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Application of Calcium Methoxide as Solid Base Catalyst for Biodiesel Production from Waste Cooking Oil

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Abstract. In this study**,** the biodiesel production of waste cooking oil using calcium methoxide as solid base catalyst was investigated. The calcium methoxide catalyst was synthesized from calcined quick lime reacted with methanol. The XRD result showed that the catalyst was successfully synthesized with sufficient purity. The strength of catalyst was examined on the transesterification reaction of waste cooking oil and methanol. Parameters affecting on transesterification such as the catalyst concentration, methanol-to-oil-molar ratio, reaction time and reaction temperature were investigated. The results showed that the percentage of fatty acid methyl ester conversion of 99.06%. The optimum conditions were achieved within 3 h using 3wt% catalyst concentration, 12:1 methanol-to-oil molar ratio and 65°C reaction temperature. In addition, the kinetic study of transesterification reaction was carried out at the temperature from 30°C to 65°C. The pseudo-first order was good agreement with the experiment results. The reaction rate constant (k) and activated energy (Ea) were determined as 0.023 min^{-1} and 55.77 kJ/mol, respectively.

Introduction

In the recent years, the heterogeneous catalysts have been developed for transesterification reaction to biodiesel production, due to some drawbacks associated with homogeneous catalysts such as difficulty in separation from products, resulting in large amount of waste water production and non-reusability of catalyst. In this regard, heterogeneous catalysts can contribute to simplify the biodiesel manufacturing process, especially in the purification stage of the final reaction products. This fact has led to numerous worldwide research efforts in the quest of developing suitable solids with good catalytic activity, selectivity to fatty acid esters and adequate reusability [1]. Between the most studied basic solid base catalysts, calcium methoxide ($Ca(OCH_3)_2$) can be highlighted because of its availability, low cost and high catalytic activity.

Waste cooking oil (WCO) was obtained from households and restaurants collection. The oil offered significant potential as low cost raw material for biodiesel production. WCO usually contained the free fatty acid (FFA) content less than 2wt%, thus it was suitable as raw material for biodiesel production via transesterification without salt formation.

In this study, Ca $(OCH_3)_2$ was synthesized from calcined quick lime and characterized by X-ray diffraction (XRD) technique. The synthesized Ca (OCH_3) was tested as solid base catalyst in the transesterification of waste cooking oil. Three variables (methanol-to-oil molar ratio, catalyst concentration and reaction time) were investigated. In addition, the kinetic study by using $Ca(OCH_3)_2$ catalyst followed pseudo first order reaction was also investigated to determine the rate constant and activation energy.

Experimental

Materials. WCO was supported by the vehicle and building station, Kasetsart University Bangkok Thailand. Quick lime powder was kindly supplied by Suthagun Co., Ltd. (Thailand). Analytical grade methanol and n-heptane were purchased from Merck (Germany). Standard chromatographic grade fatty methyl ester (FAME) acid was purchased from Sigma-Aldrich (Switzerland).