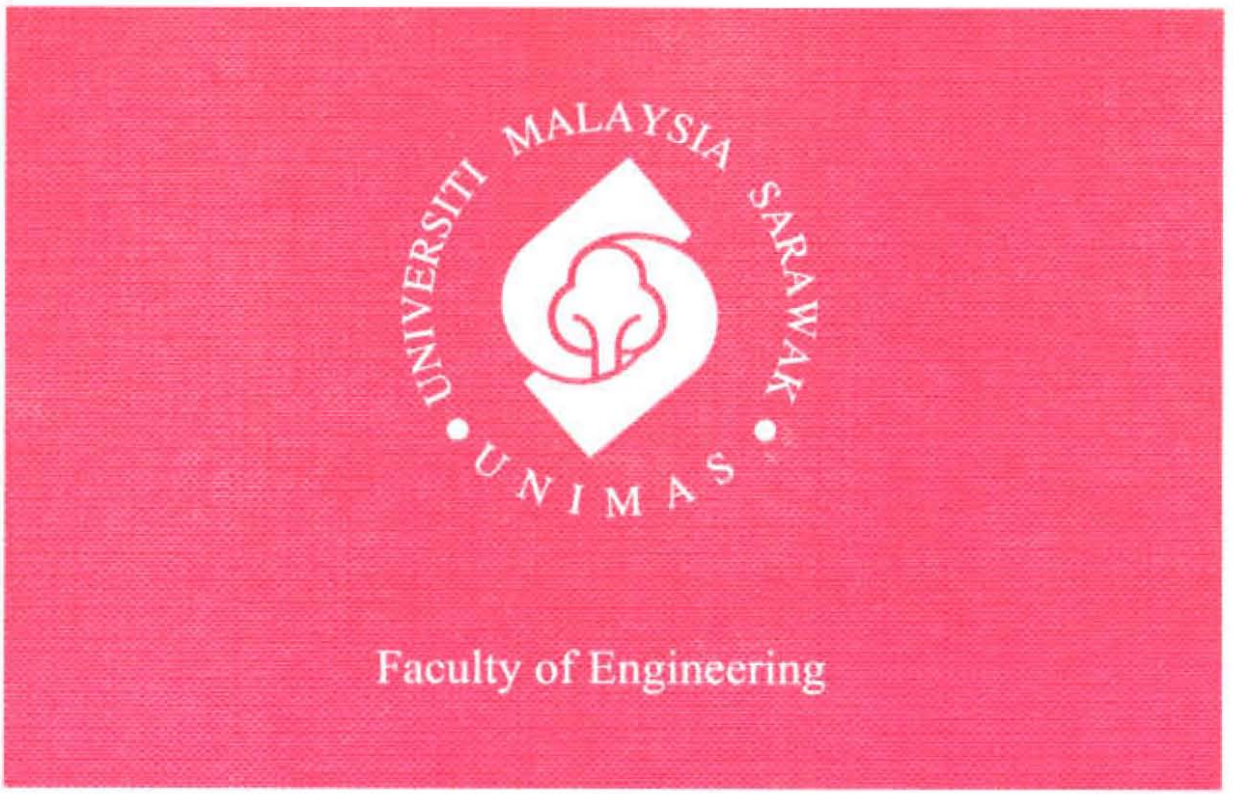

IMPROVEMENT OF PELLETIZED EMPTY FRUIT BUNCH (EFB) OF PALM OIL AND RICE HUSK BY USING TORREFACTION AND PRE-TREATMENT METHOD

Dayang Nur Farah Zurina bt Awg Salleh

Bachelor of Engineering with Honours
(Mechanical and Manufacturing Engineering)
2017

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IMPROVEMENT OF PELLETIZED EMPTY FRUIT BUNCH (EFB) OF PALM OIL AND RICE HUSK BY USING TORREFACTION AND PRE-TREATMENT METHOD

DAYANG NUR FARAH ZURINA BT AWG SALLEH

A dissertation submitted in partial fulfillment

of the requirement for the degree of

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Faculty of Engineering

Universiti Malaysia Sarawak

2017

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To my beloved family and friend

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ABSTRACT

Biomass is well known as an energy source that had been used for a decade ago and had potential to replace the coal as an energy resource. Biomass had been used to develop country such as Europe and China. Malaysia has a largest biomass resource because the agricultures activities and some area still in natural forest. Most of the biomass were used in the form of pellet and a European country have been introduced a standard to produce a pellet. Biomass crop also has a higher moisture content and lower calorific value than coal. To increase the calorific value and lower the moisture content, torrefaction process had been introduced in this study to produce a better fuel quality. In this study, the material used was from herbaceous biomass because of the abundant resources compared to woody biomass. Malaysia produced a lot of waste from rice husk and empty fruit bunch of palm oil because Malaysia is the second top producer of palm oil. Herbaceous biomass had a larger ash content than woody biomass and this can lead to slagging and fouling in boilers. To decrease the ash content a study to reduce the ash content had been conducted. Therefore the purposed of this study is to study the effect of torrefaction and pre-treatment method towards both materials.

Keywords: Biomass, pellets, torrefaction, pretreatment, rice husk, biomass

ABSTRAK

Biojisim terkenal sebagai sumber tenaga yang telah digunakan beberapa dekad yang lalu dan mempunyai potensi untuk menggantikan arang batu sebagai sumber tenaga. Biojisim telah digunakan oleh negara yang membangun seperti Eropah dan China. Malaysia mempunyai sumber biojisim terbesar kerana aktiviti industri pertanian dan beberapa kawasan masih hutan semula jadi. Sebahagian besar daripada biojisim digunakan dalam bentuk pelet dan Eropah telah memperkenalkan piawaian untuk menghasilkan pelet yang berkualiti. Biojisims juga mempunyai kandungan lembapan yang lebih tinggi dan nilai kalori yang lebih rendah daripada arang batu. Untuk meningkatkan nilai kalori dan mengurangkan kandungan kelembapan, proses 'torrefaction' telah diperkenalkan dalam kajian ini untuk menghasilkan bahan api yang lebih berkualiti. Dalam kajian ini, bahan yang digunakan adalah daripada biojisim herba kerana sumber yang banyak berbanding biojisim berkayu. Malaysia menghasilkan banyak sisa daripada sekam padi dan tandan buah kosong daripada kelapa sawit kerana Malaysia adalah pengeluar kedua utama minyak sawit. Biojisim herba menpunyai kandungan abu yang lebih besar daripada biojisim berkayu dan menyebabkan kepada slagging dan fouling dalam dandang. Untuk mengurangkan kandungan abu dalam biojisim herba, kajian untuk mengurangkan kandungan abu telah dijalankan. Oleh itu, kajian ini adalah untuk mengkaji kesan 'torrefaction' and pra-rawatan keatas kedua-dua bahan.

Kata kunci: Biomass, pelet, torrefaction, rawatan awal, sekam padi, biomass

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LIST OF SYMBOLS

%	-	percent
wt%	-	Weight percent
ha	-	hectares
kg	-	kilogram
kWh	-	Kilowatt hour
kcal/kg	-	Kilocalorie per kilogram
kg	-	kilogram
g	-	gram
°C	-	Degree Celsius
≥	-	bigger than
ml	-	milliliter
h	-	hours
mm	-	millimeter

LIST OF ABBREVIATIONS

Ca	-	Calcium
Mg	-	Magnesium
Na	-	Sodium
K	-	Potassium
P	-	Phosphorus
EN	-	European Standard
NaOH	-	Sodium hydroxide

CHAPTER 1

INTRODUCTION

1.0. Introduction

Energy is one of the main important source to the society. Almost everything in this world, depending on energy such as home appliance, lighting, transportation, heating/cooling, communication, and industrial process. About 92 % of energy comes from non-renewable sources such as natural gas, petroleum, coal and nuclear. Due to high energy consumption and limitation of energy supply make the energy cost increase so other sources have to develop to cover this current situation.

Wind, solar, geothermal, ocean, hydropower, and biomass are the example of renewable energy source. Biomass had become the main energy for many developing countries. It has been introduced to western country for a century and become their main source to generate heat. Biomass become an important energy to the world because it can help to reduce the amount of fossil fuel needed and it is always available sources.

Malaysia is the example of a developing country and has a huge biomass feedstock. Malaysia has potential to provide fossil and renewable energy because of their tropical and humid climate. Department of Statistic Malaysia have stated that the planted area for cocoa, oil palm, paddy and rubber in 2014 has increases compared to 2013. Due to high amount of

usage, the amount of residue also increases. Residue or agriculture residue is an example of biomass, which can produce energy and it's a valuable resource.

1.1. Problem statement

Agriculture biomass are significantly higher in ash. Major agriculture biomass in Malaysia comprise of rubber (39.67%), oil palm (34.56%), rice (12.68%), cocoa (6.75%) and coconut (6.34%) (Zafar, 2015). From the total amount of residues generated, only 27% is reused as fuel and the rest is disposed by burning (Zafar, 2015).This project will look into the potential of oil palm (empty fruit bunch) and rice husk by products.

Previous study by Karmakar et al., (2013) states that rice husk have 21.68% of ash content. Meanwhile a study from Madhiyanon et al., (2012), states that EFB had 5.5 wt% of ash content. High ash remained after combustion will contribute to slagging and fouling. It also will affect the calorific value of the product because heat will lose through the discharge of ash and slag. Ash also will affect the wall or the surface of the furnaces due to corrosion or erosion. A good quality of pellet should have a very low ash content below 0.7%.

Therefore, many studies have been done to minimize the amount of ash content of biomass material. Previous study by Bazargan et al., (2015), state that using a treatment of sodium hydroxide can minimize the amount of ash content in the rice husk. A study by, Abdullah et al., (2013) state that water washing pre-treatment help to minimize the ash content inside the empty fruit bunch of palm oil. Therefore, pre-treatment using sodium hydroxide and water washing pre-treatment will be conducted to reduce the ash content.

1.2. Objective

The objective for this study is to study the effect of torrefaction towards the properties of pellet made by EFB and rice husk. The second objective is to analyze the properties of pre-treatment EFB pellet and rice husk pellet. Third objective is to compare the effect of different treatment to the properties of EFB pellet and rice husk pellet.

1.3. Project outlines

Project outline summarizes of all chapters in this study. It consist of introduction, literature review, methodology, result, discussion, conclusion and recommendation.

In chapter 1, it is more to the introduction and the purpose of this study. It also include problem statement and objective of this study. For chapter 2 is the literature review, which explain more on biomass and its properties, raw material that used in this study, type of standard pellet and its benefit and the purpose of torrefaction process.

Chapter 3 is for methodology. This will include all the method that was used in this study and the testing given for this study. The testing that will be done in this study are calorific value, moisture content, ash removal, surface of material using Scanning Electron Microscope testing and Thermo gravimetric analysis testing.

1.4. Research gap

In this study, rice husk and empty fruit bunch (EFB) had been used as the main material. Both of this material is categorized as herbaceous biomass and it has higher ash content compared to woody biomass. Many researchers had introduced pretreatment method to minimize the ash content, but the ash content still higher.

Gholizadeh Vayghan et al, (2013) state that silica content in the ash make the rice husk ash increases. He also observed that acid leaching leads to higher silica dioxide (SiO_2) content in yield ashes and decrease the amount of alkali contaminants such as (K_2O and Na_2O) which reduces the melting temperature of silicates in the ash. Some research using lime also have been studied. Velandia,et al, (2016) stated that the sample with lime and quick lime produce ettringite in low proportions, and the amorphous content did not increase significantly with time. Thus the fly ash did not perform better than high- loss of ignition ashes as expected.

Due to high content of ash, a research study using sodium hydroxide can help to minimize the amount of ash content. Bazargan, et al, (2015) stated that simple alkali treatment can remove the silica ash. The result shows nearly 80% of rice husk can be retained in solid phase while 90% of ash has removed.

For empty fruit bunch, a study by Abdullah, N. et al, (2013) stated that total ash was reduced in the EFB by various water washing pretreatments. It reduces from 24.9 to 70.3 % during treatment in water washing. It also stated that the longer the time for treatment, the larger the amount of ash removed. In order to decrease the amount of ash content, water washing pretreatment and sodium hydroxide pre-treatment will done to minimize ash content in EFB and rice husk.

CHAPTER 2

LITERATURE REVIEW

2.0. Introduction

Biomass is another renewable energy resource that develop from material either from plant or animals. Basically waste from plant is the famous source which people use to generate energy. The energy is generated from photosynthesis process because the plant absorb energy from the sun and the energy store will release heat during burning. Due to the limitation and expensive of non-renewable energy such as coal, biomass have been introduce to replace the coal and almost every country use biomass as energy source. Biomass can help to reduce greenhouse gas emissions. There are many type of fuel that develop from many kind of biomass classification.

Mostly biomass has been use in developing countries which need a lot of energy consumption for transfer heat and power generator and use in the rural area in the form of heat. Brazil, United State and India are the top countries use biomass as their sources. Brazil have 18 percent share in global industrial biomass follow by 16 percent for both United State and India and the rest taken by Nigeria, Canada, Thailand and Indonesia which have four percent share. Biomass can be used as fuel, gaseous or liquid biofuels which produce from different kind of waste such as agriculture, forestry, municipal waste and residues from crop. Figure 2.1 shows the uses of biomass and Figure 2.2 shows the statistic of bioenergy power generation and forecast by region. From the figure, the bioenergy used increases from time to time.

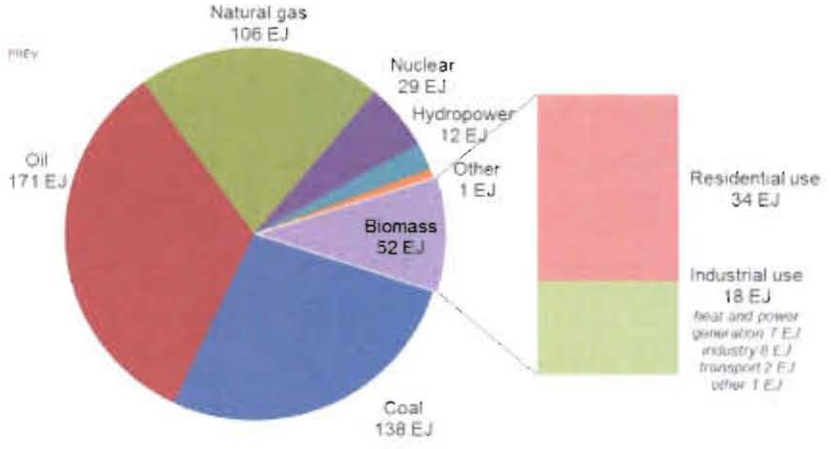

Figure 2.1: Uses of biomass (http://biomassmagazine.com/articles/9444/iea-task40-biomass-provides-10-percent-of-global-energy-use)

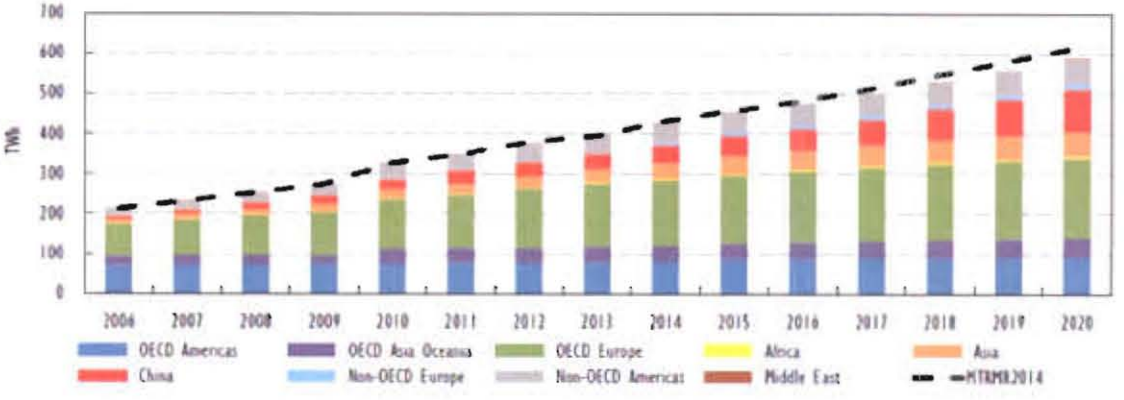

Figure 2.2: Statistical data of bioenergy power generation and forecast by region (https://www.iea.org/topics/renewables/subtopics/bioenergy/)