TO STUDY THE PRODUCTION VIABILITY OF BIO-BRIQUETTE FROM OIL PALM DECANTER CAKE

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ABSTRACT

Being among of the largest palm oil producer, Malaysia also produces large quantities of palm oil biomass such as empty fruit bunch (EFB), palm oil mill effluent (POME), palm kernel cake (PKC), decanter cake and palm shell. Due to the large of waste production, there should be a way to reuse this waste. Generally, most of oil palm biomass can be used as combustion fuel. This study is to produce the decanter cake as bio-briquettes. Decanter cakes are very difficult for storing, handling and burning because of the high moisture content levels in the residue and when associated with the organic contents in the decanter cakes, it will cause air pollution and exert polluted gaseous like ammonia gaseous. Utilization of palm oil decanter cake will improve the environment because the disposal of sludge solid waste will increase the Biochemical Oxygen Demand (BOD) of the land. The testing that been done moisture content analysis, volatile matter and ash content analysis, calorific value analysis and density testing. In order to produce the briquettes from the decanter cake, the raw material is dried at the temperature of 105^{o}C for 12 hours using oven in order to get rid the moisture. After that, the dry decanter cake will be grinding to make it into smaller size and separate into three class of sizes which is small, medium, and large to see the effect of the particle sizes. The briquetting process is done by using hydraulic press. In order to make the DC briquette more compact and and reduce the ash content of DC briquette, the raw material is mix with sawdust. Apart from that, DC briquette is compare to the sawdust briquette from Yoltan and pellet rice straw. As conclusion, particle sizes does not really affect the moisture content, volatile matter, ash content and the calorific value of the decanter cake since the raw material is been dry at the same temperature. In this study, the DC briquette can be produce by using hydraulic press and it is could be used as renewable energy in producing solid fuels.

ABSTRAK

Menjadi antara pengeluar minyak sawit terbesar, Malaysia juga menghasilkan sejumlah besar biomas kelapa sawit seperti tandan kosong (EFB), efluen kilang minyak sawit (POME), kek isirung sawit (PKC), botol kek dan sawit shell.Disebabkan besar pengeluaran sisa, jadi perlu ada cara untuk menggunakan semula sisa ini. Secara umumnya, kebanyakan biojisim kelapa sawit boleh digunakan sebagai bahan api pembakaran. Kajian ini adalah untuk menghasilkan '*decanter cake'* sebagai briket. '*Decanter cake'* amat sukar untuk disimpan, dikendalikan dan dibakar kerana tahap kelembapan yang tinggi dan apabila mengandungi kandungan organik. Ini boleh menyebabkan pencemaran udara dan pembebasan gas tercemar seperti gas ammonia. Penggunaan '*decanter cake'* akan meningkatkan tahap kualiti alam sekitar kerana pelupusan sisa kumbahan pepejal akan meningkatkan '*Biochemical Oxygen Demand* (BOD)' tanah. Ujian yang telah dilakukan adalah analisis kandungan kelembapan, *'volatile matter'* dan analisis kandungan abu, analisis nilai kalori serta ujian ketumpatan. Dalam usaha untuk menghasilkan briket dari *'decanter cake'*, bahan mentah dikeringkan pada suhu 105^{o}C selama 12 jam menggunakan oven untuk menyingkirkan kelembapan. Selepas itu, *'decanter cake'*kering akan dikisar untuk memjadikan ia ke dalam saiz yang lebih kecil dan diasingkan kepada tiga kelas saiz yang kecil, sederhana dan besar untuk melihat kesan saiz zarah. Proses '*briquetting*' dilakukan dengan menggunakan penekan hidraulik.Untuk membuat briket DC yang lebih padat dan mengurangkan kandungan abu briket DC, bahan mentah dicampurkan dengan habuk kayu. Selain daripada itu, DC briket dibandingkan dengan briket habuk kayu dari Yoltan dan pellet batang padi. Sebagai kesimpulan, saiz zarah tidak menjejaskan kandungan kelembapan, *'volatile matter'*, kandungan abu dan nilai kalori *'decanter cake'*kerana bahan mentah dikeringkan pada suhuyang sama. Dalam kajian ini, briket DC boleh menghasilkan dengan menggunakan penekan hidraulik dan ia boleh digunakan sebagai tenaga boleh diperbaharui dalam pengeluaran bahan api pepejal.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Oil palm or also known as *Elaeis guineensis* is indigenous to West Africa but is now planted in all tropical areas across the world. But now it has become the most important industrial crops especially in certain South East Asia countries like Malaysia, Indonesia and Thailand (S.H. Shuit *et al*, 2009). The African oil palm was initially introduced in early 1900s to Sumatera and Malaya areas. The oil palm fruit is reddish in color and about the size of a large plum and it is grows in large bunches where each of bunch usually weigh between 10 and 40 kg. Oil is extracted from both the pulp of the fruit which is edible oil and the kernel that mainly used in foods and for soap manufacture.

Nowadays the awareness of the need to provide alternatives sources of fuel and energy increasing across the world. Malaysian palm oil industry has grown widely over the last 40 years. Malaysia is fortunate with abundant natural resources and climate conducive for commercial cultivation of crops such as palm oil and rubber. Malaysia is the first producer of palm oil, the third largest for rubber and fourth largest for cocoa. There were more than 3.79 million hectares of land, occupying more than one-third of the total cultivated are and 11% of the total land area, under palm oil cultivation in Malaysia in the year 2003 (Yusoff and Hansen 2007).

However, besides being among of the largest palm oil producer, Malaysia also produces large quantities of palm oil biomass such as empty fruit bunch (EFB), palm oil mill effluent (POME), palm kernel cake (PKC), decanter cake and palm shell. The productions of fibre, shells, and EFB and decanter cake were estimated to be 0.894, 0.13, 1.53, and 0.27million tones per year, respectively (Chavalparit et al. 2006). Due to the large of waste production, there should be a way to reuse this waste. Generally, most of oil palm biomass can be used as combustion fuel. Currently, the shell and the fibre are the main sources of energy in palm oil mills. They are burnt in boiler to produce steam for electricity generation to be used in the milling process (Am. J Applied Sci., 2008).

But, in order to make use of resources and expand its usage in the other industries and applications, the raw oil palm biomass should be treated and upgraded into uniform and useful fuels. One of the methods in upgrading the properties of oil palm biomass is briquetting process which is a compacting of the biomass residue into a uniform solid fuel.

Development of green energy based on the use of biomass from the palm oil tree especially decanter cake is in the right path in adopting a holistic approach in the promotion of for the energy recovery in palm oil mill (POM) and renewable energy. The waste of oil palm are readily available from the palm oil industry is a renewable energy resource. In general, the fresh fruit bunch contains (by weight) about 21% palm oil, 6–7% palm kernel, 14–15% bre, 6–7% shell and 23% FFB. Instead of using fiber and shell as boiler’s fuel, decanter cake is converting from the processing wastes into alternatives fuel for electricity generation for this industry. Malaysia is now looking for the renewable energy and the most promising one is by using the palm oil tree wastes such as fiber and shell or maybe the decanter cake as a new boiler fuels to generate electricity in POM.

1.2 PROBLEM STATEMENT

Environmental issues increasingly becoming more important in Malaysia since the crude palm oil (CPO) mill can cause much environmental pollution from its residues such as decanter solids. Decanter cakes are very difficult for storing, handling and burning because of the high moisture content levels in the residue and when associated with the organic contents in the decanter cakes, it will cause air pollution and exert polluted gaseous like ammonia gaseous. Utilization of palm oil decanter cake will improve the environment because the disposal of sludge solid waste will increase the Biochemical Oxygen Demand (BOD) of the land. The drying method for removal of water from decanter cakes is also a major problem. Even though some CPO mills convert the decanter cake into fertilizer and animal feed (Chavalparit. O, 2000), the tons of the waste still in excess contribute to large land area consumption.

Besides that, decanter cake contributes to reduction of oil production. This is because there is still some oil left in the decanter cake. But large quantity of decanter cake is disposed in the landfills only causing pollution hazards. So, this decanter cake would be just wasted if the oil was not recovered and this is will contribute loss of oil in the future.

1.3 RESEARCH OBJECTIVES

i. To study the potential of decanter cake waste as renewable energy.
ii. To produce the decanter cake as bio-briquette.
iii. To study the proximate analysis of DC briquette.

1.4 SCOPE OF RESEARCH

In order to achieve the objectives, the scope of studies are identify as follow:

i. The study uses the decanter cake from LKPP Corporation Sdn. Bhd. Palm oil mill in Lepar as raw material.
ii. To study the effect of presence of moisture.
iii. The decanter cake is dry at temperature range of 100 ^{o}C – 105^{o}C.
iv. To study the effect of other material composition in DC bio-briquettes.
v. To study the calorific value of DC bio-briquettes.

1.5 RATIONAL AND SIGNIFICANCE

Based on the research scopes mentioned above, the following rationale and significance that we could get;

i. It shall minimize the storage space of decanter cake at palm oil mills.
ii. New substitute material for biomass briquettes production.
iii. Alternative way to produce valuable product from oil palm biomass (bio-briquette.)
iv. It shall reduce the environmental issues.
v. New alternative portable renewable energy.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Elaeis guineensis is the scientific name of oil palm and it is the most important species in the genus Elaeis which is belong to the family Palmae. After 2 ½ -3 years field planting, oil palm will start to bearing bunches. Mature trees are single-stemmed and can grow up to 20m tall. The leaves are pinnate and reach between 3 or 5m long. The flowers are produced in dense clusters which is each individual flower is small with three sepals and three petals. The oil palm does not produce offshoots where propagation is by sowing the seeds. The fruit to be mature it will take 5-6 months from pollination to maturity. Maturity means it comprises an oily, fleshy outer layer (the pericarp), with a single seed (kernel), also rich in oil. Oil palms are commonly used in commercial agriculture in the production of palm oil. The oil palm is a tropical palm tree therefore it can be cultivated easily in Malaysia. The fruit bunches are generally transported to palm oil mill on the day of harvestion. The first commercial oil palm estate in Malaysia was set up in 1917 at Tennamaran Estate, Selangor (MPOB, 2006). Currently, the total area under oil palm cultivation is about 3.5 million hectares, while the statistic of oil palm production for the year 2001 was 11.8 million tonnes (Hussin, Mokhtar, Wan, Ropandi.,2002).

Below are the technological process involve in extracting oil palm from fresh fruit bunches (FFB).

Loading ramp: This is the first stage of processing after the fruit is been weighbridge. For loading, ramp is the place where the FFB are transported and unloaded in the mill.

terilization: this process is happen in an autoclave for about 1 hour and 40 minutes for the FFB to be completely cooked. The temperature inside the autoclave is 120 ^{o}C – 130 ^{o}C. At this step, the steam condensate is generated as the waste water.

Stripping (Threshing): This process is to separate the sterilized FFB from it's bunches stalks. At this step, it is generates the empty fruit bunches (EFB).

Digestion: The separated fresh fruit are been put in a place where it will be mashed under the steam heated condition. There are no residues occurred on this step.

Crude palm oil extraction: The homogenous oil mash will pushed to a screw press and pass through a vibrating screen, a hydrocyclone, and decanters in order to removes the fine solids and water. At this step, decanter wastewater and decanter cake are the major wastes. The oil had been purifying by centrifugal and vacuum driers before sending to the storage tank. In the storage tank, the temperature is maintained with steam coil heating before the crude palm oil (CPO) is sold.

Nut/ Fibre Separation: After at the screw press, fibre and the nuts are separated in a cyclone. The fibre that passed out at the bottom of the cyclone is used as boiler fuel from which ash will produced after combustion.

Nut cracking: The nuts are cracked in a centrifugal cracker. After that, the kernel and shells are separated by a clay suspension which is used Kaolin. The separated shells from the kernels the sold to the other mills as fuel while the kernels are sent to the kernel drying process in a silo dryer before been sell to other mills.

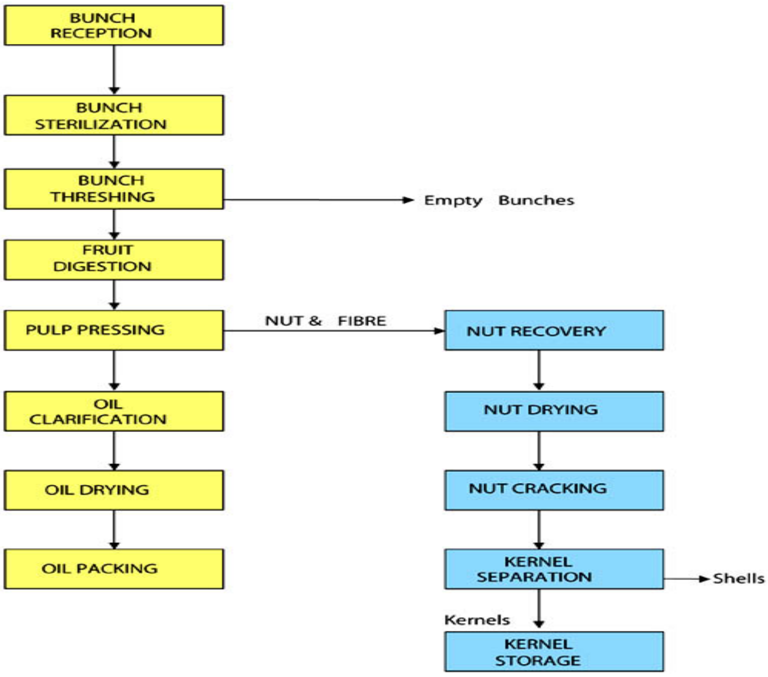

Figure 2.0: Process flow diagram of palm oil extraction

Source: *http://www.fao.org*

2.2 BIOMASS

Biomass is refers to the organic matter which can be used as a renewable energy source in a number of different ways. Biomass also 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 (Kitani and Hall, 1989).

The term biomass covers a large number of materials with highly different properties which can be used as fuels. These materials can be classified into a few main categories, each of which can be divided into several types:

i. Wood from forestry
ii. Residues from wood and food industries
iii. Agricultural residues

iv. Energy crops (Madsen, 1998).

Biomass generally contains a lower percentage of carbon and a higher percentage of oxygen than fossil fuels. The result is a lower heating value per unit mass of biomass compared with fossil fuels. This means that more biomass fuel must be handled and processed to obtain an equivalent unit of usable energy (Unger, 1994). As second largest producer of palm oil with 15.88 million tones or 43% of the total world supply in year 2oo6 as shown in the Figure 1 **(**U.S. Department of Agriculture, Indonesia and Malaysia palm oil production), it is currently contribute the largest amount of biomass with 85.5 % out of more than 70 million tones as shown in the Figure 2 (Hassan MA and Shirai Y, 2003). The type of biomass produced from palm oil industry includes the empty fruit bunches (EFB), palm shells, palm kernel cake (PKC), fiber, decanter cake, fronds and trunks. Instead of the huge production of oil palm, the oil consists of only about 10% of the total biomass produced in the plantation.

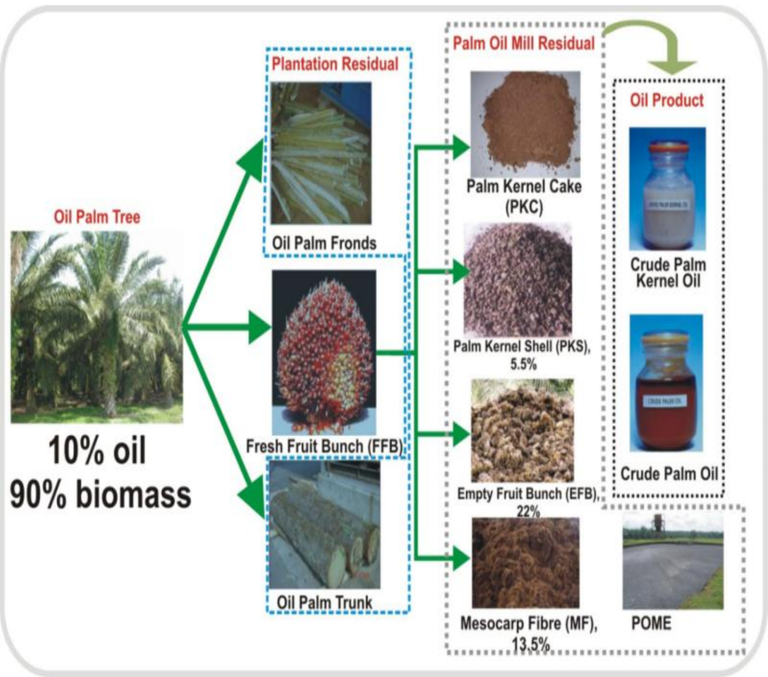

Figure 2.1: Oil palm biomass

Source: *http://jfe-project.blogspot.com*

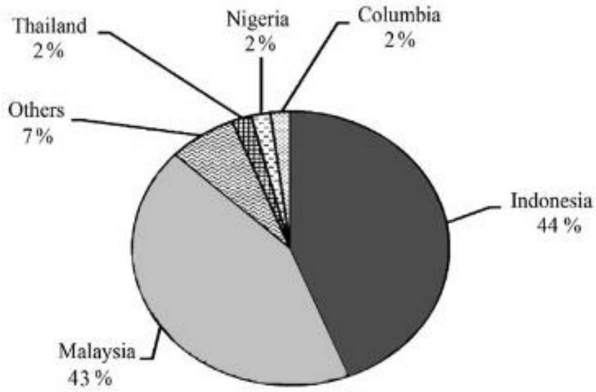

Figure 2.2: World producers of oil palm in 2006

Source : U.S. Department of Agriculture, Indonesia and Malaysia palm oil production)

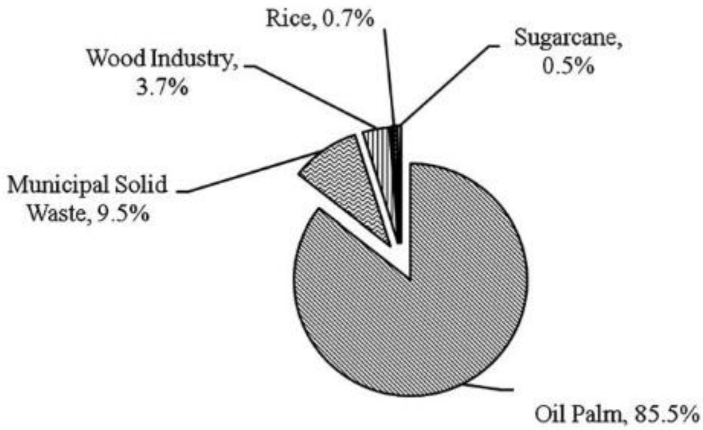

Figure 2.3: Biomass produced from different industry in Malaysia

Source: Hassan MA and Shirai Y, 2003

2.3 RENEWABLE ENERGY

Renewable energy sources are those resources which can be used to produce energy again and again, e.g. solar energy, wind energy, biomass energy, geothermal energy, etc. and are also often called alternative sources of energy (Rathore NS, Panwar NL, 2007). According to the world energy council projections, if the adequate policy initiatives are provided, in 2005, 30% of direct fuel use and 60% of global electricity supplies would be met by renewable energy sources (M.P Koh and W. K. Hoi, 2003). For the other renewable energy sources such as wind and solar, its have limitation due to the form energy that they produces. Biomass energy is versatile because it can be produced in gaseous form (gas and biogas), liquid form (alcohol) and solid form (charcoal and briquettes) by adding value to commercialization. Furthermore, biomass energy system is not site specified so it can be established in any places where the plants are grown and animal waste are available. Renewable energy is a clean or inexhaustible energy like hydrogen energy and nuclear energy and it can decrease of environmental pollution.

Table 2.0: Main renewable energy sources and their usage

Energy Sources	Energy conversations and usage options
Hydropower	Power generation
Modern biomass	Heat and power generation, pyrolysis, gasification, digestion.
Geothermal	Urban heating, power generation, hydrothermal, hot dry rock
Solar	Solar home system, solar dryers, solar cookers
Direct solar	Photovoltaic, thermal power generation, water heaters
Wind	Power generation, wind generators, windmills, water pumps
Wave	Numerous design
Tidal	Barrage, tidal stream

Source: Kralova I, Sjöblom J, 2010

2.4 PALM OIL BIOMASS AS RENEWABLE ENERGY

Oil palm biomass has good potential to be converted into renewable energy sources due to its calorific value of each component shown in the Figure 2.4. Based on the calculation in the table, oil palm biomass has a total energy potential of about 15.81 Mtoe (million tons of oil equivalent). Taking an efficiency of 50%, the energy generated from oil palm biomass may reach almost 8 Mtoe. In the year 2006, Malaysia's energy demand is 40.4 Mtoe (Pusat Tenaga Malaysia, 2008). From that, oil palm biomass can provides up to 20% of the total energy demand in Malaysia. If all the 8 Mtoe produced is converted into energy replacing the petroleum crude oil, Malaysia can save up to RM 7.5 billion per year (S.H Shuit *et al*, 2009).

When there is oil palm biomass is burned instead of fossil fuels as an energy sources, a certain amount of carbon will be displace. If fossil fuels such as coal or natural gas are burned, it will release the carbon to the environment. Reduction in carbon emission to the environment is crucial to prevent further global warming. The combustion of oil palm biomass does not contribute to net amount of carbon in the atmosphere as carbon is assimilated during plant growth. Biomass normally regarded as waste product and therefore utilizing biomass to generate energy such as electricity or bio-fuel can reduce the country dependence on fossil fuels and ensure sustainable source of fuel, since biomass is renewable (S.H Shuit et al. 2009).

Oil palm briquettes can be applied for household uses and for industrial heating unit operation such as boiler. Besides its helps to reduce carbon content in the atmosphere which is through zero carbon emission, but its usage can also qualify for carbon credit under Kyoto Protocol mechanism that helps to mitigate global warming (S.H Shuit et al. 2009). Research shows that briquettes made from 100% of pulverized empty fruit bunches (EFB) exhibited good burning properties. But in order to increase the quality of briquettes from EFB fiber and PKE, it is recommended to blend with sawdust. Converting the oil palm biomass into briquettes will increase its energy content by at least 5% and 38% respectively compared to its raw material (Nasrin AB et al. 2008). There are some advantaged of using palm briquettes which is low cost, available all year around, longer burning duration, high calorific value and environmental friendly makes it can become a potential renewable energy source in the future.

2.5 BRIQUETTING

Briquetting is a process in making the briquettes. This section will cover the principle and technology using in the briquetting process and the characteristic of bio-briquettes. Bio-briquettes is can be used either for heat generation in households and small scale home industries, or even for power generation in large industries (Kettunen and S. Foster Wheeler, 2004).

2.5.1 Principle and Technology

Densification or briquetting is a mechanical treatment to upgrade the loose biomass into a higher density and uniform solid fuel via compaction. It has higher density and energy content and less moist compared to its raw material (A.B Nasrin *et al.* 2008). The briquetting process will increase the physical, chemical and combustion properties over of the raw material and easy to handle. There are two technologies that can be used in the process which is screw extrusion and piston pressing where both can be done with or without binder. The central hole incorporated into the briquettes produced by a screw extruder helps to achieve uniform and efficient combustion and, also, these briquettes can be carbonized (Grover. P.D and Mishra. S.K, 1996).

Another type of briquetting machine is the hydraulic piston press. This is different from the mechanical piston press in that the energy to the piston is transmitted from an electric motor via a high pressure hydraulic oil system. It is compact and light. Because of the slower press cylinder compared to that of the mechanical machine, it results in lower outputs. This machine can tolerate higher moisture content than the usually accepted 15% moisture content for mechanical piston presses.

Pelletizing is closely related to briquetting except that it uses smaller dies so that the smaller products are called pellets. The pelletizer has a number of dies arranged as holes bored on a thick steel disc or ring and the material is forced into the dies by means of two or three rollers. The two main types of pellet presses are which is flat and ring types (Eriksson, S. and M. Prior, 1990). The flat die type features a circular perforated disk on which two or more rollers rotate. The ring die press features a rotating perforated ring on which rollers press onto the inner perimeter. Pellet press capacity is not restricted by the density of the raw material as in the case of piston or screw presses (Grover. P.D and Mishra. S.K, 1996).

There are different forms of compressed materials. These forms are cubes, pellets and crumbles. American society of Agricultural Engineers (ASAE, 1991) defined these forms as follow:

i. Cubes: An agglomeration of ungrounded ingredients. The configuration of the agglomeration may take any form.

ii. Pellets: An agglomeration of individual ground ingredients, or mixture of such ingredients, commonly used for animal feed.

iii. Crumbles: Palletized feed reduced to granulate form. The best known forms of the compressed materials are pellets and briquettes. In general there is no difference in properties between them. The small-length pressed materials are called pellets and the course materials are called briquettes. The use of briquetting for the conversion of agricultural residues is comparatively recent. Briquetting makes these wastes easier to transport, to handle and to store.

Figure 2.4: Piston press technologies in the production of palm biomass briquettes

Source: MPOB Information Series. ISSN 1511-7871, Jun 2010.

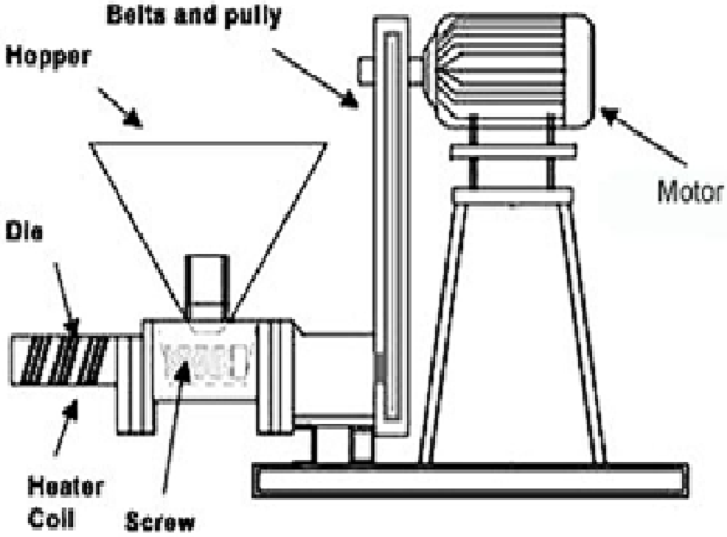

Figure 2.5: A typical commercial screw extrusion set-up

Source: MPOB Information Series. ISSN 1511-7871.Jun 2006

2.6 CHARACTERISTICS OF BIO-BRIQUETTES

2.6.1 Moisture content

The moisture content is expressed as the mass of moisture per unit mass of wet or dry material. In the wet-mass method of measurement, the moisture in a sample is expressed as a percentage of the wet mass of the material; in the dry mass-method, it is expressed as a percentage of the dry mass of the material (Peavy, Howard S., Environmental Engineering Book). Equation for the calculation of wet-mass moisture content:

$$\text{Moisture Content (\%)} = \left(\frac{a-b}{a}\right) \times 100$$ …………………..Equation 2.1

Where a = initial mass of sample as delivered
b = mass of sample after drying

The moisture content in bio-briquettes should be as low as possible, generally in the range of 10-15 percent. Problems will occurred in grinding and excessive energy will required in drying process if high moisture content is in the bio-briquettes**.** If the feed moisture content is around 8-10% and the resulting briquettes after compaction process will have 6-8% moisture content**.** The significant of bio-briquettes having more moisture contents, the solid fuels result in easily cracks, poor and weak and the operation is erratic. Excess steam is produced at higher moisture content leading to the blockage of incoming feed from the hopper, and sometimes it shoots out the briquettes from the die. Therefore, it is necessary to maintain optimum moisture content (Grover. P.D and Mishra. S.K, 1996).

2.6.2 External additives

The briquetting process does not add to the calorific value of the base biomass. In order to upgrade the specific heating value and combustibility of the briquette, certain additives like charcoal and coal in very fine form can be added. About 10-20% char fines can be employed in briquetting without impairing their quality (Grover. P.D and Mishra. S.K, 1996). The variety of biomass had been used to improve the mechanical strength and the energy content like calcium carbonate, beach sawdust, ash chipping, nut shell, rice shell, huskus of grape-vine and cuttings of grape-vine (Mitic and Nesic, 1997) and the result revealed that the briquettes are compact, no crumbling, no cracking in drying phase, and it is possible to cut and engrave them (Jankovic. S, 1997).

2.6.3 Ash content and composition

Biomass residues normally have much lower ash content (except for rice husk with 20% ash) but their ashes have a higher percentage of alkaline minerals, especially potash. These constituents have a tendency to devolatalise during combustion and condense on tubes, especially those of super heaters. These constituents also lower the sintering temperature of ash, leading to ash deposition on the boiler’s exposed surfaces (Grover. P.D and Mishra. S.K, 1996). The ash content of different types of biomass is an indicator of slagging behavior of the biomass which is the greater the ash content, the greater the slagging behavior. But this does not mean that biomass with lower ash content will not show any slagging behavior. The temperature of operation, the mineral compositions of ash and their combined percentage determine the slagging behavior. If conditions are favorable, then the degree of slagging will be greater. Minerals like Silicon Oxide (SiO) are more troublesome. Many authors have tried to determine the slagging temperature of ash but they have not been successful because of the complexity involved. Usually slagging takes place with biomass fuels containing more than 4% ash and non-slagging fuels with ash content less than 4%. According to the melting compositions, they can be termed as fuels with a severe or moderate degree of slagging (Grover. P.D and Mishra S.K, 1996).

Table 2.1: Ash content of different biomass type

Biomass	Ash content (%)	Biomass	Ash content (%)
Corn cob	1.2	Coffee husk	4.3
Jute stick	1.2	Cotton shells	4.6
Sawdust (mixed)	1.3	Tannin waste	4.8
Pine needle	1.5	Almond shell	4.8
Soya bean stalk	1.5	Areca nut shell	5.1
Bagasse	1.8	Castor stick	5.4
Coffee spent	1.8	Groundnut shell	6.0
Coconut shell	1.9	Coir pith	6.0
Sunflower stalk	1.9	Bagasse pith	8.0
Jowar straw	3.1	Bean straw	10.2
Olive pits	3.2	Barley straw	10.3
Arhar stalk	3.4	Paddy straw	15.5
Lantana camara	3.5	Tobacco dust	19.1
Subabul leaves	3.6	Jute dust	19.9
Tea waste	3.8	Rice husk	22.4
Tamarind husk	4.2	Deoiled bran	28.2

Source: P.D. Grover & S.K. Mishra, 1996.

CHAPTER 3

METHODOLOGY

3.0 INTRODUCTION

Raw material that involve is decanter cake (DC). The equipment that been state is the major equipment that will be used in this research.

3.1 RAW MATERIAL

The decanter is derived from the palm oil mill sludge separation. It is material that remains after decanting the palm oil effluent. The decanter cake contains high percentage of oil. Most of the palm oil mills were currently disposed the decanter cake by incineration, inclusion in animal feeds, and land filling method or concrete manufacturing. In this project, decanter cake is taking at LKPP Corporation Sdn. Bhd. Palm oil mill.

Figure 3.0: Decanter cake

3.2 EQUIPMENT

The equipments that been used are oven, furnace, press technology and automatic oxygen bomb calorimeter (OBC). Besides that, the other equipments that been used are analytical balance, electronic densimeter, and moisture analyzer.

3.2.1 Oven

Oven is used in the decanter cake drying process. The concept of oven is using the electric to heat the heating medium so that the sufficient heat will produce to dry the samples. The oven can generate temperature up to 300 ^{o}C. The temperature been used in this experiment is 100 ^{o}C – 105 ^{o}C which is the temperature for water to evaporate. Oven been chosen to dry the samples rather than microwave oven. On heating terms, microwave is more efficient in terms of radiation of magnetic wave that generate from the electric energy. But, due to samples condition which is high in volatile matter that easily to ignite and it may cause ignition to the microwave.

Figure 3.1: Oven

3.2.2 Screw extrusion/ piston press technology

There two ways of briquetting this is through screw extrusion or piston press technology. Both of this ways can be done with or without additional of binder in the raw material. In this research, piston press technology will be use. In palm biomass briquettes production, it involves two main processes which are pre-treatment of the material and the briquetting process. Pre –treatment is a vital and most crucial process to prepare suitable feedstock for the production (Nasrin Abu Bakar et al. 2010). Basically, in a piston press, the palm biomass is pressed in a die by a reciprocating ram at a very high pressure and moderate temperature. In this project, the briquetting process use hydraulic press to produce the product.

Figure 3.2: Hydraulic press

3.2.3 Furnace

Furnace is been used in the ash content and volatile matter test. The maximum temperature of furnace is up to 1100 ^{o}C. In the ash content test, the temperature is at 815 ^{o}C while for the volatile matter test the temperature is at 900 ^{o}C.

Figure 3.3: Furnace

3.2.4 Automatic oxygen bomb calorimeter

Oxygen bomb calorimeter (OBC) is used in obtainable the releasing heat from the sample. But there are certain precautions and corrections on operating the OBC such as temperature reading, sulfur content correction, the part per million (ppm) of total suspended solid of the water used and all precautions must always be observed when using OBC. The pressure that been supplied when doing this testing is ±3000 KPa and the fuse length is 10 cm. By using the automatic oxygen bomb calorimeter, the result will become more accurate than using the manual OBC.

Figure 3.4: Automatic oxygen bomb calorimeter

3.2.5 Electronic densimeter

The Electronic Densimeter MD-300S provides a highly accurate calculation of specific gravity of almost any object of any shape. It has been used in testing the briquette density. The electronic densimeter can measure the solid and liquid specific gravity. It is highly precise general with density resolution of 0.001g/cm^3 and measurable weight 0.01~300g.

Figure 3.5: Electronic densimeter