PHYSICAL AND COMBUSTION PROPERTIES OF TORREFIED EMPTY FRUIT BUNCH AFTER DENSIFICATION

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Specially dedicated to my parents Zulkiflee Bin Daud and Zaleha Binti Ismail, my dear siblings, my supportive supervisor, Dr. Mohd Faizal Bin Hasan and my lovely friends.

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ABSTRACT

Increasing demand of energy, depletion of the fossil fuel reserves and increasing in air pollution have increased interest in biomass especially on palm biomass as a renewable energy sources. However, untreated palm biomass which is empty fruit bunches, EFB has a couple shortcomings such as high moisture content, low calorific value and energy density that cause difficulty and high cost in storage and transportation. Therefore, it is important to perform torrefaction and densification on EFB before it is used as renewable energy sources. In this project, EFB biomass was torrefied at fixed conditions and then they were densified under various heating temperature. The physical and combustion characteristics of the torrefied EFB briquettes have been discussed. It is found that the briquetting temperature does not affect density, calorific value and fixed carbon content significantly. These all characteristics most influence to the torrefaction temperature. However, during briquetting temperature the compressive strength of the torrefied briquettes increases. The performance of torrefied EFB briquettes fulfils requirement as stated by standard DIN 51731 in terms of calorific value and moisture content.

ABSTRAK

Peningkatan permintaan kepada sumber tenaga, pengurangan simpanan bahan api fosil dan peningkatan dalam pencemaran alam sekitar telah meningkatkan minat dalam pengunaan tenaga biomas terutamanya tenaga biomas kelapa sawit sebagai sumber tenaga boleh diperbaharui. Walau bagaimanapun, biomas kelapa sawit yang tidak dirawat seperti tandan buah kosong, TKS mempunyai beberapa kelemahan seperti kandungan kelembapan yang tinggi, nilai kalori yang rendah dan ketumpatan tenaga yang menyebabkan kesukaran dan kos yang tinggi dalam penyimpanan dan pengangkutan. Oleh itu, adalah penting untuk melaksanakan 'torrefaction' dan pemadatan pada TKS sebelum ia digunakan sebagai sumber tenaga boleh diperbaharui. Dalam projek ini, TKS biomass telah di 'torrefied' pada situasi malar dan kemudian di 'densified' di bawah pelbagai suhu pemanasan. Ciri-ciri fizikal dan pembakaran 'torrefied' briket TKS telah dibincangkan. Ia didapati bahawa suhu 'briquetting' tidak menjejaskan ketumpatan, nilai kalori dan kandungan karbon tetap dengan ketara. Semua ciri-ciri ini lebih terpengaruh kepada suhu 'torrefaction'. Walau bagaimanapun, semasa suhu briquetting kekuatan mampatan 'torrefied' briket bertambah. Prestasi 'torrefied' briket EFB memenuhi syarat seperti yang dinyatakan oleh piawai DIN 51731 dari segi nilai kalori dan kandungan kelembapan.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Energy is an essential part in life, survival, and improvement of humanity. Despite the fact that is has been superseded by other more intense fossil energy sources amid the most recent 200 years, biomass has assumed a noteworthy part in supplying energy.

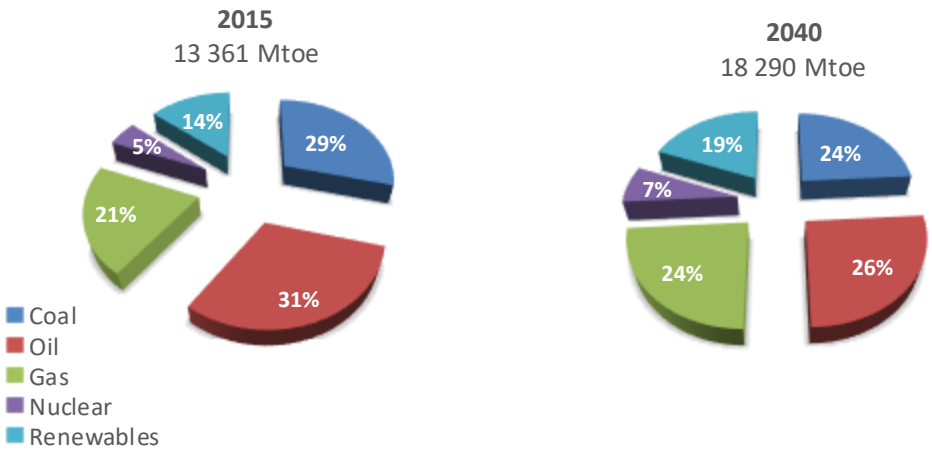
Malaysian palm oil industry produces high amount of biomass especially from oil milling sector. Malaysian oil palm industry continues to expand to fulfill the demand of rapid market growth. In general for 1 ton of fresh fruit bunch processed, the following residues are generated which 0.23 ton of Empty Fruit Bunch (EFB), 0.13 ton of mesocarp fibre, 0.06 ton of palm shell and 0.65 ton of Palm Oil Mill Effluent (POME) (Prabir Basu, 2008).

The upgrading techniques of biomass have been generally studied to upgrade its undesirable properties. The torrefaction of raw biomass is an updating technique that is a thermochemical treatment with working temperature within the range of 200 to 300℃. Torrefaction is one of the pretreatment for biomass. It involves heat treatment at a certain temperature of range for a specific period of time. This process would result in a lower moisture content, increased calorific value and ease to grind. Densification is additionally another pre-treatment technique intended to improve the physical characteristic of biomass such as density. Densification process is a process to compress the raw material to form densified biomass by rolling it through a die (Prabir Basu, 2008).

1.2 Problem Statement

To cope the increasing demand of energy because of economic activities, increment in level of population and development of advanced energy technologies, it has become very important to seek alternative energy sources. It can be said from medium variant projection, world population is anticipated to grow by 0.9% per year on average because of increase in fertility rates. Definitely this will increase interest for goods and service.

That is why demand for the energy is needed, to produce and operate equipment used to provide those services. Figure 1 shows that renewable energy demand grows faster than other sources of energy from 14% to 19% in the future demand. In addition to depletion of fossil fuels and increase in air pollution have increased the interest in renewable energy sources such as wind, sunlight based, geothermal, wave, sea thermal and biomass. Among that, biomass is the without a doubt as one of the energy sources.



(Figure 1): World primary energy demand in the New Policies Scenario (World energy outlook 2015)

To utilize biomass as an energy source, there are many various transformation strategies such as torrefaction, pyrolysis, direct combustion and gasification. In any case, an untreated biomass has a couple of shortcomings that must be overcome before it can be

converted into useful energy source. These include its high moisture content and low energy density that can impact the burning properties such as calorific value (Ahmad et al., 2011).

These incorporate its low vitality thickness, high dampness substance and trouble to pound into little particles. The low vitality thickness and high dampness substance of biomass can impact the burning properties, for example, calorific quality (Ahmad et al., 2011).

These disadvantages likewise make the cost of transporting the biomass becomes high. In order to increase the efficiency and to reduce the costs of storage and transportation, biomass can be treated via heating in an inert temperature, a process that is known as torrefaction. To increase the energy density, torrefied biomass can be compress into pellet or briquettes and this is known as densification process.

1.3 Objective of Project

The main objective of this experiment is to understand the physical and combustion properties of torrefied palm biomass after densification.

1.4 Scope of Project

The scopes that have been determined for the study are:

1. Empty fruit bunch (EFB) will be used as raw material.
2. Physical (Density compressive strength) and combustion (calorific value, proximate analysis) characteristics will be investigated.
3. The parameter varied is briquetting temperature.

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