TEMPERATURE EFFECT ON CARBONIZATION OF WATER HYACINTH AS A SOLID BIOFUEL

MOHD ZUBIR BIN OTHMAN

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

MOHD ZUBIR OTHMAN BACHELOR OF MECHANICAL ENG. (PLANT & MAINTENANCE) (HONS) 2015 UTeM

SUPERVISOR DECLARATION

"I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of the degree of
Bachelor of Mechanical Engineering (Plant and Maintenance)"

Signature : .....
Supervisor : Dr Nona Merry Merpati Mitan
Date : 29 June 2015

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MOHD ZUBIR BIN OTHMAN

This thesis is partial fulfilment of the award of Bachelor of Mechanical Engineering (Plant and Maintenance) with Honurs

Faculty of Mechanical Engineering
Universiti Teknikal Malaysia, Melaka (UTeM)

JUNE 2015

DECLARATION

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

Signature : .....
Author : Mohd Zubir Bin Othman
Date : 29 June 2015

Dedication for Beloved,

Mom and Dad

ACKNOWLEDGEMENT

First of all, praise to the Almighty God that I was able to complete the final year projectwith successful and could be done properly. We would like to take this opportunity to thanks all organization or individuall who have helped me in finished my final year project Universiti Teknikal Malaysia Melaka (UteM). In addition, I would like to said thank you so much to my supervisor Dr. Nona Merry Merpati Mitan on her effort to supervise and cooperate in any phase of the project. All knowledge and guidance that has been provided is really appreciated. Alhamdulilah, Bachelor's degree project report finally reached at the end. I would like to said thank tou to my parent, my family who gives a full support on me all the time with love and care. Not forgetting my gratitude to the Universiti Teknikal Malaysia Melaka (UteM) and Jabatan Alam Sekitar Negeri Melaka for provided a comfortable atmosphere, data and equipment in the laboratary during the session and allows me to complete my project without any problems. Finally, I would like to give greatest thanks to my friend who have been supportive, understanding, motivation, patience and good cooperation in preparing this report.

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ABSTRACT

Water hyacinth is one of the pest plants that live on the surface of water, river and lake where it is able to remove the oxygen and nutrient in the water. Water hyacinth consists of 10 % of lignin, 25 % of cellulose and 35 % of hemicelluloses. Therefore, the components exist in water hyacinth have a potential to become a solid biofuel. Water hyacinth can be converted into high quality fuel by carbonization process. Carbonization is a treatment method for upgrading biomass feedstock into solid biofuels. The purpose of this research is to investigate the temperature effect of water hyacinth briquette which carbonized at temperature 300, 400, 500 and 600 ^{o}C at heating rate 5 °C per minutes for two hours. There are six steps involved to produce of water hyacinth as a briquette which are collecting of raw material, drying, crushing, milling, carbonization and densification. The briquette products produced have been passed through some analyses such as proximate analysis, calorific test, compressive test, and FTIR test so that the properties of briquette product can be determined. A comparison will be made between these types of briquettes in order to identify the optimum temperature of carbonization in producing highest quality briquette product in the future. The highest calorific value is C300 briquette with 4414 cal/g. The lowest percentage of moisture content and volatile matter is carbonization briquette with temperature 600 °C which is 3.00 and 20.33 % respectively while for ash and fixed carbon content, C600 briquette shows the highest percentage with 50.67 and 26.00 % respectively. The highest compressive value obtained was C300 briquette compared with other carbonization briquette. Based on the analysis, carbonization temperature at 300 °C are the optimum temperatures that can be applied on water hyacinth to become solid biofuel.

ABSTRAK

Keladi bunting adalah salah satu tumbuhan perosak yang hidup di permukaan air, sungai dan tasik di mana ia mampu untuk mengeluarkan oksigen dan nutrien dalam air. Keladi bunting terdiri daripada 10% daripada lignin, 25% daripada selulosa dan 35% daripada hemicelluloses. Oleh itu, komponen wujud dalam keladi bunting mempunyai potensi untuk menjadi biofuel yang kukuh. Keladi bunting boleh diprose menjadi bahan api yang berkualiti tinggi melalui proses karbonisasi. Karbonisasi adalah satu kaedah rawatan untuk meningkatkan bahan mentah biojisim pepejal ke dalam bahan bakar bio. Tujuan kajian ini adalah untuk mengkaji kesan suhu keladi bunting briket yang akan dikarbonisasi pada suhu 300, 400,500 dan 600 °C pada kadar 5°C perminit selama dua jam. Terdapat enam langkah dalam penyediaan keladi bunting sebagai briket iaitu pengumpulan bahan mentah, pengeringan, penghancuran, pengisaran, karbonisasi dan pemadatan. Produk briket terhasil melalui beberapa analisis seperti analisis proksimat, ujian kalori, ujian mampatan dan FTIR supaya sifat-sifat produk briket boleh ditentukan. Perbandingan akan dibuat di antara jenis briket untuk mengenal pasti suhu optimum karbonisasi dalam menghasilkan produk yang berkualiti tinggi briket pada masa akan datang. Nilai kalori paling tinggi ialah C300 briket dengan 4414 cal / g. Peratusan terendah kandungan kelembapan dan perkara yang tidak menentu adalah karbonisasi briket dengan suhu 600 ° C iaitu 3.00 dan 20.33% manakala bagi kandungan abu dan kandungan karbon tetap, C600 briket menunjukkan peratusan tertinggi dengan 50.67 dan 26.00%. Ujian mampatan untuk C300 briket menunjukkan nilai yang paling tinggi berbanding dengan karbonisasi briket lain. Berdasarkan analisis yang telah dilakukan, suhu karbonisasi 300 °C menunjukkan suhu yang paling optimum yang boleh dikenakan terhadap keladi bunting untuk menjadi biojisim pepejal.

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CHAPTER I

INTRODUCTION

1.1 BACKGROUND

The rising of oil prices and global warming is a major problem in this world. Therefore, the Government of Malaysia implemented various initiatives to expand environmentally practices and the application of green technology in an effort to preserve the country's ecosystem while ensuring the conducive environment for life. One of the government's initiatives is the sustainable development.

Renewable energy is one of the most efficient government initiatives to meet the sustainable development advocated by the government. Hence, the government of Malaysia has introduced a number of policies like National Green Technology Policies 2009 and Nation Renewable Energy 2010 where the aimed is to encourage the use of renewable energy. According to Asia Pacific Economic Cooperation (APEC) 2014which held at Beijing, a new goal was announced by President of United States which need to double renewable energy used by 2030 (Schroeder, 2014). There are many renewable energy sources such as biomass.

Biomass has recommended as an alternatives energy resources for fossil fuels in recent years due to green house effect from fossil fuel combustion. This effect contains carbon monoxide, nitrogen oxides, sulfur oxide and hydrocarbon. As we know, there are

many biomass resources that has in our country such as water hyacinth, cow manure, durian peel and others which has a potential for renewable energy.

1.2 PROBLEM STATEMENT

The consumption of fossil fuel is tremendously increasing and causing fossil fuel resources dwindling every year. By then, the world was introduced biomass as a source of sustainable energy to meet the needs in the future.

Water hyacinth in scientific name *Eichornia crassipes* is one of pest that live on the surface of the water, rivers and lakes. As the one of the most productive plants on earth, they can growth up in two times from its normal size in a few weeks then spread rapidly, where it is able to form mats on the water surface along a river or lake. In addition, the low oxygen condition below the surface of the water hyacinth will block the flow of water will affect the ecosystem in which to make a river or lake as a breeding ground for mosquitoes. Besides that, water hyacinth causes the loss of water and obstruction of boat traffic. Water hyacinth also can block the suction lines of irrigation and drainage pump where it can reduce the efficiency of pump and increase the cost of maintenance if the pump failure or defect (Ndimele et., 2011).

Based on Tejinder et al. (2012), the water hyacinth is rich in polyphenol oxidase where it can be easily combustible. In addition, the content of lignin in water hyacinth is low, while the cellulose and hemicelluloses is high (Rezania et al.,2015). Due to this content the water hyacinth have capability to become a biofuel. Therefore, the advantages that existance in water hyacinth should be utilized as well as to reduce the fossil fuel consumption and the global warming as well.

OBJECTIVES

The objective of this study as follows:

a) To produce briquette from water hyacinth.
b) To identify the effect of temperature on the calorific value of briquette.
c) To perform proximate analysis (moisture content, ash content, volatile matter and fixed carbon) and mechanical properties (compressive test) of briquette product.
d) To determine the functional group of water hyacinth by using Fourier Transform Infrared Spectroscopy (FTIR).

1.3 SCOPES

This project involves the preparation of water hyacinth as a raw material to produce briquette as a solid biofuel by drying, pulverization (crushing and milling), carbonization and densification process. The main focus of this project is to study the effect of temperature on carbonization of water hyacinth as a solid biofuel. Water hyacinth have been went through the carbonization process with different kind level of temperature. Besides that, the **proximate analysis** of water hyacinth briquette was performed to identify the percentage of moisture content, ash content, fixed carbon and volatile matter. It also covered the **calorific value test**, **FTIR test** and **compressive test** of water hyacinth briquette product.

CHAPTER II

LITERATURE REVIEW

2.0 Overview

The uses of fossil fuel are tremendously increasing and causing fossil fuel resources dwindling every year. Nasir et al. (2013) stated the recent production of fossil fuels like natural gas, coal, crude oil and natural gas plant liquid (NGPL) has increased up to 79 % than to another energy sources as shown in the figure below. Figure 2.1 shows the world primary energy production and consumption in November 2010. Based on the world primary energy, natural gas shows the highest consumption compared to other energy and this problem closely related to the increasing of the world's population every year.

The increasing of this number had made the world worrying because the emission of carbon from the fossil fuel combustion will cause the environmental issue like the depletion of ozon layer and the climate changes. Therefore, the renewable energy was introduced as an option which purposely to reduce the reliance on fossil fuels. Renewable energy is the energy that are constantly replenish and will never run out. There are many types of renewable energy such as solar energy, wind energy, bioenergy and ocean energy. Bioenergy is the energy that produce from orgarnic matter or known as biomass. Water hyacinth is one of the biomass sources that contains 35% of hemicellulose, 25 % cellulose and 10 % of lignin. The constituent of water hyacinth will be convert after going through a conversion process like thermochemical conversion and

biochemical conversion which have potential to become biofuel (Rezania et al., 2015). Therefore, this project will study about thermochemical conversion which are more focussing on the temperature effect during the carbonization process of water hyacinth to become solid biofuel

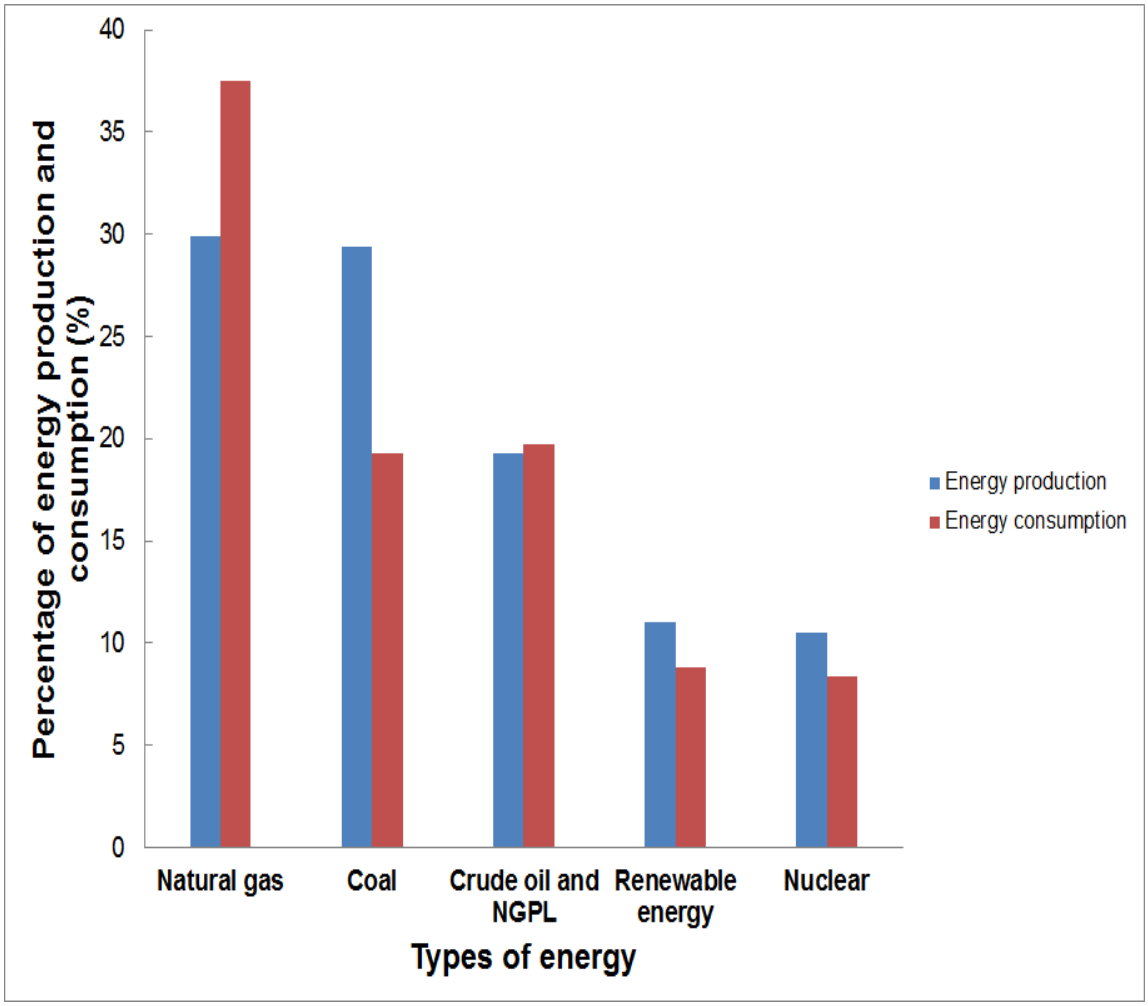

Figure 2.1 World primary energy production and consumption in November 2010 (Source: Nasir (2013))

2.1 Biomass

The use of fossil fuel as the primary energy production in the world today, is a threat to all mankind such as climate change and the greenhouse effect due the emission of

carbon from fossil fuel combustion. The increase of greenhouse gases (CO_2, CH_4, NO_x) can cause global warming which can lead to dangerous phenomenon such as tornadoes and unexpected flood (Ciubota-Rosie et al., 2008). Therefore, one of the solutions is by using the biomass as sustainable energy.

According to Demirbas (2009) biomass is refers to biodegradable organic material from living such as plants, animal which derived from biological sources. Agbor et al. (2014) in their study, stated biomass is a renewable energy sources where it is derived from organic matters which are friendly to environment (carbon neutral). The example of organic matter is agricultural crops, harvest residue, seaweed and organic waste. In addition, biomass is consisting of living organism or biological material from living (Piech, 2012).

Biomass resources can be categorized into four which is waste, forest product, energy crop and aquatic plant. The example of waste stock is mill wood waste, agricultural production waste and others. The forest product is like wood and trees that comes from forest clearings. The energy crops are like short-cycle crops such as wheat, sugarcane and other while aquatic plant likes algae and water hyacinth (Ciubota-Rosie et al., 2008).

Photosynthesis process is closely related to biomass. Photosynthesis is a process by which they convert solar energy into chemical energy to produce carbohydrates that form the basis formation of biomass and the carbon fixation by reduction of carbon dioxide (Demirbas, 2009). Figure 2.2 shows the biomass production technologies which involve of carbon cycle and photosynthesis. It is a cyclic process in which it is able to generate new biomass and continuous. The majority of photosynthetic will be utilized and directly towards the production of biomass growth. During the processing and consumption of biomass, the waste organic material will be generated, which can be used for energy production via thermochemical conversion or biochemical conversion.

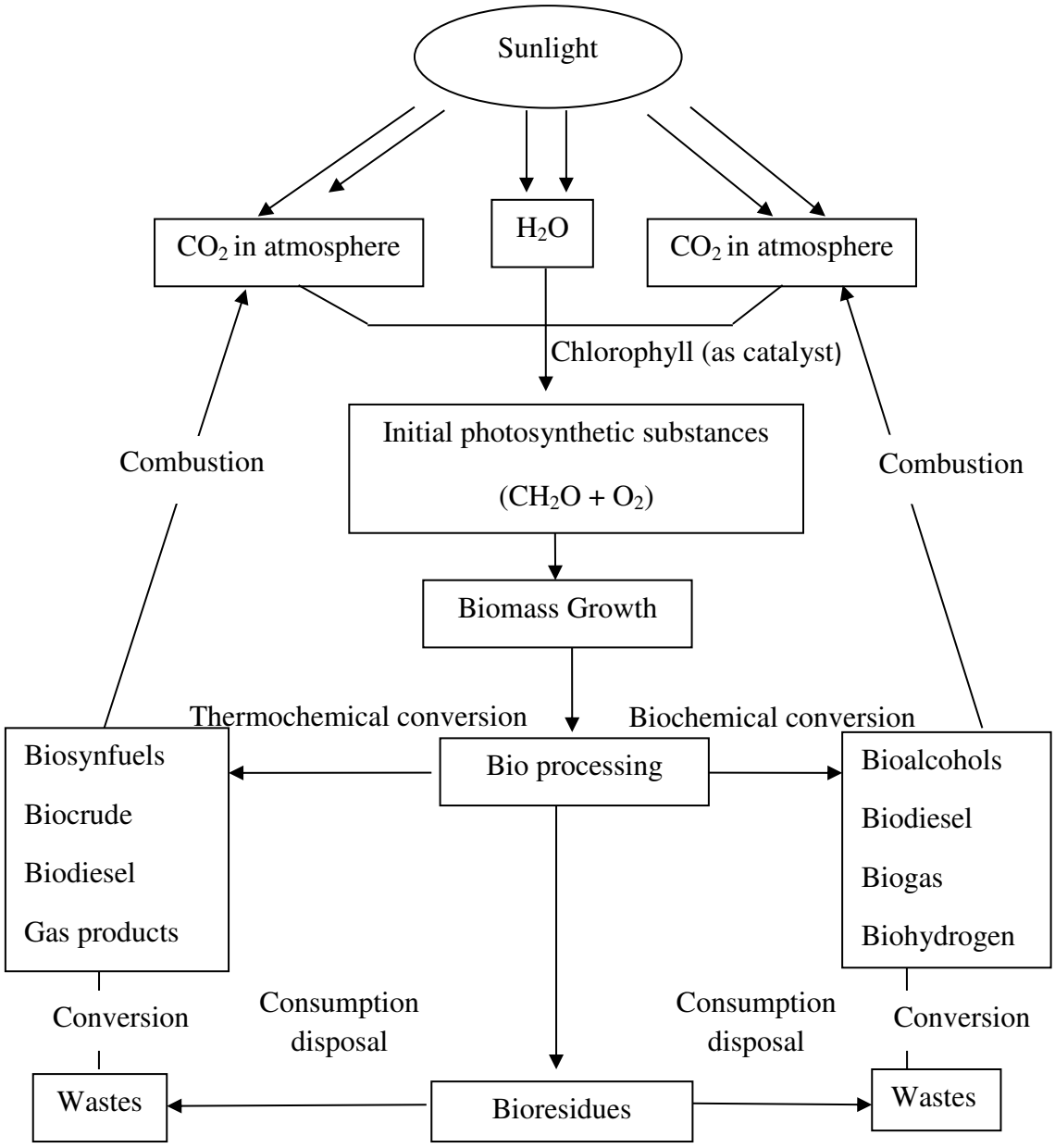

Figure 2.2 Carbon cycle, photosynthesis and biomass technologies

(Source: Demirbas, (2009))