SOLID FUEL FROM EMPTY FRUIT BUNCH FIBER AND WASTE PAPERS PART 6: DIMENSION STABILITY TEST AFTER EXPOSED TO AMBIENT CONDITION

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ABSTRACT

This research discussed on the results obtained for each sample that have been conducted to the solid fuel briquettes made of empty fruit bunch fiber and waste papers from view of physical performance which is dimension stability test after exposed to ambient condition. This solid fuel prepared by manual compression technique. This analysis important to know the capability of the solid fuel to sustained/maintained the physical shape after exposed to ambient condition. Experimental work shows that most samples of solid fuel have good performance for the test.

Keywords: *Empty Fruit Bunch Fiber, Waste Papers, Dimension Stability, Ambient.*

1.0 INTRODUCTION

Producing energy from renewable biomass is only one of the various ways of responding to the challenges of the energy crisis. Since the oil crisis in 1970's the use of biomass as a source of energy is a topic of growing interest and debate as agreed by Gómez-Loscos (2012), Tong and Li (2012), Arias (2011), Vaclav (2010), Fernando (2009), Kaygusuz and Keles (2008).

Corley and Tinker (2008) in their book discuss in detail about oil palm in Malaysia. In 2004, Malaysia had about 3.87 million hectares of land under oil palm cultivation. Currently, more than 80 percent of the oil palm produced is used for food applications like cooking oil, frying oil and many others. Oil palm is a perennial crop. It has an economic life span of about 25 years. Traditionally, oil palm is grown for its oil example like palm oil, palm kernel oil, and palm kernel cake as the community products. Besides palm oil and palm kernel, oil palm industry generates large quantity of biomass residue which is side products as stated before like fronds, trunks, EFB, palm oil mill effluent, palm fibre and shell that have not been fully commercially exploited.

Through concerted research and development efforts by many research organizations including Malaysian Oil Palm Board, this co – products from palm oil industry have been found to be good resources for many application such as palm oil fuel ash a biomass residue (Brown *et al.*, 2011), oil palm as a viable concrete pozzalanic material (Foo and Hameed, 2009), Oil palm ash as partial replacement of cement for solidification/stabilization of nickel hydroxide sludge (Chun *et al.*, 2008), oil palm ash in concrete (Tangchirapat *et al.*, 2007).There are many competitive uses of these materials. One of them is to utilize them as a fuel for energy production but in term of biodiesel fuel. In fact, Malaysian government has identified biomass as fifth fuel resource to compliment the petroleum, gas, coal, and hydro as energy resources, while palm biomass has been identified as a single most important energy source as stated by Sumiani (2006). On the other hands, the main sources of biomass in Malaysia are domestic wastes, agricultural wastes, effluent sludge and wood chips (Yuhazri *et al.*, 2011) and (Yuhazri *et al.*, 2010).

Biomass energy systems can be based on a wide range of feedstock like food and garden wastes (Romeela and Ackmez, 2012), solid wastes and sewage sludge (Despina *et al.*, 2012), cellulosic ethanol (Gonzalez, 2011), coal and cattle biomass (Carlin *et al.*, 2011) and many more. They use many different conversion technologies to produce solid, liquid, and gaseous fuels. These can then be used to provide heat, electricity and fuels to power vehicles; using burners, boilers, generators, internal combustion engines, turbine or fuel cells. Power can be generated by co – firing a small portion of biomass on existing power plant, burning biomass in conventional steam boilers, biomass gasification and anaerobic digestion.

Converting palm biomass into a uniform and solid fuel through briquetting process appears to be an attractive solution in upgrading its properties and add value as reported by (Sławomir, 2012), (De *et al.*, 2012), (Nasrin *et al.,* 2011), (Chuen-Shii, 2009). Biomass briquette is the process of converting low bulk density biomass into high density and energy concentrated fuel briquettes. Biomass briquette plant is of various sizes which converts biomass into a solid fuel. Briquettes are ready substitute of coal or wood in industrial boiler and brick kiln for thermal application. Biomass briquettes are non conventional source of energy, renewable in nature, eco – friendly, non polluting and economical. Process of converting biomass into solid fuel is non polluting process. It involves drying, cutting, grinding, and pressing with or without the aid of a binder.

Malaysia has involved in palm oil industry over the last four decades and since then it has generated vast quantities of palm biomass, mainly from milling and crushing palm kern`el. Empty fruit bunch is the main solid waste from oil palm obtained from milling process. This biomass can be used as an alternative energy for combustion purposes especially in industry. Unfortunately, due to its poor physical properties EFB is not normally utilized as fuel. However, it can be use in optimise by upgrading and treating its properties. The method that can be used is the briquetting technique. Briquetting is the alternative method in upgrading biomass into a useful solid fuel that can be done through various technologies. In this research, EFB material will be mixed up with the recycled papers and it will be turned into solid briquette through the briquetting process. The used of recycle papers in this research is to utilized the abundant papers into something useful, thus helps in reducing the number of municipal wastes generated every year. Papers are selected as a material to be used compared to the other types of recycled wastes such as glass and plastic because it is known to be a good material for a combustion ignition. As for plastics, it may be compatible to papers to be used as ignition material in combustion, but it will spread a toxic gas while it is burn.

The scope of this research is mainly focusing on the mixing of the empty fruit bunch, EFB and the recycled papers. All these palm oil mills is to be obtained, mixed up and to be develop as a fuel briquette at a certain ratio or percentage with the EFB as the major element. This fuel briquette is to be carried out with the performance tests and comparison tests in terms of its calorific values (Yuhazri *et al.,* 2012a), gas emission (Yuhazri *et al.,* 2012b), ash content (Yuhazri *et al.,* 2012c), compression test at lateral position (Yuhazri *et al.,* 2012d), crack test for transportation and storage purpose (Yuhazri *et al.,* 2012e), but in this paper (part 6) only discuss on the dimension stability after exposed to ambient condition.

2.0 MATERIALS AND METHODS

Empty Fruit Bunch (EFB) supplied by Malaysian Palm Oil Board (MPOB) from one of plantation in Malaysia was used as reinforced material in this green composites fabrication. The EFB used in the composites was in a chopped strand form. The EFB type used was shown in the Figure 1(a) and the Table 1 is the basic properties of EFB used for the fabrication of the composites based on study done by (Nasrin *et al.*, 2008).

(a) **(b)**

Figure 1: **(a)** EFB in fibrous form, **(b)** Shredded paper in shredder machine.

Recycled papers are use as a matrix material in the solid fuel briquette fabrication. The reason to choose papers as recycled waste in this research is because due to the properties of papers which can provide good properties for combustion. Furthermore, it can act as a binder during the blending of papers and EFB during fabrication stage. The papers are obtained from waste papers of the paper shredder machine. This is because the crushing papers have a standard size and dimension after is shredded inside the crushing machine. The standard size and dimension helps to ensure that the blending of papers and EFB is uniform.

Table 1: Properties of EFB as raw materials. (Nasrin *et al.*, 2008).

Raw Material	Average size of Materials	Calorific Value kJ/kg	Moisture Content %	Ash Content %
Pulverized EFB	<212μm	17000	12.0	2.41
EFB Fibre	3 cm	16641	16.0	4.70
EFB Fibre	2.5 mm	16641	14.0	4.60

The dimension of sample briquette produced during sample preparation is 40 mm in diameter and 73 mm in length with average weight about 67.64 grams. The ratio of briquette produced is presented in Table 2 and Figure 2 is actual specimens.

Table 2: Sample ratio and its serial number.

Ratio of EFB to Paper	Serial Number
90:10	S/N 1
80:20	S/N 2
70:30	S/N 3
60:40	S/N 4
50:50	S/N 5
40:60	S/N 6

There are several steps involved in producing a single briquette according to its ratio. Firstly, the waste papers need to be immersed in water for 24 hours and then it is blended using a blender to mash up the waste papers. Then, the blended papers it weighed again to get the weight of mashed papers with water. After dividing the EFB and shredded papers according to their ratios, the EFB fiber is mixed up with the shredded paper. Then, the compacting step takes place by compacting the mixing of EFB and waste paper into a solid briquette by using hydraulic press machine and cylinder mold. The size of the mold is 100 mm in length and 40 mm in diameter. The mixing is compressed into the mold until it gets to the desired length which is 73 mm. The amount of pressure applied during compacting process is 3 bars. Finally, the solid briquette is placed inside a drying oven at temperature 100 °C for 24 hours to remove the water obtained during the compacting process.

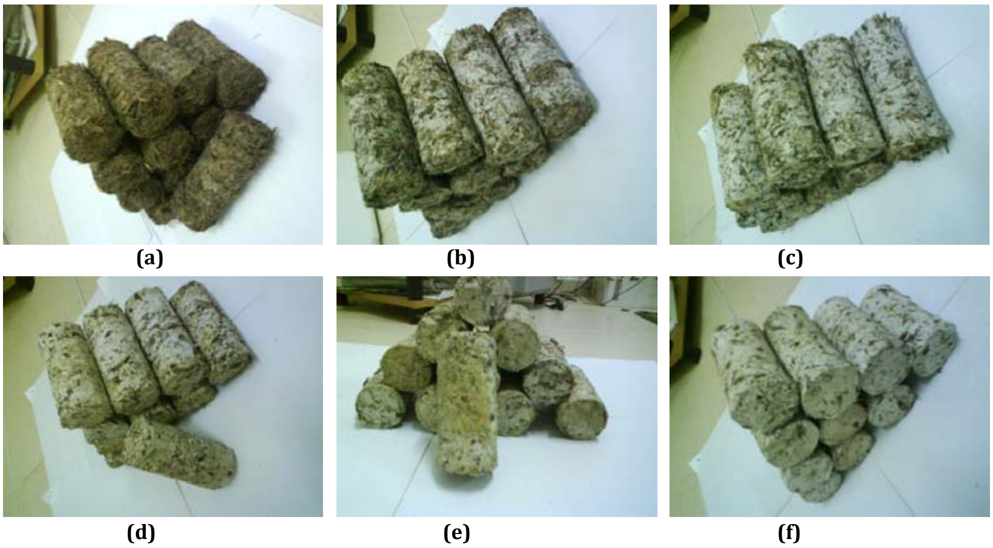

Figure 2: Samples of solid briquettes in different ratios; **(a)** S/N 1, **(b)** S/N 2, **(c)** S/N 3 **(d)** S/N 4, **(e)** S/N 5 and **(f)** S/N 6.

3.0 Results and Discussion

The stability of fuel briquette is measured by recording the radial expansion of briquettes weekly for four weeks. Five locations are measured for each sample ratio and the average reading is recorded. A data for a stability test in four weeks on each briquette is presented in Table 3.

Table 3: Stability of fuel briquettes

Sample Ratio	Weeks			
	1	2	3	4
S/N 1	44.16	44.26	44.26	44.26
S/N 2	43.31	43.33	43.37	43.37
S/N 3	42.27	42.32	42.48	42.48
S/N 4	42.10	42.64	42.66	42.66
S/N 5	41.37	41.46	41.48	41.48
S/N 6	41.17	41.18	41.30	41.30

From the Table 3, it can be deduced, the sample briquettes have experienced a radial expansion during week one to week three. After that the sample started to maintain its dimension and become stable after week 4. It also can be seen that going down the ratio from S/N 1 to S/N 6, the dimension of briquette produced is different. The larger the percentage of papers presence in the ratio, the smaller the dimension it get from the size of mould. Figure 3 illustrated the stability of each briquette in a bar graph form.

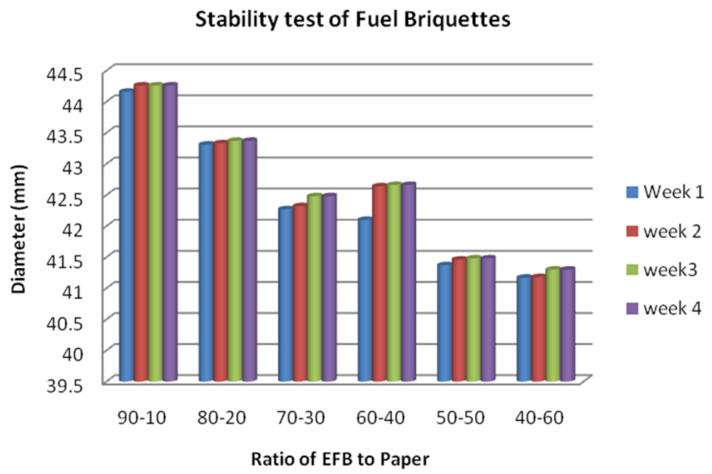

Figure 3: Stability Test of fuel briquettes

Stability test is conducted to check how well a briquette can maintain its dimension as time goes by and when it is exposed to ambient condition. Referring to Figure 3, the most stable briquette is S/N 1. This is because, based from the shape of the bar graph in figure above, sample for S/N 1 does not experienced large different in the dimensional changes through the four weeks time. Similarly to sample S/N 2 which also experienced a slight change in dimensional stability through the four weeks time of data recording process. From the result, it can be seen that briquettes started to maintain its stability after week three where no changes in dimensional length and diameter recorded for each sample briquettes. Samples with a higher amount of fiber shown more stability compared to others. In this case, S/N 1 and S/N 2 shown a greater stability compared to S/N 4 and S/N 6. This may be explained by the composition of the briquettes which higher in fiber content. Fiber is a long cellulose material that binds the particle in the briquette strongly.

Theoretically, fibrous material tends to have a higher ability to maintain the briquettes dimension. In contrast, sample briquettes that contained higher fiber tends to expand larger compared to sample with greater amount of waste paper after the compaction process. This is explained by the original diameter of briquettes during compaction in the mould is 40 mm. After compaction process, the sample briquettes are placed inside drying oven to remove all the water content and moisture inside the briquettes. After removing the water, it is observed that sample with greater percentage of fiber expands in larger diameter from its original diameter, compared to other briquettes. Referring to Figure 3 it can be seen that S/N 1 sample recorded the largest diameter changes compared to others, which is from 40 mm to almost 45 mm. It can be deduce that sample with greater percentage of fiber tends to expand fast at the early stage but started to maintain its stability consistently from time to time compared to sample with higher percentage of waste paper. This point is supported by Olorunnisola (2007), in her study of waste paper and coconut husk briquettes, which stated that briquettes produced with 100 % and 95 % of waste paper in the mixture exhibited the largest linear expansion about 9 percent, whereas those with smaller percentage of waste paper recorded least expansion about 3 percent. The finding seems to suggest that the coconut husk perhaps had some stabilizing effect of the briquettes. Bruhn *et al.,* (1959) had observed that the type of material briquetted is one of the factors that have appreciable effects on product expansion. Same goes on with Mani *et al.,* (2006) in his study of corn stover briquettes which stated that the briquettes produced also had experienced an expansion in length after three to four weeks of storage. In his study, a stability of corn stover briquettes is determined in terms of dimensional expansion in the lateral and axial direction before and after four weeks of storage. The briquettes was stored and the results is the briquettes expand largely in the axial direction than lateral direction. But still, this point supported that there will be an expansion in terms of length of the compacted briquettes for a few times before it started to maintain its stability later on. The moisture content also will affect the stability of the briquettes. The sample briquettes must be stored in an open air or room temperature to avoid the formation of fungi due to the condition of the briquettes which absorb moisture from environment easily. This point also supported by Al-Widyan *et al.,* (2002) which stated that increased in briquettes moisture will increase the axial and lateral expansion of briquettes dimension. The increasing dimensional change was reduced with an increase in pressure.

4.0 CONCLUSION

From the experiment carried out, it was generally found out that the characteristics of palm biomass briquettes produced from compaction of EFB and waste paper were satisfactory and compatible with the other researches that involved the palm briquettes. From the result, it can be seen that briquettes started to maintain its stability after week three where no changes in dimensional length and diameter recorded for each sample briquettes. Samples with a higher amount of fiber shown more stability compared to others. In this case, S/N 1 and S/N 2 shown a greater stability compared to S/N 4 and S/N 6. This may be explained by the composition of the briquettes which higher in fiber content. Fiber is a long cellulose material that binds the particle in the briquette strongly.

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