdust as high graded fuel. Adegoke and Muhammed (1999) and Ogundeji (1995), worked on the addition of some biomass material such as palm kernel shell, charcoal, coconut shell and fibre to sawdust in various proportions and determined their calorific values. These works was improved upon by Ajuitse (2011), who worked on mechanical properties of sawdust briquettes using various additives as predicted by other research in the University.

Another research work carried out was the evaluation of composite sawdust briquettes as a high-grade fuel for domestic cooking, Kuti (2003). Adekunle (2004), investigated the performance of the briquettes of different species of wood-sawdust as solid fuel. His work revealed that, both calorific

value and mechanical properties of sawdust briquettes made from various species of wood or mixtures of wood-sawdust is of no great significant. In all, they concluded that 70% of sawdust with 30% of other additives gave the best result. This work is to find out the effect of paper paste on the calorific value and some constituents of sawdust briquettes. This will reduce the burning of waste papers and atmospheric pollution as a result of paper burning.

2.0 MATERIALS AND METHOD

It has been established that the calorific values of briquettes of different hard wood species do not vary significantly; this guided the choice of samples for this work. Four (4) samples of hard wood sawdust, namely: *Iroko, Afara, Teak and Masonia*, were selected. The sawdust from these four woods were mixed together in the same proportion by weight. This mixture was then prepared into three (3) different grain sizes with the aid of sieving machine. In addition palm kernel shell was prepared into two different grain sizes and added to the sawdust in different ratios. These mixtures were used to prepared briquettes, using briquette making machine developed by Adegoke et al. (2006). Also added to the samples of briquette was paper paste in different ratio with equal amount of starch as binder, less ten percent (10%) as compared to those specified by other researchers. Since one of the aims is to reduce the usage of starch as binder.

The grain sizes of sawdust mixtures were labeled A (1.2 mm); B (1.15 mm) and C (0.75 mm). There are only two grain sizes of palm kernel shell, 1.18 mm and 1.70 mm. The sawdust (SD) palm kernel shell (PK) and paper plastic (PP) were mixed in the ratios shown in Table 1 for sawdust grain size A only. The same ratios were repeated for B and C. So there are sixteen (16) sample briquettes for each grain size. Therefore, there are forty-eight samples in all. These briquettes were labeled A(1) to A(16); B(1) to B(16) and C(1) to C(16) for grain sizes A, B and C respectively. These samples were tested using various standard methods. Full detail of experimentation and calculations can be found in the work of Seriki (2012). However, it should be noted that five samples of each were tested and average values were recorded. The moisture content and other conditions were kept relatively as far as permitted by the experimented conditions.

TABLE 1

MATERIAL RATIO BY MASS FOR THE
 PREPARATION OF BRIQUETTE SAMPLES.

Sawdust Sample	Palm Kernel	Ratio	Code
A	1.18	70:30:00	(A1)
		70:20:10	(A2)
		70:10:20	(A3)
		70:00:30	(A4)
A	1.70	70:30:00	(A5)
		70:20:10	(A6)
		70:10:20	(A7)
		70:00:30	(A8)
A	1.18	65:30:05	(A9)
		65:20:15	(A10)
		65:10:25	(A11)
		65:00:35	(A12)
A	1.70	65:30:05	(A13)
		65:20:15	(A14)
		65:10:25	(A15)
		65:00:35	(A16)

3. RESULT AND DISCUSSION

The result of experimentation is as shown in Figs. 1 to 12. Figs. 1 to 4 show the comparison of ash contents, Figs 5 to 8 show the comparison of volatile matters while Figs 9 to 12 are for the comparison of % fixed carbon contents all expressed in percentage per unit mass.

As indicator earlier, A, B, C stand for the sawdust grain sizes, while, a, c and d stand for %

ash content, % volatile matters and % ash content in (A1). As shown in Fig.1 the % ash contents in A, B, and C for the first four samples are shown. Where (A1) is the ratio 70:30:00 of sawdust; to palm kernel to paper paste as shown in Table 1. In all the figures, we have group bars – three per group. In each group, the one on the far left is for sample A, the middle one is for B and the last on the far right is for C.

As indicated in Figs 1 to 4, the % ash contents for all the samples decreases as percentage of paper paste increases. This is common to all the samples. In Fig. 3, however, there is no significant difference between samples 9 and 10, but there is a little difference between samples 11 and 12 when paper paste was increased to 20% and 30% respectively. This is due to change in the grain size of palm kernel shell. The same effect is seen in figs. 2 and 4.

Figs. 1 and 2 have the different grain sizes of palm kernel shell (1.18 and 1.70 respectively), and different compositions of the materials. Fig. 3 in particular indicated lower ash content when the % of sawdust was reduced and that of paper paste increased by 5% each, whereas the ash content in Figs. 1 and 2 are almost the same. It can then be concluded that the addition of paper paste has reduced the % ash content. The same is justified by Figs. 5, 6 and 7 and Figs. 9, 10 and 11 for B and C respectively.

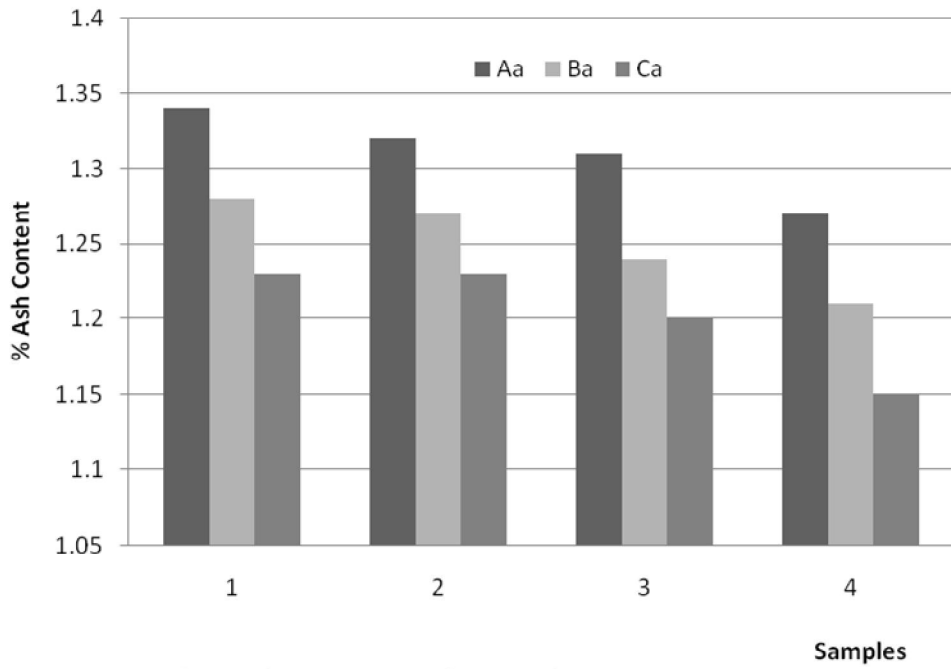


Fig. 1 Ash contentents for Samples 1 to 4

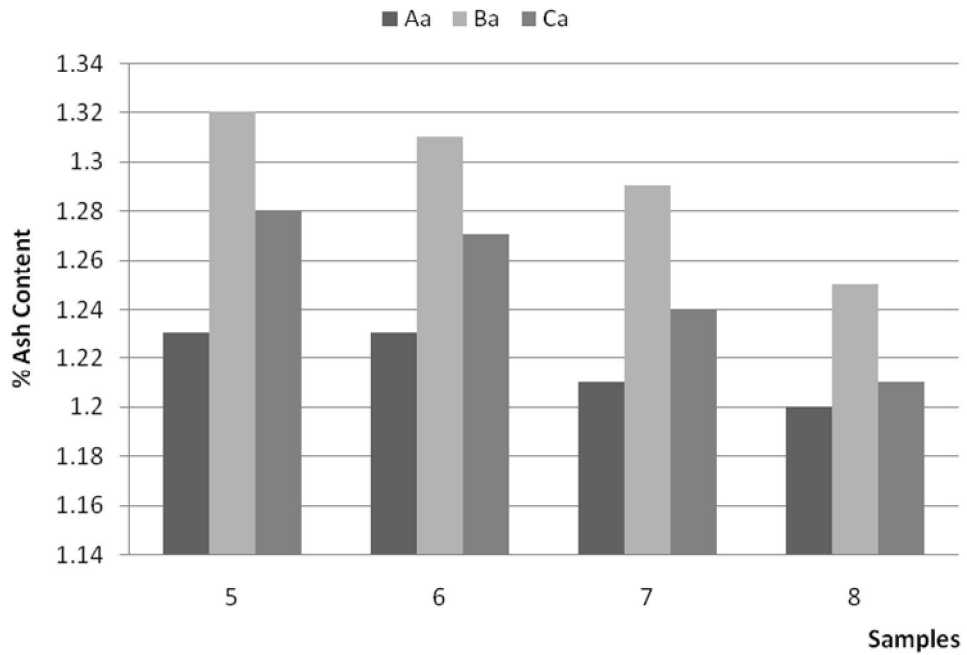
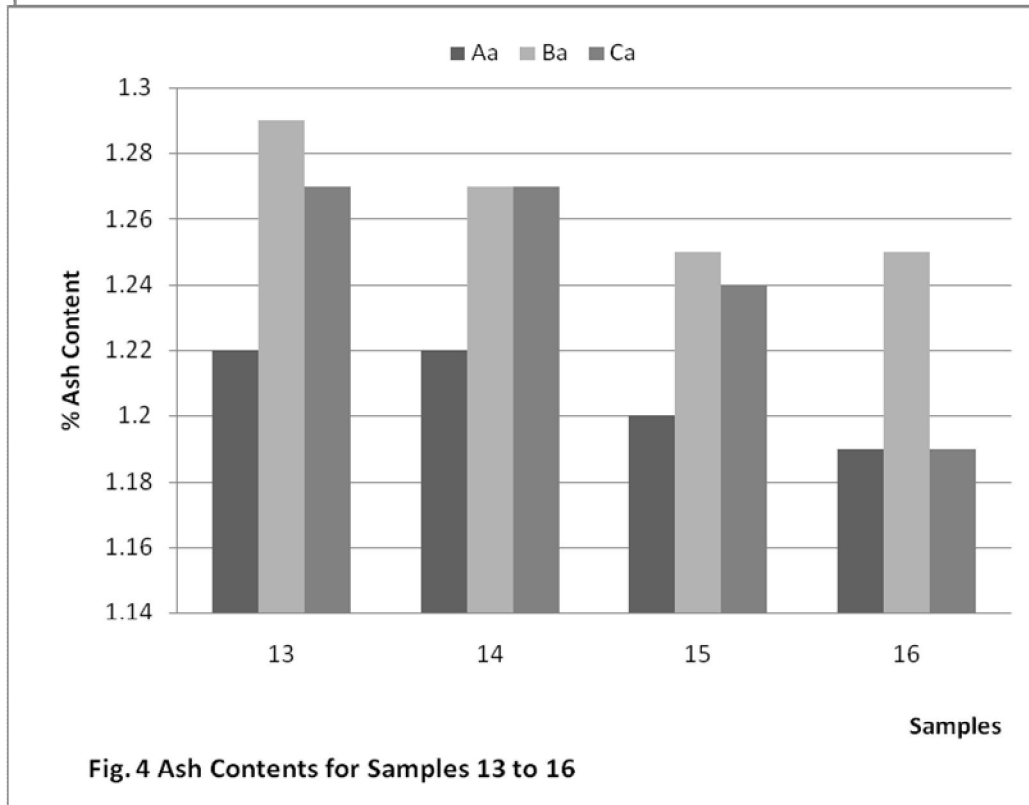
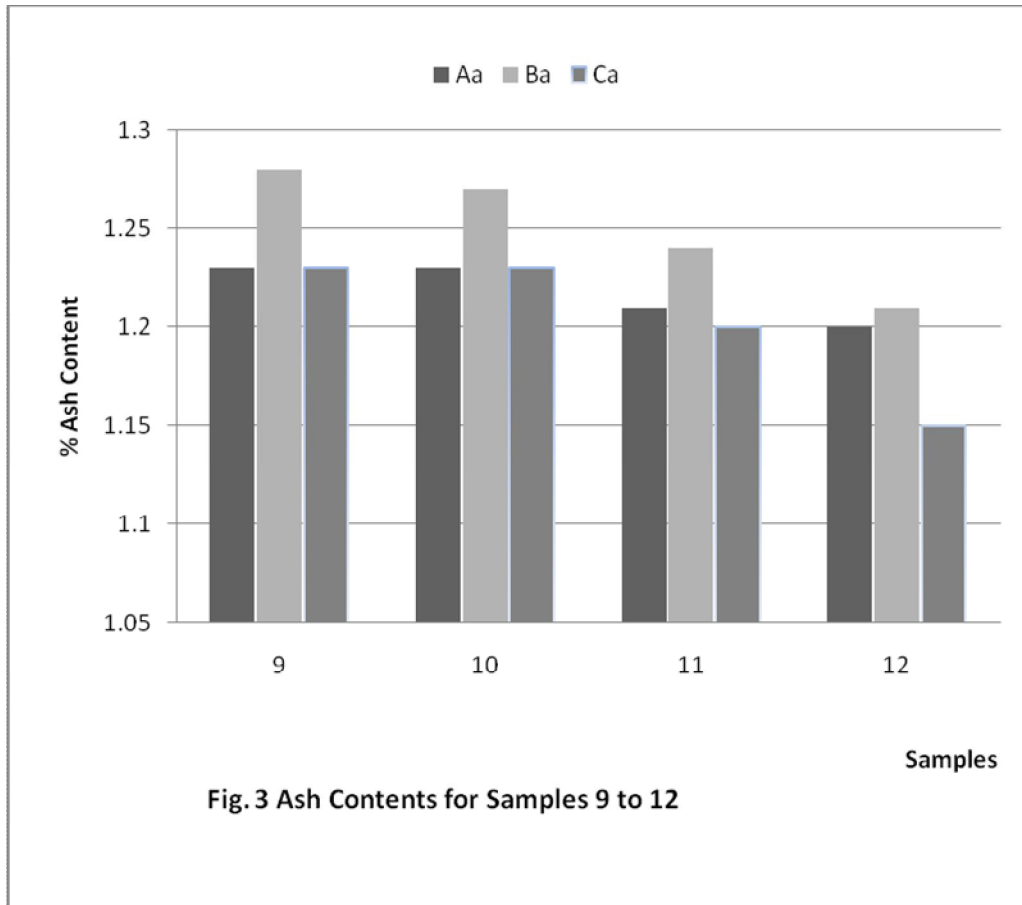
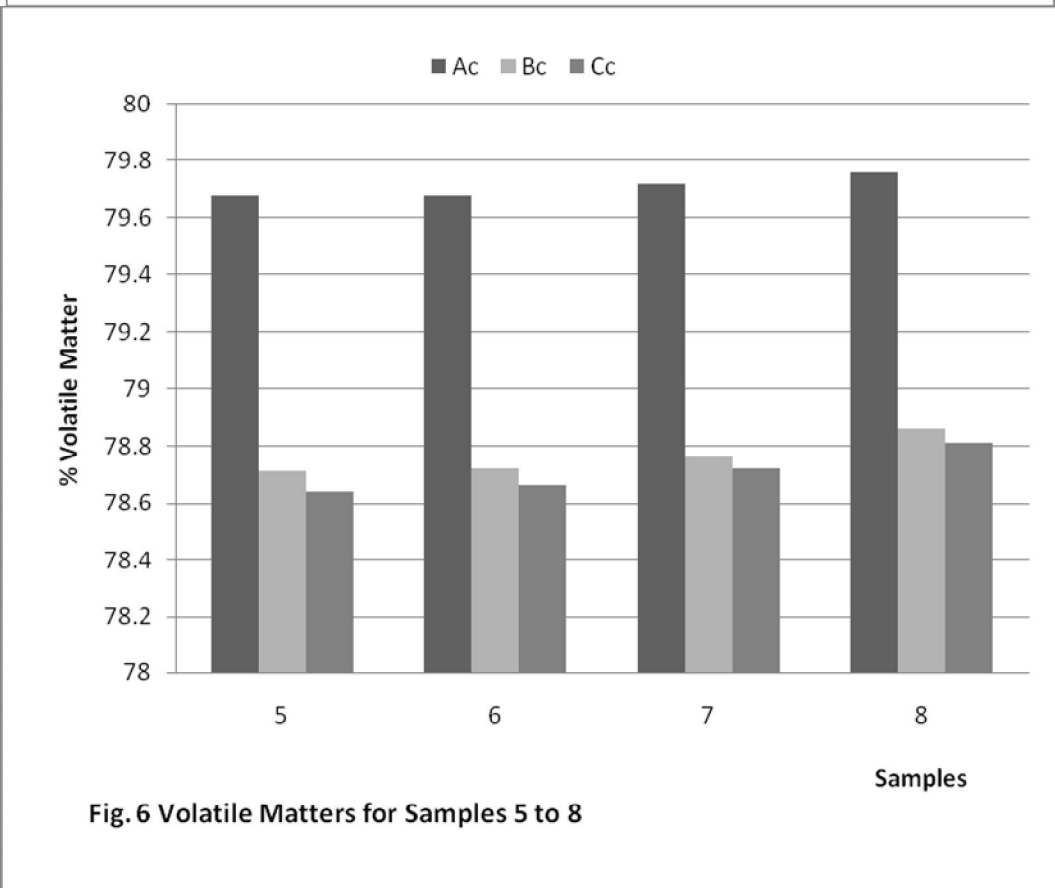
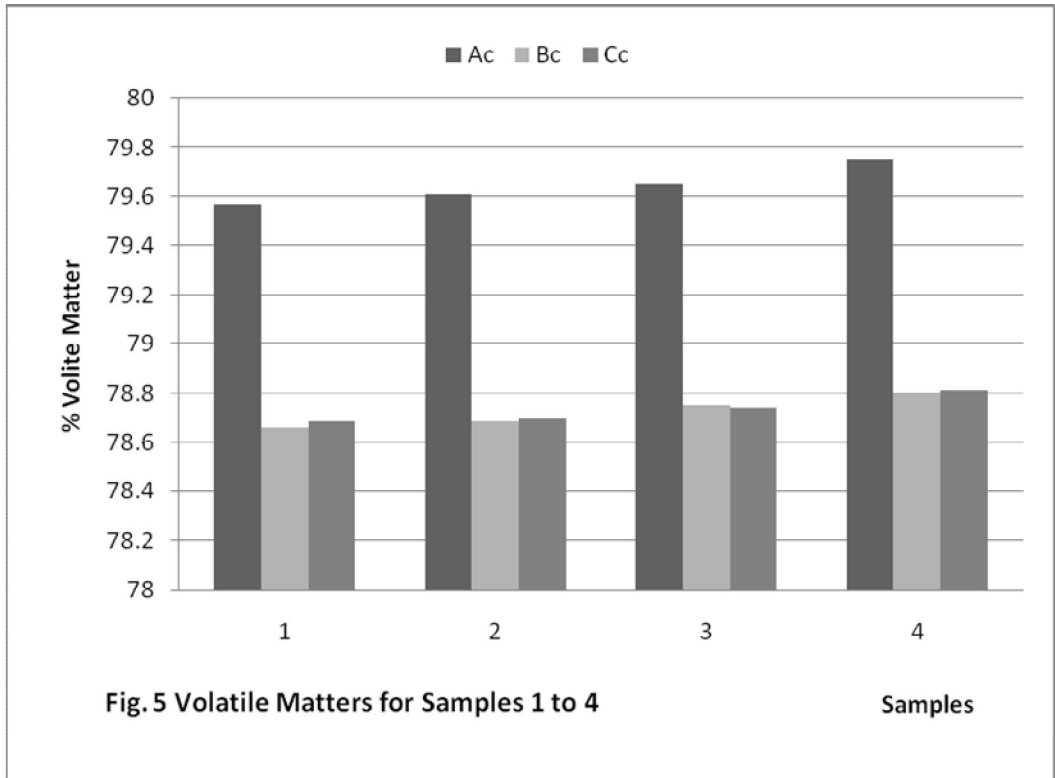
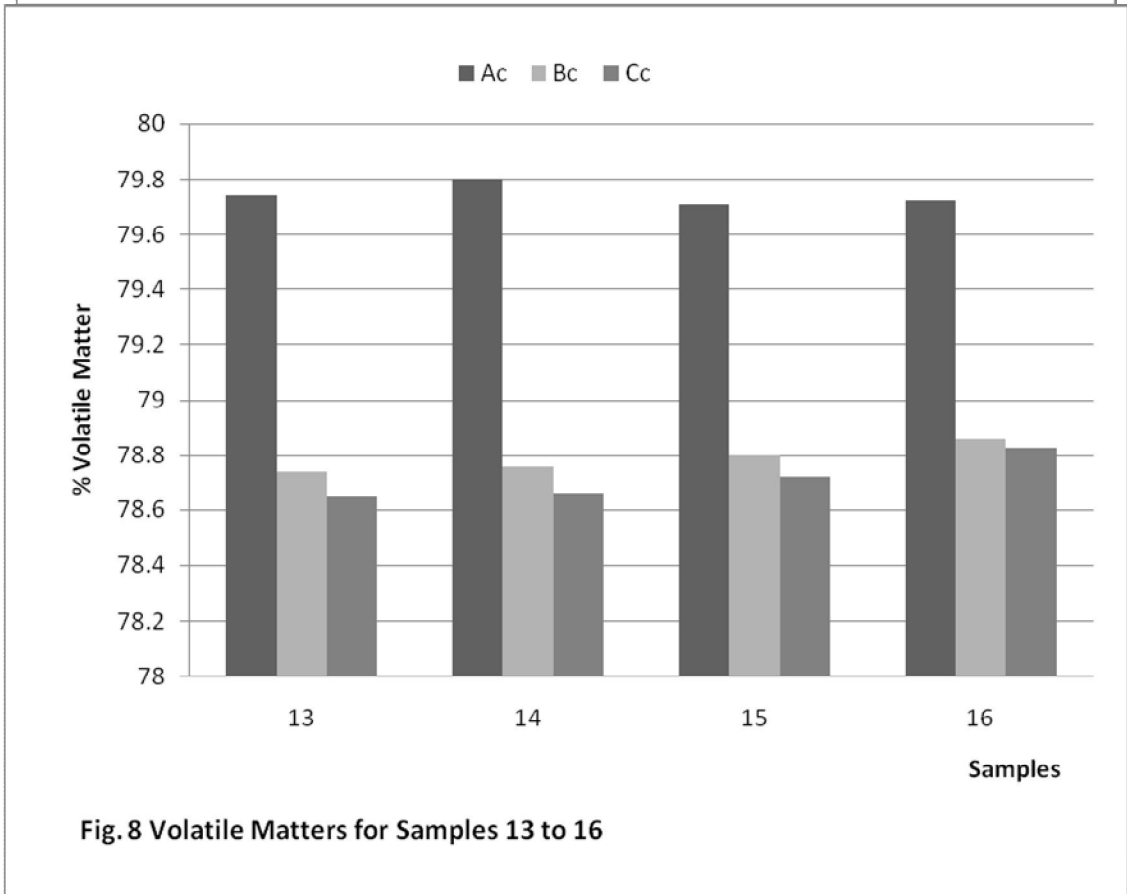
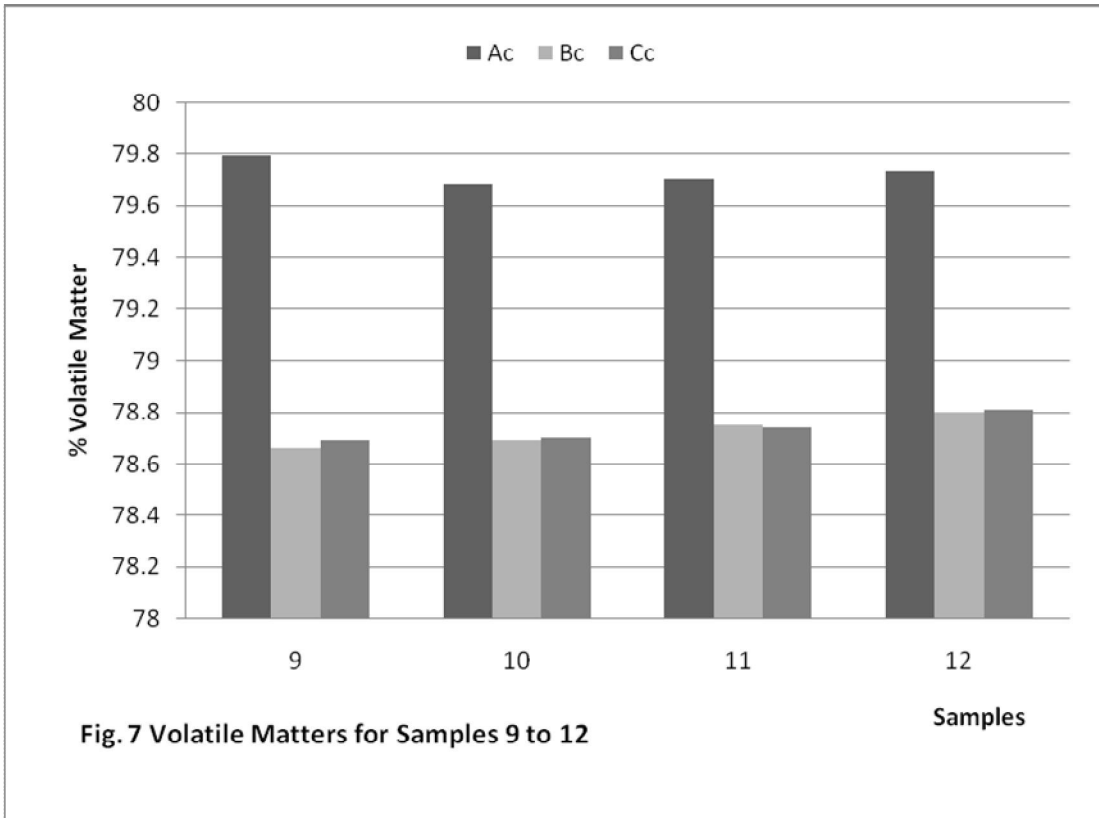
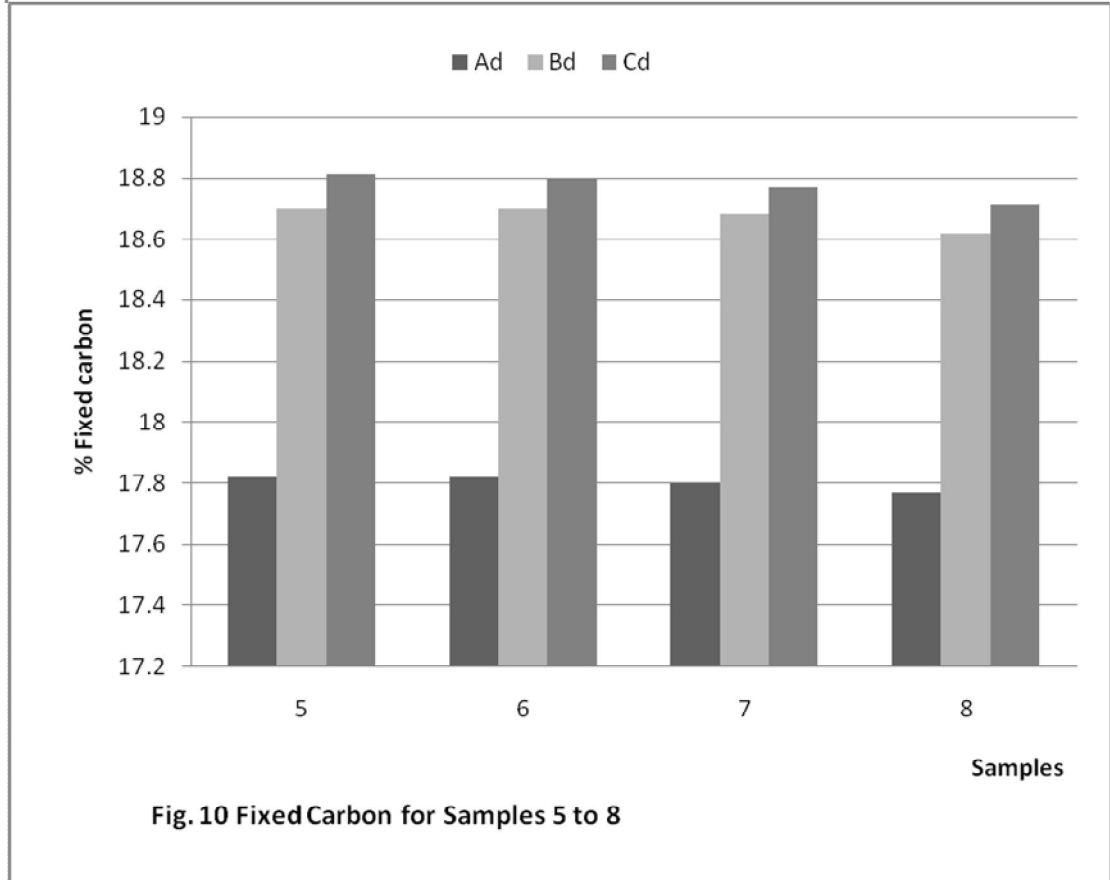
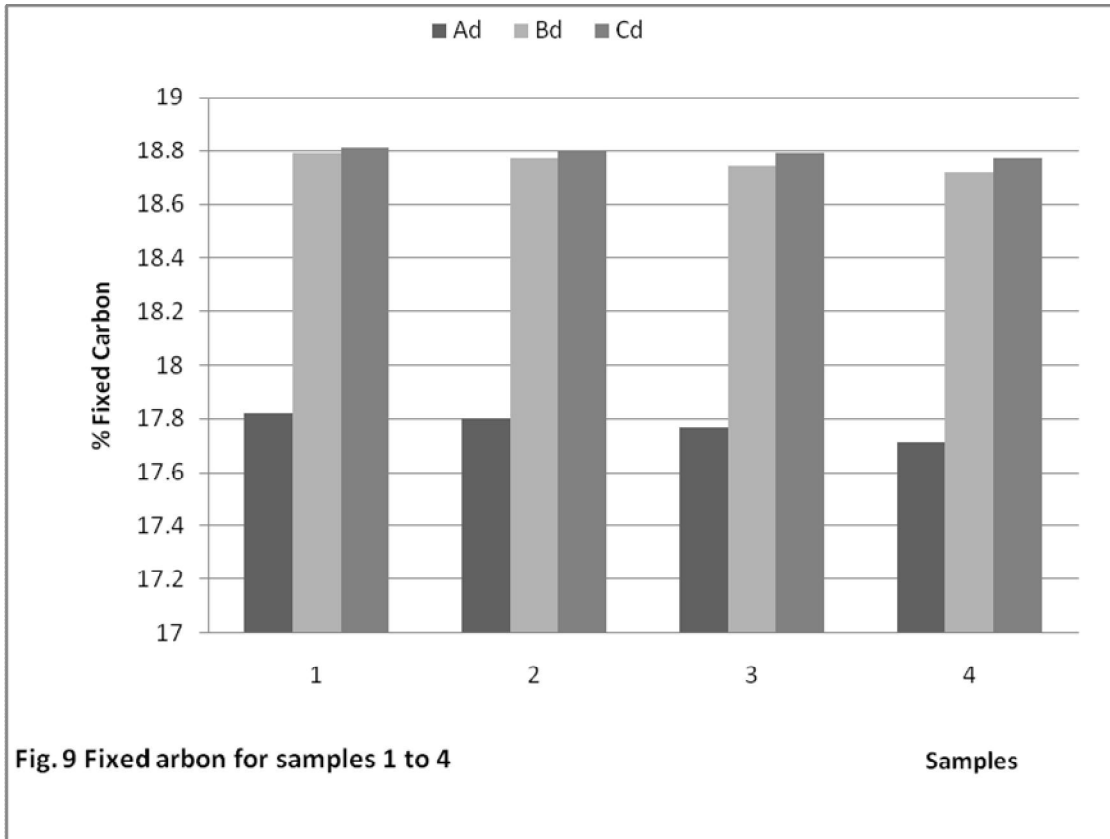


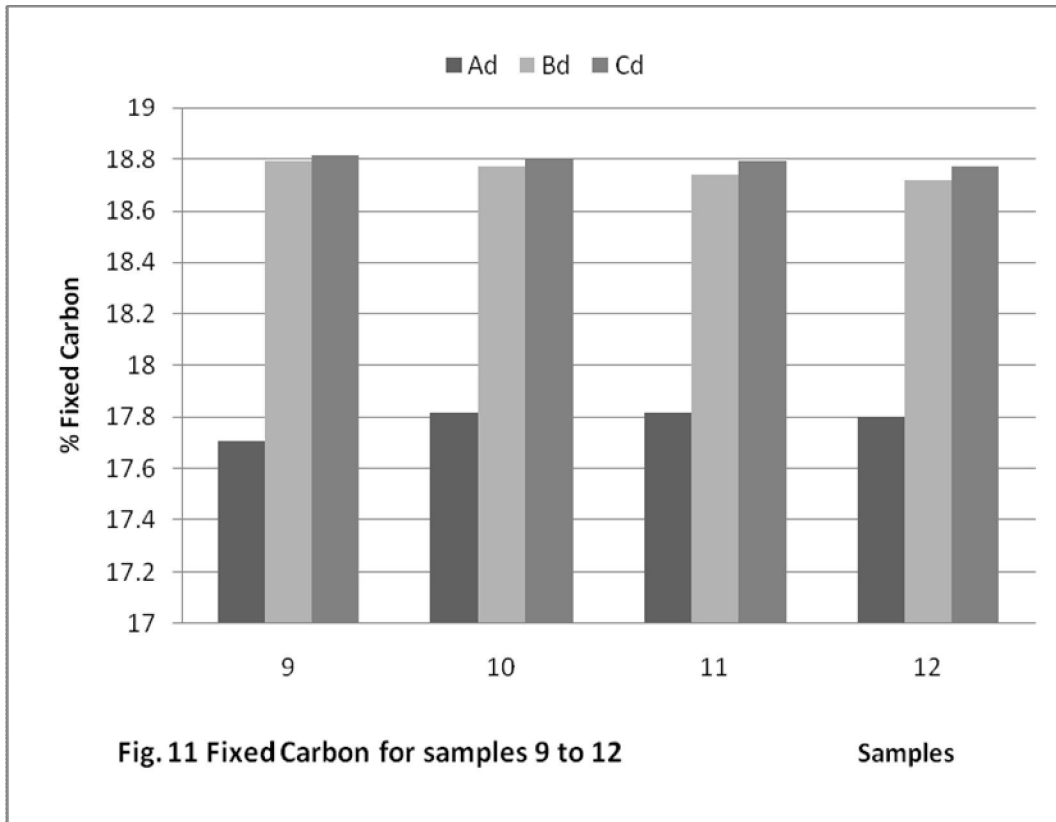
Fig. 2 Ash content for Samples 5 to 8











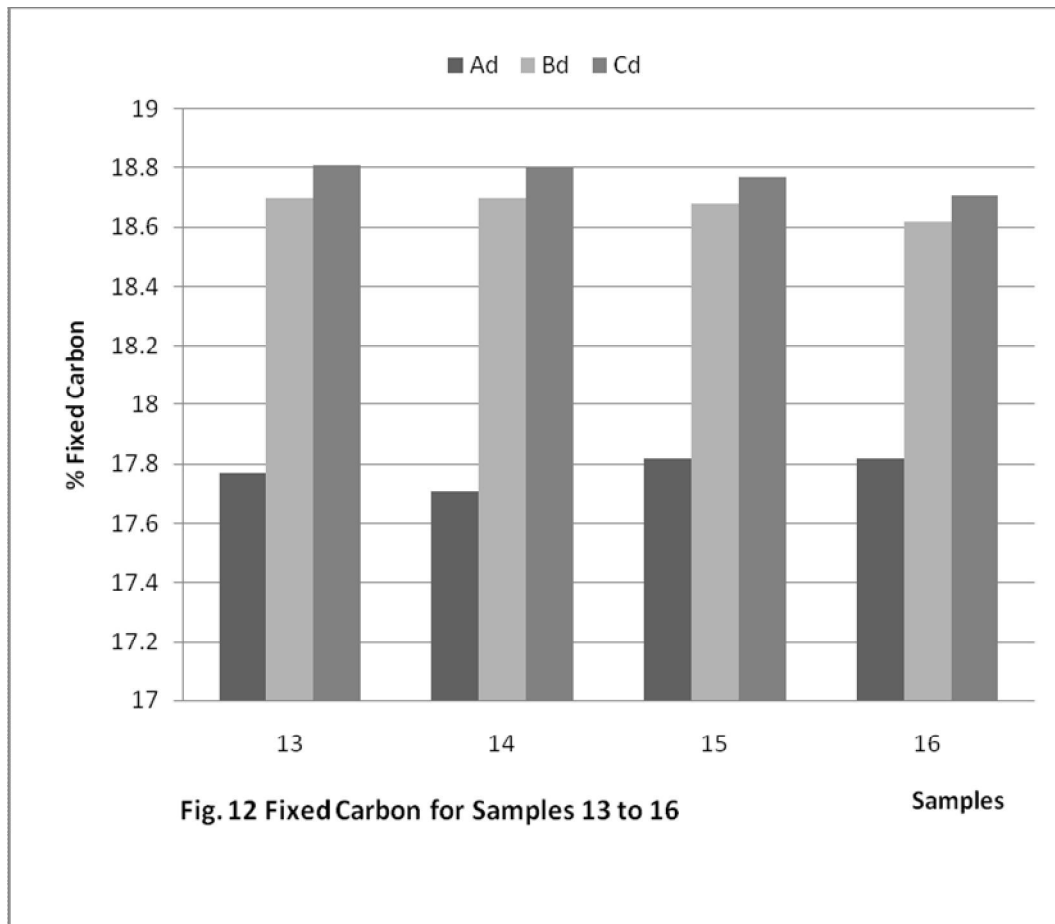


Fig. 12 Fixed Carbon for Samples 13 to 16

When comparing Figs. 5 and 7, both have same grain sizes of palm kernel shell. But there is increase in the volatile matters as the percentage of paper paste increases. This indicated that more energy is released, by the addition of paper paste. As the % paper paste (PP) increases from 20% to 30% in Figs. 5 and 7, from 25% to 35% in Figs. 7 and 8, the volatile matters decreases. This shows that the % PP should range between 20% to 25%, irrespective of the grain size of palm kernel shell (PK) used. Also the calorific value increases with increase in % PP up to same percentage of paper paste. As indicated in Figs. 8 and 9 also in Figs. 10 and 12, the percentage fixed carbon is almost constant. This is not unlikely since paper is also made of wood.

4 CONCLUSION

In this study, sawdust of four species of hard woods (Iroko, Mosonia, Teak and Afara) were sieved into three grain sizes (1.2 mm, 1.15 mm and 0.75 mm) was used as base for production of solid briquettes. To these three grain sizes were mixed various ratios of palm kernel shell of two different grain sizes (1.18 mm) and 1.70 mm) and paper pastes

to produce forty-eight samples of the briquettes. It was discovered that the grain size of the sawdust have little or no effect on the calorific values of the briquette. It only has effect on the ash content, and this is obviously due to the increase in surface area. As the grain size reduces there is a slight increase in the percentage ash content.

Also, the grain size of the palm kernel has no significant effect on the calorific value as well as on the on the volatile matters. However, the calorific value, ash content and the fixed carbon content were altered by the addition of paper paste and so also the calorific value of the briquettes. As the percentage of paper paste increases from 0% to 20% both the volatile matters and the calorific values increased. However, a decrease in the values of both calorific value and volatile matters were noted at 30% and above of the paper paste.

Hence for optimal performance paper paste between 20% and 25% could be added to sawdust briquettes. This is shows that paper paste, can be used to improve the performance of sawdust briquettes. Hence, mixing paper waste with sawdust briquettes could lead to better briquettes

performance and cost effectiveness making these fuel more attractive to both producers and consumers.

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