GLOBAL ENGINEERS & TECHNOLOGISTS REVIEW
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# SOLID FUEL FROM EMPTY FRUIT BUNCH FIBER AND WASTE PAPERS PART 7: WATER ABSORPTION TEST

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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 water absorption test. 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 immersed in water. Experimental work showed most samples behave same physical behaviors.*

***Keywords:*** *Empty Fruit Bunch Fiber, Waste Papers, Solid Fuel, Water Immersed.*

## 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), dimension stability (Yuhazri *et al.,* 2012f) but in this paper (part 7) only discuss on the water absorption of the solid fuel.

## 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).

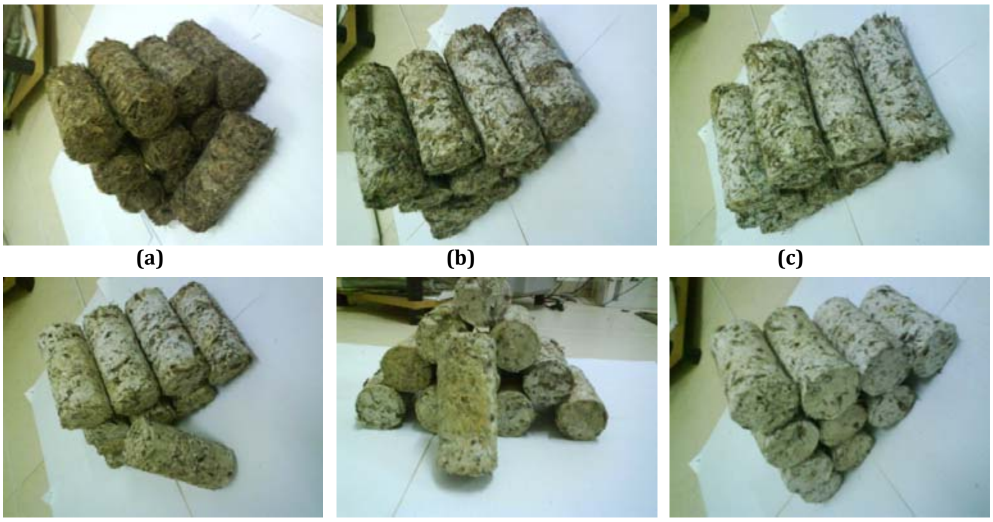
| Raw Material | Average size of Materials | Calorific Value kJ/kg | Moisture Content % | Ash Content % |
|---|---|---|---|---|
| Pulverized EFB | <212μm | 17000 | 12.0 | 2.41 |
| EFB Fibre | 3 cm | 16641 | 16.0 | 4.70 |
| EFB Fibre | 2.5 mm | 16641 | 14.0 | 4.60 |

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.



**(a)** **(b)** **(c)**

**(d)** **(e)** **(f)**

**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

An immerse test is conducted by immersing the sample briquettes into water for 30 minutes to observe the percentage of water absorption for each sample briquettes. The results shows all briquettes have recorded 100 % water absorption after immersed into water for 30 minutes. EFB and papers on its own is known for high affinity for water. This explained why all the sample briquettes recorded 100 % of water absorption after immersed in water. After completed the 30 minutes immersed, the briquettes are leaved in the water for 24 hours to observe whether the briquettes will disintegrate in water during the period of time. As a result, none of the briquettes disintegrated in the water after they are immersed for 24 hours. The figure of briquettes after 24 hours of water immersed is presented in Figure 3.

(a) (b)

**Figure 3: (a)** briquette with ratio S/N 1, S/N 2 and S/N 3 and **(b)** briquette with ratio S/N 4, S/N 5 and S/N 6.

After 24 hours, there are radial expansions in term of the length of sample briquettes. A result of dimensional changes of briquettes is recorded in Table 3.

**Table 3:** Dimensional changes in briquettes after 24 hours immersed.

| Sample ratio | Initial Length (mm) | Final Length (mm) | Percent Expansion (%) |
|---|---|---|---|
| S/N 1 | 73 | 100 | 37.0 |
| S/N 2 | 73 | 95 | 37.0 |
| S/N 3 | 73 | 90 | 37.0 |
| S/N 4 | 73 | 85 | 37.0 |
| S/N 5 | 73 | 83 | 37.0 |
| S/N 6 | 73 | 80 | 37.0 |

Table 3 shown dimensional changes in briquettes after immersed for 24 hours in water. From the table, briquettes S/N 1 experienced the highest dimensional changes compared to other samples with percent of expansion in length of 37 %. This is followed by sample of S/N 2 with percentage of expansion 30 %. Sample S/N 6 recorded the least percentage of expansion in length which is 9.6 % from its initial length. This shown that the larger percentage of papers in the ratio, the smaller expansion in length the briquette will be. This is because, sample with larger percentage of EFB fiber in it will experience greater expansion in length due to the condition of the fiber which is in fibrous form and easy to absorb water. When they have fully absorbed the water, a debinding process occurred in which starch which added to act as a binder in the mixture will become saturated with water thus causing the binding force of the mixture become loosen. Fibrous element will expand fast thus causing the increased in length of the sample briquettes. Comparing the result with a study on waste paper and coconut husk mixtures briquette conducted by Olorunnisola (2007), the average percent of length expansion is relatively smaller which is 10 %. This is because, coconut husk, is known for its relatively high affinity for water. The relatively high resistance of the briquettes to water may therefore be attributed to the waste paper inclusion. Paper is composed mainly of cellulose fiber which at the microscopic level contains waxes (water repellents) among other noncellulosic substances.

## 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. The experimental results conclude that the larger percentage of papers in the ratio, the smaller expansion in length the briquette will be. This is because, sample with larger percentage of EFB fiber in it will experience greater expansion in length due to the condition of the fiber which is in fibrous form and easy to absorb water.

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