POSSIBILITY OF BIOMASS ENERGY USAGE AT PALM OIL PROCESSING PLANT

SHAHRUL NIZAM BIBID

Universiti Malaysia Sarawak
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POSSIBILITY OF BIOMASS ENERGY USAGE AT PALM OIL PROCESSING PLANT

SHAHRUL NIZAM BIBID

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Alamat Tetap: Jln. Sri Jaya, Pt. Baru,
45100 Sabak Bernam,
Selangor Darul Ehsan.

Nama Penyelia: Nazeri Abdul Rahman

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Nazeri Abdul Rahman
(Supervisor)

25 Mac 2000
Date

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DEDICATION

Bibid Busra

Misskiah Shaari

Sabarita & Noor Azmi

Mohd Hafizudin

Aidayati & Mohd Sham

Nor Amirah Syafikah

Nor Aina Izzati

Azurawati

Norhayati

and

Zaihasra Abu Talib

ABSTRACT

Biomass is a plant materials and animal wastes. Plant materials are such as branches, dried leaf, fibers and others. Biomass energy is an energy, which obtained from or produced by plant materials and animas wastes. In general, the method to obtain heat energy from biomass energy is by direct combustion. In Kilang Sawit Sampadi, oil palm fruit wastes consists of fibers and shells is used as boiler fuel feed. However from researcher observations, boiler fuel feed was not efficient due to unknown optimum amount fuel utilization. The relationship between amount of fuel used with percentage of fibers and shells was also unknown. Therefore, this study tried to solve the two problems above by imposing two methods, which was through experimental and analysis. Experiment was used to determine calorific value for fibers, shells or by mixing both. Analysis was used to ensure that calorific value which obtained from experiment was reliable. There have five factors affected calorific value during experiments, which are wind from surrounding, excess air, content of samples, combustion initiating character and amount of samples. Calorific value was decreased as increased of percent of samples. The relationship for calorific value to fuel feed is inversely proportional.

ABSTRAK

Biojisim adalah terdiri daripada bahan buangan haiwan dan bahan buangan tumbuh-tumbuhan. Bahan buangan haiwan terdiri daripada najis, manakala bahan buangan tumbuhan terdiri daripada ranting-ranting, daun-daun kering, sabut dan juga sebagainya. Tenaga biojisim pula adalah tenaga yang diperolehi atau dihasilkan oleh bahan-bahan tersebut. Secara umum kaedah yang digunakan untuk mendapatkan tenaga haba daripada tenaga biojisim ini adalah melalui proses pembakaran terus. Di Kilang Sawit Sampadi, bahan buangan daripada buah kelapa sawit iaitu sabut dan tempurung telah digunakan sebagai bahanapi dandang. Akan tetapi daripada pemerhatian pengkaji, bahanapi untuk dandang tersebut tidak effisyen kerana tidak diketahui jumlah penggunaannya yang optima. Selain itu, perkaitan antara jumlah bahanapi dengan peratusan antara sabut dan tempurung juga tidak diketahui. Oleh yang demikian, kajian ini cuba untuk menyelesaikan dua persoalan di atas melalui ekperimen dan penganalisaan. Ekperimen telah digunakan untuk mencari kandungan haba yang dihasilkan oleh sabut dan tempurung serta campuran kedua-duanya. Penganalisaan telah digunakan untuk menentukan haba yang dihasilkan itu sesuai. Terdapat lima faktor yang mempengaruhi nilai kandungan haba semasa ekperimen iaitu angin dari persekitaran, pengudaraan, kandungan sample, sifat bahan pemula pembakaran dan jumlah sampel. Nilai kandungan haba semakin berkurangan dengan bertambahnya peratusan kandungan tempurung dalam sampel. Perkaitan antara nilai kandungan haba dan bahan api dandang ialah berkadar songsang.

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NOMENCLATURES

A_1	Area of circle
A_2	Area of sphere
Cv	Calorific value (kJ/kg)
Cv_{total}	Total calorific value (kJ/kg)
c_g	Specific heat capacity of glass (0.2 cal/g.°C)
c_w	Specific heat capacity of water (1.0 cal/g.°C)
h_{fw}	Heat content of feed water (kJ/kg) or,
	Saturated liquid, h_f
h_s	Heat content of steam (kJ/kg) or,
	Saturated vapor, h_g
m_g	Mass of glass (g)
m_s	Mass of sample (g)
m_w	Mass of water (g)
Q_1	Heat to heat up water and glass (kJ/kg)
Q_2	Heat release by sample (kJ/kg)
R_f	Fuel flow rate (kg/h)
R_s	Steam flow rate (kg/h)
X_{avg}	Average of X

GREEK LETTER

ΔT	Temperature increase (°C)
η_B	Boiler efficiency
π	pi, to determine are of circle and sphere
σ	Standard deviation
Σ	Summation of all values

CHAPTER 1

INTRODUCTION

1.1 The Oil Palm

The oil palm is a monoecious plant (male and female flower in one plant). Normally, female flower will produce fruits and it is known as fresh fruit bunches (FFB), see **Figure 1.1**. Each of oil palm trees is able to produce from 10 to 12 bunches per year and contains about 1000 to 3000 number of fruits per bunch. The average weight of each bunch can reach from 20kg to 30kg and the life of oil palm tree is around 20 to 30 years [Union, 1999].

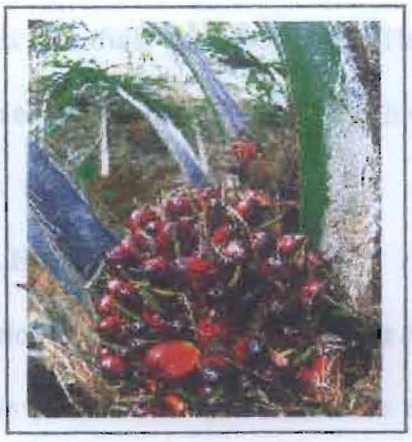

Figure 1.1 Fresh Fruit Bunch (FFB) [Union, 1999]

The crude palm oil (CPO) is obtained from the mesocarp (the fruit wall or fiber) and depending on the variety and age of the oil palm tree. Only about 25 to 28 percent of oil produced per bunch. The oil can also be obtained from the kernel (endosperm) known as palm kernel oil.

The location of palm oil mills is usually closed to the plantation. This is because fresh fruit bunch (FFB) must be processed quickly after harvesting in order to obtain high quality oil.

The palm oil is very versatile and processes many uses such as for cooking oil, the production of Vitamin E and Vitamin A, and for commercial scale it is possible to use oil palm trunks for furniture. It is also available in a variety of forms such as crude palm oil. In Malaysia, crude palm oil (CPO) processed into various products to meet the user requirement.

By utilizing the oil palm product, recycling of waste and effluent it prove that all of oil palms sources are fully can be used. Therefore, it friendly to our environment and improve economical aspects of the palm oil industry.

1.2 Introduction to Biomass Energy

In 1970s, the energy problem occurred due to high cost of coal and oil prices [Bansal al, 1990]. Therefore, it is preferred to use alternative energy as new sources. The alternative energy should be able to change, support and supply the existing energy today. Thus, it is necessary to have some other sources based on renewable energy sources. The renewable energy sources can be found from solar, biomass, wind, tidal, wave, geothermal and ocean thermal energy sources. The research and development

of renewable energy are very important activities in order to develop and increase the future energy supply. The main interest in renewable energy sources is due to limitation of energy and increased prices of existing energy sources.

Biomass is referring to plant materials and animal wastes that can be used for energy. In common way, biomass energy can be obtained through direct combustion to produce heat, steam and electricity. Biomass function as natural storage to store the solar energy; because chlorophyll in plants gets the sun energy to generate photosynthesis process by converting carbon dioxide from the air and water from the ground into carbohydrates to form complex compounds that contains of carbon, hydrogen and oxygen. When carbohydrates are burned, then it turns back into carbon dioxide and water and ultimately released the sun's energy.

Biomass containing low-density fuel caused of moisture by heating from the sun. Biomass can supplied energy in the fraction only 20% of coal and oil sources [Wrixon et. al, 1993]. Moreover, the biomass created problems regarding to collection, transportation and storage. Wet biomass is usually attack by insects and decay by microbial process. This situation can reduce the heat value from biomass sources. Usually, biomass is a major energy source in the rural areas, which depend mostly on agricultural and forestry production and processing activities.

Traditionally, the energy from biomass is used to produce heat for cooking and space heating. In developing countries, biomass are used in the form of wood, crop residues and animal wastes. In advanced situation, the biomass sources are used for commercial and industrial heat processes, whether in processing of agricultural

product or forestry products. However, the traditional biomass energy systems sources suffer due to reduction of biomass capacity and growing of populations.

There are two approaches to obtain the sources of energy from biomass; growing plants for energy usage and used the plant residues from agriculture/ industry. The main advantage of using biomass energy sources are due to low sulfur, where sulfur could caused air pollution, and it produce small amount of ash and continuously renewable.

1.3 The Biomass Energy Sources

The biomass energy sources can be obtained from plant residues or animal wastes. Usually, after the plants been processed for other purposes, its residues can be used to obtain the energy. In large scale, the forestry, agricultural, plantation and industry can produce plant residues and animal wastes in large quantities. In the city, city wastes such as garbage and sewage could also be used as biomass energy sources.

From the forest, forestry wastes such as lumber and pulp from paper mills can be used to produce heat and electricity to generate power in the factories. After timber harvesting operations, treetops and branches are left behind. Instead, they can be used as a source of biomass energy. Other sources of wood waste are sawdust and bark from sawmills.

In the agriculture, most crop residues are left in the field. Some of them should be left in the field to maintain and recycle the field nutrients and some could be used for fuel. In the animal farms, animals produce a lot of wet waste that can be either for fertilizer or disposal. For dry waste, it can be burned to obtain heat energy.

In the plantation such as oil palm plantation, most of fiber and shell can be reused for the heat energy. In the palm oil mills, fiber and shell used as fuel to generate the boiler operation. For empty bunches and ash, it can be used as fertilizer.

In the city, people generate biomass waste in many forms such as leftover construction wood, the biomass portion of garbage such as paper, food and leather, and the gas when biomass waste decomposes. In the some sewage treatment plants, it methane can be captured and burned it to obtain heat and power.

1.4 Converting Biomass to Energy

All biomass need to be processed in order to produce the primary energy sources that are ultimately converted into final energy [Wrixon, 1993]. The biomass source needs specific processing or conversion technology to obtain the final energy form. This final energy form can be used for any suitable processes.

The old way of converting biomass to energy, practiced for thousands of year is simply to burn it to produce heat [Union, 1999]. The simple, cheapest and most common method of obtaining from biomass is direct combustion [Baird, 1999]. Usually, heat energy can be obtained from direct combustion for heating, cooking and industrial processes directly. It also can be used indirectly when use heat energy through steam turbine to produce electricity.

In non-combustion methods for converting biomass to energy, there is one thing in common, which converting raw biomass into a variety of gaseous, liquid or solid fuels before it can be used [Union, 1999]. Commonly, this conversion can be done in three ways:

a. Thermochemical

Thermochemical conversion process usually involved either temperature related oxidation (slow conventional or flash, pyrolysis, liquefaction, gasification) or purely chemical reactions (esterification) [Wrixon, 1993]. During this process, it will release various products such as gases, liquid and solids. These products can be processed into fuel such as methane and alcohol. If this methane from biomass gases is burned, it can be utilized to produce electricity by using gas turbine. For another approach, when these fuels burn into fuel cells, shown in **Figure 1.2,** it converts heat energy into electricity. When the fuel is burned in the cell, it will release some amount of heat and heating the boiler. Steam from boiler can be used to generate steam turbine to produce electricity.

b. Biochemical

Bacteria, yeasts and enzymes are the main agents in this conversion. These agents break down carbohydrates, which is main part of plant materials. The process changing the biomass liquid into alcohol is called fermentation. The fermentation is also used to produce grain alcohol or ethanol from corn. Ethanol can be mixed with gasoline to produce gasohol. Generally, when the bacteria break down biomass, it will produce methane and carbon dioxide.

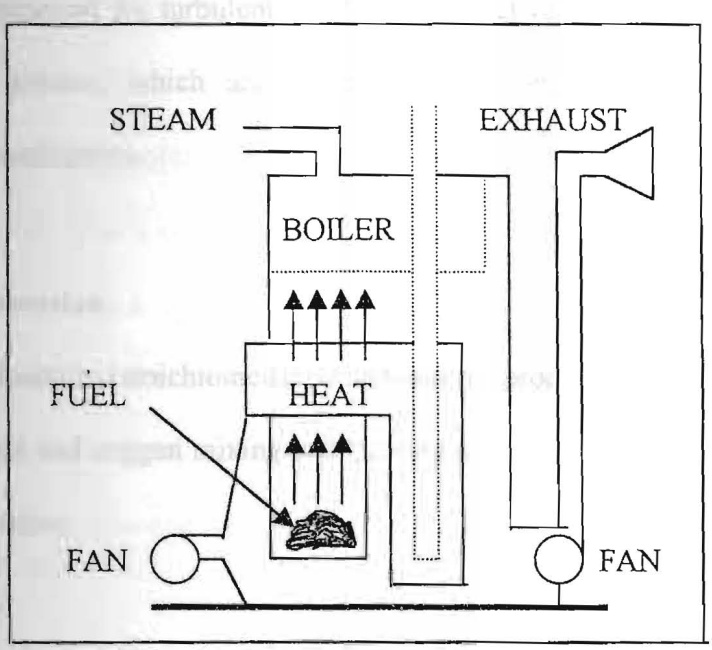

Figure 1.2 Basic Fuel Cell of Bioconversion [Cheremisinoff, 1980]

c. Chemical

Soybean, canola oil and palm oil can be converted into fuel such as diesel and gasoline. Used cooking oil from restaurant, can be used as source to make biodiesel for trucks.

1.5 Combustion Process

Combustion is a process of rapid combination of oxygen (O_2) with certain amount of fuel to release of heat and carbon dioxide (CO_2) and water (H_2O) at the end of the process. The combustion can also produce of heat by rapid oxygenation fuel process [Sauselein, 1997]. During combustion process, there are three factors to be considered; time, temperature and turbulence. All combustion process take certain time to complete, must occur at high temperature and mixing process between fuel

and air is enhanced by turbulent condition respectively. There are three types of combustion process, which are perfect combustion, complete combustion and incomplete combustion.

a. Perfect Combustion

Perfect combustion (stoichiometric combustion) process is obtained when right amount of fuel and oxygen mixing and burning together and left carbon monoxide at the end of product.

b. Complete Combustion

Complete combustion process is obtained when excess oxygen is supplied during combustion process. Normally, the flame should be less than perfect combustion, short and clear. The existence of excess air is to reduce the optimum heat transfer.

c. Incomplete Combustion

Incomplete combustion process is obtained when not enough oxygen or excess fuel is supplied during combustion process. Normally, it will produce carbon dioxide, carbon monoxide, hydrogen, unburned hydrocarbons and free carbon. Usually the flame is smoky.

1.5.1 Combustion Analysis

Perfect combustion is the proper mixture of fuel and air under control conditions where both the oxygen and the fuel are completely consumed in the combustion