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LIFE CYCLE ASSESSMENT FOR THE PRODUCTION OF PALM BIODIESEL

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ABSTRACT

A gate-to-gate life cycle assessment (LCA) for the production of palm biodiesel was performed. The LCA study was conducted using SimaPro software version 8.5, and the impact assessment was performed according to ReCiPe 2016 methodology. A three-year (2015-2017) inventory data was obtained from five commercial palm biodiesel producers in Malaysia. Methanol, acids and sodium methoxide (catalyst) were identified as three major contributors to the environmental impacts. Impact assessment showed that replacement of fossil-based methanol with biomethanol produced from biogas is the most preferred option, saving up to 63% fossil resources and 22% reduction in global warming impact. Allocation based on economic value was found more suitable compared to mass or energy content. This is because both palm biodiesel and crude glycerol differ in terms of economic value and being used in different applications.

Keywords: LCA, palm biodiesel, transesterification.

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INTRODUCTION

Biodiesel is an important industry for Malaysia. The commercial production of palm biodiesel in Malaysia began in 2006 with the setting up of three commercial biodiesel plants, registering a total production of 54 981 t (Harrison, 2018). With 15 plants in commercial production in 2018, the annual production volume of palm biodiesel had then exceeded one million tonnes. Out of the total biodiesel produced, 515 000 t were sold, generating an export earnings of RM 1.43 billion, while 429 000 t were utilised for the biodiesel programme implemented locally (MPOB, 2019; Unnithan, 2019).

Refined, bleached and deodourised (RBD) palm oil is the typical feedstock for biodiesel production in Malaysia. During biodiesel manufacturing, RBD palm oil is reacted with methanol in the presence of an alkaline catalyst to produce palm methyl ester (PME) or palm biodiesel (*Figure 1*). The transesterification reaction is carried out at 60°C under an atmospheric pressure (Van Gerpen and Knothe, 2010). Commercially, the reaction is typically performed in two or three reactors with a continuous flow system. Glycerol, the by-product of transesterification, is separated from the methyl ester phase in settling tanks by gravity or using a centrifuge to expedite the phase separation. Upon removal of the glycerol phase, acid is used for neutralisation of the residual catalyst in the methyl ester phase and at the same time to split any soap that is formed between the alkaline catalyst and free fatty acids. Soap reacts with acid to form water-soluble salts which will be removed in the water washing process. Excess methanol is removed, recovered and reused in the transesterification reaction. Any remaining catalyst, soaps, salts, methanol and free glycerol are further removed from methyl ester during water washing. Lastly, water is removed by a vacuum dryer. PME with water content below 500 mg kg^{-1} is stored at a bulk storage facility and ready to be used as biodiesel. The glycerol produced is also subjected to a series of purification, *i.e.* acidulation, neutralisation and methanol recovery to produce

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