CHAPTER 6

Influence of Torrefaction Pretreatment Temperature of Coconut Copra on Pyrolysis Product Yields

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6.1 INTRODUCTION

Malaysia's primary sources of energy in generation of power are the burning of fossil fuels such as natural gas, petroleum, and coal. However, the experts have estimated that the Malaysia's oil and gas reservoirs will be depleted approximately in the next 50 years. According to Shah Alam et al. (2013), the production of oil and gas emit greenhouse gases (GHG) through flaring and venting which primarily releases carbon dioxide (CO_2) and methane (CH_4). Excessive flaring activity will contribute to global warming and accelerate climate change and later risk human health due to contamination of toxins in the air.

Biomass is a promising option of renewable energy in replacing fossil fuels as power generation due to its carbon-neutral properties and abundancy. It is easily accessible all over the world as agricultural biomass or residual wastes. The energy generated by biomass may readily be transformed into all the various types of energy that are now needed in contemporary life. However, the long-term viability of biomass-based energy is

heavily reliant on the availability of arable land. Only 0.19% of the world's 13.2 billion hectares of land are presently used to cultivate energy crops and the raw materials for biofuels (Ozturk et al., 2017). It will be necessary to consider significantly greater areas for the cultivation of additional energy crops in order to meet future demands for the generation of biofuels.

Pyrolysis is one of the feasible technologies in converting biomass or wastes into biofuels and chemical valuable products. Pyrolysis converts the biomass into three main products that are pyrolysis oil, biochar, and non-condensable gas. Pyrolysis will undergo thermal degradation in the absence of oxygen at moderate temperatures between 400 to 650 °C (Chen & Lin, 2016). The yield and quality of the pyrolysis products specifically pyrolysis oil is depending on the composition of biomass feedstock. Compared to other thermochemical technologies such as gasification, and combustion, pyrolysis has more advantages such as: the pyrolysis oil may have higher yield as much as 75%, pyrolysis oil may have higher heating value (HHV), pyrolysis oil has low nitrogen and sulfur and the biomass feedstock requires no processing (Zhang et al., 2019).

Torrefaction is the pretreatment for pyrolysis process to improve the quality of pyrolysis product mainly pyrolysis oil. Torrefaction is a mild thermochemical process that involves heating samples for extended periods of time between 200 to 300 °C in the absence of oxygen. Torrefaction is an effective method to reduce the moisture, acid, and oxygen contents of pyrolysis oil to improve its heating value and pH (Meng et al., 2012). After torrefaction, the oxygen content in biomass was decreased according to temperature of torrefaction (Chen et al., 2016). The solid after torrefaction containing approximately 70% of the initial weight and approximately has 80 to 90% of the original energy content (Pach et al., 2002). Torrefaction

process reduced the hydroscopic property of biomass that less moisture absorbed when stored (Hamaguchi et al., 2012).

Previous study by Zheng et al. (2014) found out that by increasing the torrefaction temperature of pine wood from 220 °C to 280 °C, the pyrolysis oil yield decreased and the oxygen contents like acids and aldehydes in pyrolysis oil was sharply decreased. However, the aromatic hydrocarbon content in pine wood pyrolysis oil increased which resulting an increased in heating value (HV) of pyrolysis oil. Wigley et al. (2016) also pretreated wood chip by torrefaction and found out that the biochar yield was higher. Moreover, other researchers also pointed out that the effect of torrefaction pretreatment on pyrolysis product improved the quality of pyrolysis oil and gas products from biomass (Chen et al., 2015). In addition, Chen et al. (2019) observed thermal degradation behaviour on torrefied biomass on hemicellulose, cellulose and lignin activity and found that the thermal degradation mechanisms such as fragmentation and depolymerization of biomass depend on the reaction temperatures. They also found out that after torrefaction process, hemicellulose become unstable due to depolymerization but cellulose remain unchanged.

Globally, coconut industry produced high volume of coconuts approximately 55 billion annually from 12 million hectares areas worth USD 6 billion (Smith et al., 2019). In Malaysia, 5 millions of fruits in year 2013 was generated. Large amount of coconut copra waste produced can cause the increasing amount of the waste (Zulkifli & Rasit, 2020). It also can affect the environmental and health issue when the mass generation of the waste is not being properly disposed. By converting the coconut copra into biofuel, the amount of waste will reduce and could convert waste to wealth.