UNIVERSITI TEKNOLOGI MARA

OPTIMIZATION OF ELECTRON BEAM IRRADIATION AND IONIC LIQUID PRETREATMENT ON OIL PALM TRUNK

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ABSTRACT

Oil palm trunk (OPT) waste from the oil palm plantation is one of the lignocellulosic biomass feedstock to produce biofuel. Pretreatment is an important process to break the rigid structure of the lignocellulose and makes it accessible for enzymatic hydrolysis. In this project, the OPT was pretreated by using electron beam irradiation and ionic liquid at varying parameters which are irradiation dose, shaking frequency, and time. The effectiveness of the pretreatment process was investigated by analyzing the crystallinity index (CrI) and lateral order index (LOI) of the pretreated OPT by using X-Ray Diffractometer (XRD) and Fourier Transform Infrared spectrometer (FTIR) and was compared with the untreated OPT. The combination of electron beam irradiation and ionic liquid is an effective method since the CrI values shown for the pretreated OPT was reduced as compared to the untreated OPT. The optimal conditions for the pretreatment process were determined by response surface methodology with Box-Behnken Design via the experimental design. The results showed that the optimal conditions for the pretreatment process are at 346.5 kGy of irradiation dose, 686.9 rpm of shaking frequency and 3 hours of dissolution time. The predicted CrI value at the optimal conditions is at 32.82%.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

The oil palm industry in Malaysia has been introduced for over 100 years and today the country becomes the second largest producer of palm oil in the world. In 2017, the planted area of oil palm reached 5.81 million hectares with an increment of 1.3% from the year of 2016 (Malaysian Palm Oil Board, 2018). From the plantation and milling activities, large amount of oil palm biomass such as oil palm fronds (OPF), oil palm trunks (OPT), empty fruit bunches (EFB), palm kernel shells (PKS) and mesocarp fibres (MF) were generated (Onoja *et al.*, 2018).

The oil palm biomass is a lignocellulosic biomass composed of three chemical constituents which are cellulose, hemicellulose and lignin. Cellulose is a crystalline regular polymer where its crystalline structure makes it impervious to both corrosive and enzymatic hydrolysis. Hemicellulose is comprised of various monosaccharide units, dominatingly pentose sugars. It exists as either homopolymer or on the other hand hetero-polymer. Both are promptly dissolvable insoluble bases, making the hydrolysis of hemicellulose generally simple. Meanwhile, lignin is an aromatic polymer fundamentally made up of randomly substituted phenylpropane monomeric units (Onoja *et al.*, 2018).

However, the oil palm biomass needs to be pretreated which is an absolute necessity in order to break the crystalline structure of the cellulose, separate lignin and hemicellulose. Besides, the pretreatment is able to increase the porosity of the lignocellulosic materials. Few requirements must be met by the pretreatment process which are enhancing the formation of sugars by hydrolysis, prevent the degradation of carbohydrate, prevent the formation of byproducts and be cost-effective (Kumar *et al.*, 2009). Physical, chemical, physicochemical, biological and electrical are the categories of method available for the pretreatment process which have their own advantages and disadvantages. Combination of these methods is also possible.