

**IMPACT OF CARBONIZATION PROCESS ON BRIQUETTE FROM PALM OIL
RESIDUE**

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**IMPACT OF CARBONIZATION PROCESS ON BRIQUETTE FROM PALM
OIL RESIDUE**

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**This report is submitted in partial fulfillment of the requirement for the degree of
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SUPERVISOR DECLARATION

“I hereby declare I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Thermal-Fluids).”

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Date : 28 JUNE 2013

DECLARATION

“I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged.”

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ABSTRACT

This project is about the impact of carbonization process on briquette for palm oil residue. In this project, the palm oil waste that is used are empty fruit bunches (EFB) and palm oil shell. The used of carbonization process is conducted in this project as to compared the results of the product analysis of the briquette with or without carbonization process. Based on recent studies, the best composition of briquette consists of EFB and shell has been determined. The best ratio of EFB and shell are 40% and 60%. In this project, the composition will be conducted based on the previous study. The process that will be used in this project is involving crushing, drying, compacting, pyrolysis process and product analysis. For this kind of project, the analysis covered is the proximate analysis, consists of moisture content, volatile matter, fixed carbon, ash content, and calorific value.

ABSTRAK

Projek ini adalah tentang kesan daripada proses karbonisasi pada briket untuk sisa kelapa sawit. Dalam projek ini, sisa kelapa sawit yang digunakan adalah tandan buah kosong (EFB) dan tempurung kelapa sawit. Penggunaan proses karbonisasi yang dijalankan di dalam projek ini adalah untuk membandingkan keputusan analisis antara briket mentah dan juga briket yang melalui proses karbonisasi. Berdasarkan kajian terbaru, komposisi terbaik briket terdiri daripada tandan kosong dan tempurung kelapa sawit telah ditetapkan. Nisbah terbaik tandan kosong dan tempurung kelapa sawit adalah 40% dan 60%. Dalam projek ini, komposisi akan dijalankan berdasarkan kajian sebelumnya. Proses yang akan digunakan dalam projek ini melibatkan penghancuran, pengeringan, pemadatan, proses pirolisis dan analisis produk. Untuk jenis ini projek, analisis yang dijalankan adalah analisis proksimat, terdiri daripada kandungan kelembapan, bahan meruap, karbon tetap, kandungan abu, dan nilai kalori.

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LIST OF ABBREVIATIONS

EFB = Empty fruit bunch

CPO = Crude palm oil

PKO = Palm kernel oil

POME = Palm Oil Mill Effluent

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

The world nowadays is having a concern on improving the utilization of energy provided for each of the country. It is because the utilization of energy is contributing to the surrounding and causing lots of consequences. For example, the conventional method of energy utilization will producing a global warming effect to the surrounding and contributing to the rise of global temperature. Besides that, the world before is really depending on the fossil fuel as the primary sources of energy. Along the way, the world realized that they should find a new alternative on solving the problem that becoming worse.

Due to the situation, they are taking a decision on improvising the energy utilization in order to reduce the global warming effect as well to be less depending on the fossil fuel as their primary source of energy. Thus, the renewable energy has been introduced. Renewable energy is a kind of energy that comes from natural resources. The renewable energy can be in the form of any natural resources, such as sunlight, tidal, waves, wind and geothermal. To be more specific, the sunlight energy is called solar energy. This kind of energy is divided into two types, which are direct solar energy and indirect solar energy.

Direct solar energy is referring to the photovoltaic panel, that is use to convert the sunlight recovered to the electrical energy. For indirect solar energy, it is referring to the

materials that contain a stored solar energy, for example, the plants. This kind of indirect solar energy is always related to the biomass energy. Biomass is a biological material that can be use directly or converted to other form to produce energy. This energy can be utilized and converted into other energy, depending on the application.

In Malaysia, the government is encouraging the development of renewable energy, particularly biomass, as the fifth fuel resource under the country's Fuel Diversification Policy. The report is focusing on the material to be used to produce biomass energy. Recent studies proving that the production of biomass product needs to undergoing certain process namely, pyrolysis process.

1.2 PROBLEM STATEMENT

Due to the global demand of energy, the power production needs to be increase in order to provide the demand. Unfortunately, the fossil fuel source is depleted from year to year, and lastly, this kind of sources will be vanished at certain period of time. Besides that, the supply of the sources is unstable due to the availability of the sources. In fact, the price of the fossil fuel is fluctuating and not consistent in term of its increment.

The utilization of fossil fuel also contributes to the global warming issue. The uses of fossil fuel as the fuel for combustion contribute a negative impact toward the increase in global temperature as well as green house effect. This is due to the carbon dioxide produced by the combustion of the fossil fuel. For example, the burning of coal will produce sulphur and nitrogen. This kind of chemical is corrosive and poisonous towards human's health. In fact, the use of fossil fuel also contributes to the production of carbon monoxide. Note that this gas is carcinogen.

The world population is increasing from year to year. This is due to the development of countries as well as to provide a better lifestyle for human being for this century. For example, even in Malacca, there a huge amounts of the housing construction as to fulfill the demand of the citizen. Generally, the energy demand is

directly proportional to the world population. The higher the population, the higher the energy demands.

Based on the problem above, a new alternative of producing energy is encouraged to ensure the production of energy meets the demand. In palm oil industry, they are producing million tons of waste. Surprisingly, the waste generated by the sector can be utilized to become a new source of renewable energy, called biomass. Thus, the availability of this kind of waste needs to be utilized maximally in order to use it as a fuel for power production generation.

1.3 OBJECTIVE

The main objective of this project is to produce a briquette by using palm oil residue, focusing on palm oil shell and empty fruit bunches (EFB). Besides that, it is also to study the effectiveness of carbonization process toward the production of briquette. The other objective of this project is to study the effect on carbonization and non-carbonization process to the characteristics of the briquette in terms of calorific value, the moisture content, ash content, volatile matter and fixed carbon.

1.4 SCOPE OF STUDY

The scope of the project has been set up before it begins. This is to ensure that the project needs to follow the scope of study constructed by the author. The first scope of the study is the use of EFB and palm oil shell as the samples of the briquette production. The other scope that is covered is to study the calorific value changes to the sample with or without carbonization process. The next scope is to determine the moisture content, ash content, volatile matter and fixed carbon of the briquette produced.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The world today is really depending on the fossil fuel as the conventional sources of energy. The problem regarding the energy crisis is getting worse from year to year. This is due to the energy demand and the spending power phenomenon. Based on the general statistics, the price of crude oil is increasing rapidly as the market growth every year. To be noted that the oil and gas industry also having a problem of instability in supply. Besides that, the demand and the increasing price of crude oil also affecting the production supply due to the instability towards the supply of the crude oil. From 1996 to 2020 the world expecting that the increase of world energy consumption will becoming 65% (Ahmed, 2008). From here, the world should find a new alternative way of utilizing new sources of energy as to ensure that the world will be less dependency towards the fossil fuel.

Fossil fuel is a kind of non-renewable energy sources. It clearly means that the sources will be depleted from time to time and lastly it will be completely vanished. Compare to the renewable sources, this kind of energy cannot be depleted as well as vanished. This is due to the availability of the sources as it is a kind of natural sources. For example, the available technologies of renewable energy that have been used by some countries are solar energy, hydropower energy, oceanic energy, geothermal energy, wind energy, and bioenergy. All of these renewable energy really help in reducing the dependency towards the energy crisis related to fossil fuel energy as well as

to ensure that the world can possibly using this kind of energy to provide the energy demanded by the human population.

Biomass is officially announced to be the new sources of energy that makes the world to be less dependency towards the fossil fuel. This is due to the energy contained in the biomass as the energy absorbed from the sun, and this is so called indirect solar energy. It clearly means that the energy from the sun is stored inside the particular crops, and by this way, the energy can be utilized as the renewable sources that needs to be improvise to use it to generate electricity.

Malaysia palm oil industry is having the huge potential in producing the edible oil in order to provide the global demand. Malaysia is one of the largest leading exporters of palm oil including Indonesia and Nigeria (Asiah, 2004). There are several primary products of the palm oil industry, namely, crude palm oil (CPO) and palm kernel oil (PKO).

The wastes produced by processing a fresh fruit bunches (FFB) are empty fruit bunches (EFB), mesocarp fibre, palm oil shell, and palm oil mill effluent (POME). Basically, for every 1 ton processing of fresh fruit bunches, it is producing 23% of Empty Fibre Bunch (EFB), 13% of mesocarp fibre, 6% of palm shell, and 65% of Palm Oil Mill Effluent (POME) (Nasrinl, 2011). For the palm oil sector, it uses all mesocarp fibre and certain value of shell to generate electricity for the mill by generating heat at the boiler and supplying the steam to the steam turbine.

Not all palm oil mills using the EFB as the source of boiler fuel as the energy provided by the mesocarp fibre and certain amount of shell is enough to generate the electricity for the mill. The reason of this is because the calorific of mesocarp fibre and palm shell is higher than the calorific value of EFB. The calorific value of the EFB is 18838 kJ/kg, 20108 kJ/kg for palm shell, and 19068kJ/kg for the mesocarp fibre (Vijaya, 2004).

To convert the biomass into a better energy form, there are four methods of thermochemical process that can be used, which are pyrolysis, liquefaction, gasification, and combustion. Liquefaction is a process of converting the material into a liquid type of products, such as ethanol that is being used as biofuel. On the other hand, gasification process is a process of converting the material into a carbon and energy in the gas phase.

Combustion process is the common process of handling the biomass, which is by conducting a combustion process through the material in order to generate the heat energy that is then converted into another energy based on the application. Pyrolysis is a process of converting the material into a carbon-rich and volatile matter material by conducting a combustion process without the presence of oxygen (Brownsort, 2009). The pyrolysis process is divided into 2 types, namely, fast pyrolysis and slow pyrolysis. The difference between these two types of pyrolysis is the duration of time and the temperature used to heat up the material.

After conducting the thermochemical process required by the biomass, this material needs to be in the form of easy to handle. Commonly, densification process is used to make sure that the material will be in a uniform shape. In fact, this process is also to make sure that the bulk density of the material is higher compared to without the use of densification process.

Densification process basically producing some kind of simpler form of material called briquette. The densification process producing different types of products even the material or the composition is the same. This is due to the size of the products. Generally, the products of densification process consist of briquette and pellet. The used of different molding shape and size indicates the application of the products provided by the densification process.

2.2 ENERGY CRISIS IN MALAYSIA

From the previous century, the world is really focusing on the utilization of fossil fuel sources to be the primary source of energy as in that particular time, the price of the source is still cheap as well as in abundance condition. In 1900s, the century has been announced as ‘Petroleum Century’ as this type of energy is widely used by the world. From year to year, the demand of the energy is increasing due to the development of each of the country as well as the spending power of the civilization.

This kind of phenomenon affects the expansion of economic throughout the industrialized world. The increase in automobile ownership is also contributing to the

demand of liquid transportation fuels. As a result, the production of energy from fossil fuel sources needs to be according to the world demand. In fact, the effects of widespread use of this kind of sources also contributing to the global environmental impact, which is the carbon emission produced by the combustion of the fossil fuel, green house effect, global warming, and also the emission of methane gas to the atmosphere. These negative impacts are finally being put into the international concern as the huge impacts of the uses of fossil fuel sources. Besides that, the supply of this kind of sources is unstable due to the availability of the sources which is depleted as a result of increasing demand of this type of energy.

Furthermore, the increasing price of the crude oil also contributing the global to find a new alternative in finding a new sources of energy that is renewable and sustainable in order to provide a sufficient demand of energy as well as to preserve the natural environment to ensure a better lifestyle for future generation.

2.3 RENEWABLE ENERGY

In order to reduce the dependency towards the fossil fuel sources, the use of renewable energy is encourage by each of the country of all over the world. Generally, there are several types of renewable energy that have been founded, namely, solar energy, hydropower energy, geothermal energy, oceanic energy, wind energy and bioenergy. The use of this type of energy making the utilization of the energy to be more environmental friendly due to the way of producing energy is cleaner and using natural sources of energy.

Solar energy is related to the Photovoltaic (PV) array, and solar thermal process. For the PV array, it is a process of converting the sun radiation to electrical energy by undergoing some process conducted inside the panel. Scientifically, the energy carried by the sunlight will be captured by the cell inside the PV array. This cell is then converting the sunlight energy into electric current. This cell not having the ability of storing the energy. That is why the solar system needs to use battery in order to store the energy.

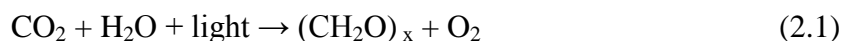
For hydropower energy, the basic principle of the system is by turning the impeller of the turbine. By this process, the impeller that is connected to the alternator will eventually producing electric current as the alternator will convert the rotation of itself to electric current.

Compared to geothermal energy, this kind of energy is dealing with how water that comes out from the underground. This hot water having a high temperature. When the hot water flows upward, the pressure of the hot water is decreasing and some of them becoming steam. The steam is then transported to the generator of turbine in order to generate electricity. After the process, the condensed steam is then transported back to the reservoir, that is where it is comes out.

Oceanic energy is the system that uses the principle of pressure difference to produce electricity. The term specified for this process is Ocean Thermal Energy Conversion (OTEC). For this system, the higher temperature of water is collected from the upper surface of the ocean. This water needs to be pumped into the boiler as to transfer the heat to the working fluid inside the boiler. To be noted that the working fluid used need to have a low boiling point characterization such as propane, or ammonia. When the heat is transferred by the warm water to the working fluid, this fluid will convert into vapor and it expands through the turbine coupled with a generator. From here, electrical power is produced. In order to make sure that this working fluid returns back to liquid phase, the cold water from the bottom of the ocean is pumped to the condenser as to absorb heat from the working fluid.

Wind turbine having a simple basic of principle on the process of producing electrical power. Hydropower energy and wind energy are having a similar principle of producing electricity but the difference of these two systems is the natural sources used. For wind energy, the used of wind speed is sued in order to turn the impeller of the generator. By this way, the impeller that is coupled to the alternator is then converting the kinetic energy into electrical energy.

Bioenergy is a term referring to indirect solar energy. To be more specific, it is called stored solar energy. The term is always related to plants and organic matter. During photosynthesis process, plants capture solar radiation as fixed carbon and converts CO_2 and water to sugar, (CH_2O) .



Produced sugars are store in three different polymers which are cellulose, hemicelluloses and starch. Normally, biomass composed of 65-85 wt% sugar polymers principally hemicelluloses and cellulose, and other 10-25wt% is lignin. The energy can be converted into another type of energy by conducting several type of process, which is thermochemical, biochemical, and mechanical process. Based on the stated processes, the biomass can be converted into several types of products depending on the application.

2.4 BIOMASS

Differ from coal, natural gas and oil, biomass having a great availability due to the abundance of organic waste, such as wood, rice husk, empty fruit bunches (EFB), coconut shell, and many more. Generally, the biomass utilization is becoming widespread as it is a new alternative method of reducing the dependency towards charcoal as a fuel for combustion process. Basically, the composition that needs to be contained by the biomass is a hydrocarbon compound. This is due to the characteristics of hydrocarbon compound that is flammable.

The other type of renewable energy such as solar energy, wind energy, hydropower energy and geothermal energy contribute to a small fraction towards the global energy use. The most reliable source of energy is biomass. To be noted that the biomass contribute about 12% of total energy requirement for global needs. However, biomass contributes about 36% of energy demand for developing countries (Smith 1987 and De Coninth, 1985).

Besides that, the emission from the combustion process of biomass to power generation is better compared to the use of fossil fuel as the fuel for combustion. Based on estimation, it is indicates that if the biomass is taken into account to be used, the carbon dioxide emission can be potentially being reduced about 50 million tons by the year 2010 (Sharma, 1999). To be noted that this situation can be achieved if the biomass