CHAPTER 5
The Effects of Hydrogenation Temperature on Empty Fruit Bunch for High Energy Content

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5.1 INTRODUCTION

Recently, the demand for fossil fuel is increasing rapidly due to the population growth and rapid industrialization. Developing countries are one of the main contributors to the population growth in the world (Kannan & Vakeesan, 2016). The excessive consumption of fossil fuel gives harmful impact to the environmental like as air global warming, pollution, and climate change (Braungardt et al., 2019). This situation has driven researcher to discover clean and renewable energy resources as an alternative and sustainable energy production.

Solar energy, hydropower and biomass are renewable energy sources that abundant available in Malaysia (Mohd Chachuli et al., 2021). In particular, biomass has received significant attention as one of the important renewable sources since it is considered as carbon neutral and grows extensively in many countries (Wang et al., 2018). Palm oil production in Malaysia is the main biomass contributor like empty fruit bunch (EFB), palm kernel shell (PKS) and oil palm fiber (OPF). Typically, about 230 to 250 kg of EFB waste per ton of raw fruit

produced during palm oil milling process (Nurdiawati et al., 2015). Indeed, the substantial amount of agriculture waste generated from this process gives negative impact on the environmental. Hence, it is inevitable to convert this waste into useful product which later can be exploited for advance materials production such as renewable energy materials. In doing so, the environment impact associated with agricultural waste management can also be reduced (Mohd Chachuli et al., 2021).

There are some important properties need to be considered before biomass product is utilize as a fuel source, such as ultimate and proximate analysis and calorific value of the biomass and its components. In many applications emphasizing a higher calorific value in their production as reported by (Herumurti et al., 2018) which enhance the calorific value by blending plastic into biochar derived from tree branches. Thus, this study aims to analyse the effects of hydrogenation temperature in enhancing calorific value of biochar derived from EFB using Response Surface Methodology (RSM) through One Factor analysis technique. A significant response which is calorific value will be utilized in order to obtain desired hydrogenation temperature of EFB.

5.2 HYDROGENATION PROCESS IN INCREASING ENERGY CONTENT

Hydrogenation process is one of the methods employed by other researchers to enhance the product quality. The initial purpose of hydrogenation process is to synthesis light hydrocarbons of coal (Gordon, 1933). Weak bond of the molecules can be achieved through the reduction of oxygenated groupings in the ulmin compounds as well as eliminating sulphur and nitrogen

prior to thermal decomposition. In order to obtain lower molecular weight hydrocarbon with relatively higher hydrogen to carbon ratio, high molecular weight product with low hydrogen to carbon ratio must be weakened by hydrogen cracking (Gordon, 1933).

5.3 STATISTICAL ANALYSIS USING RESPONSE SURFACE METHODOLOGY

RSM is mainly a set of statistical procedure which needs to choose type of design of experiments (DOE) corresponds to factors, and responds, thus, various models of designing experiments are developed (Karimifard & Moghaddam, 2018). Implementing RSM increases the parameter space studied while decreasing the number of experiments (Karimifard & Moghaddam, 2018; Majdi et al., 2019). The one factor design allows researchers to evaluate the influence of a factor when the conditions of other factors changed. Thus, it gives a greater knowledge on how current method inputs affect the performance levels (Mohd Najib et al., 2021).

5.4 RESULT AND DISCUSSION

The finding shows that the hydrogenation process successfully improved the calorific value of EFB-derived biochar from 14.67 MJ/kg to 16.38 MJ/kg. The success of RSM in identifying the maximum calorific value of hydrogenation at the temperature of 50 ℃ is achieved. To analyse the effect of hydrogenation temperature, the samples had been characterized using Fourier Transform Infra-Red (FTIR). Quadratic model is obtained using one factor design of RSM in Design Expert version 6.0.4 software.