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Vacuum Distilled Post Blend Crude Palm and Rubber Seed Oil Methyl Esters: Optimisation and Parametric Studies

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Abstract

Optimisation studies on post blended crude palm and rubber seed oil methyl esters were investigated. Post blended characteristics of methyl esters have been studied before and after vacuum distillation. The fuel properties of methyl esters met the international criteria of EN 14214 and ASTM D6751. Influential parameters that effects transesterification reaction have been analysed and optimised by response surface methodology. Catalyst loading and reaction temperature are the most influential variables which effects the methyl esters conversion. The optimised values were found to be alcohol to oil ratio of 6:1, catalyst loading of 1 wt%, reaction temperature of 65°C and reaction time of 2.5h.

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Keywords: Optimisation, methyl esters, vacuum distillation, response surface methodology

Nomenclature

CPO	Crude palm oil
RSO	Rubber seed oil
RSM	Response surface methodology
CCD	Central composite design
FAME	Fatty acid methyl ester

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1. Introduction

Fossil fuels depletion has become a highly emphasised concern nowadays in this fast moving world. Fossil fuel has been expected as a major source of energy in the world. It has been supported by the research stating that the estimated percentage of transportation using fossil based liquid fuels is 97.6% whereas 2.4% remaining is relying on gaseous fossil fuels [1, 6]. Fossil fuel is in high demand for the growth of other sectors such as industry sector, automotive sector and even for basic living. Therefore, alternative and renewable fuels are being explored in order to overcome the crisis of fossil fuels depletion. Malaysia, as a resourceful country, has brought hopes to world fuel demand because mineral-rich resources can be discovered everywhere in the country. Renewable fuels which are more environmental-friendly, sustainable and pump up economic efficient are under exploration. Biomass, biogas, bioethanol and biodiesel are undeniably being focused as these products meet the criteria as renewable fuels. Among all, biodiesel or methyl esters have been selected as the most preferable alternative fuel because of its characteristics. Methyl esters can be readily mixed with fossil diesel fuel without any further modification. In addition, by using available technologies, biodiesel production can be enhanced to a satisfying level [2-3]. The lower emission of greenhouse gases from pure biodiesel has brought itself to be more desirable renewable fuel [9].

Palm plantations are continuously increased at the rate of 4.4% per annum to fulfil both local and international demands for biodiesel production. Since that 95% of world biodiesel are produced from edible oil, serious concern has arisen over the reliability of this edible oil that if it is still harnessing in the same manner it will undoubtedly compete with the food resources. Therefore after seeing that, utilising the non-edible oil is the best solution for biodiesel production to avoid the food crisis [4-5, 7]. Malaysia has a huge amount of rubber seeds oil plantation which are still not utilised as sustainable fuel at commercial extent. Association of Natural Rubber approximated that about 1.2 million hectares of unutilised rubber seed is cultivated in Malaysia. Rubber seed as non-edible oil has better low temperature properties and has a significant potential to replace palm oil methyl esters that will hence boost Malaysian economy [5, 11]. Rubber seed oil can successfully contribute as a potential non edible feedstock for biodiesel production [2, 8].

In the current study, crude palm oil (CPO) and rubber seed oil (RSO) methyl esters were produced independently by base transesterification reaction. The both methyl esters than post blended with different ratios and characterize according to ASTM D6751 and EN 14214 standards for biodiesel production. The design expert 8.0 software was implemented Response Surface Methodology (RSM) for the optimization of the process parameters that affects conversion of methyl esters [10]. The experimental design employed by using Central Composite Design (CCD). The suitable modeling techniques from the RSM helps to predicts the optimum values at higher yield of output response within the range of experimental design by CCD. Base transesterification reaction was affected by same variables as acid esterification and response surface methodology (RSM) was adopted to assess the parametric effect of four independent variables i.e. alcohol to oil molar ratio, catalyst loading, reaction temperature and time on fatty acid methyl esters (FAME) conversion of CPO and RSO. FAME is considered as an output response for a given set of variables. Design Expert 8.0 software designed 21 experiments using CCD under RSM approach. All the experiments were performed according to the designed runs and each run was operated by following the purpose set of process conditions. For each designed run, FAME conversion was measured as a response variable. Biodiesel quality was enhanced by

2. Materials and Methodology

2.1. Chemicals

Crude palm oil was purchased from the local industry called Felcura Chemicals Sdn Bhd, Seri Iskandar Perak Malaysia. While, crude rubber seed oil was import from the Vietnam via Kinetics Chemicals Sdn Bhd, Malaysia. Methanol, sodium hydroxide pellets, anhydrous sodium sulphate, isopropanol, toluene, phenolphthalein, and sulphuric acid were procured from the Merck (Darmstadt) Germany. All the chemicals used were analytical grade.