UNIVERSITI TEKNOLOGI MARA

CATALYTIC TRANSESTERIFICATION OF WASTE COOKING OIL INTO BIODIESEL USING VARIOUS POTASSIUM BASED Al_2O_3 CATALYST

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ABSTRACT

The waste cooking oil, WCO (from household area taman scientex, Pasir Gudang) obtained was found to have low in free fatty acids (<2%) and will undergo a transesterification process directly by using potassium salt as based catalyst. Potassium carbonate (K_2CO_3) and potassium hydroxide (KOH) as potassium-based salt precursor was chosen and immobilized onto the surface of Al_2O_3, the catalyst was named as K_2CO_3/Al_2O_3 and KOH/Al_2O_3. The catalyst was prepared via incipient wetness impregnation (IWI) method. The perforated hydrophilic materials (PHM) that made from high-density polyethylene (HDPE) was used as the catalyst reactor bag. The prepared catalysts were investigated using TGA, XRD, BET, SEM-EDX, TPD and for leaching of the prepared catalyst was studied by using FTIR, ICP-AES and XRF analysis. The optimum condition for transesterification of WCO were 700°C calcination temperature, 10 wt% catalyst concentration, 5 wt% catalyst loading, 2 h reaction time and 60°C reaction temperature. Based on the surface area for the beads catalyst by using PHM, found to have larger surface area compared to powder catalyst by showing 97.97% biodiesel yield for KOH/Al_2O_3 powder catalyst (2.36 m^2/g of surface area and 6.24 nm of pore size), 93.58% biodiesel yield for KOH/Al_2O_3 beads catalyst (133.37 m^2/g of surface area and 7.08 nm of pore size), 88.94% biodiesel yield for K_2CO_3/Al_2O_3 powder catalyst (1.51 m^2/g of surface area and 5.43 nm of pore size) and 96.70% biodiesel yield for K_2CO_3/Al_2O_3 beads catalyst (199.94 m^2/g of surface area and 6.51 nm of pore size). In addition, from the reusability study, bead catalyst of KOH/Al_2O_3 and K_2CO_3/Al_2O_3 beads catalyst successfully can be recycle up to 8 and 12 times respectively by using PHM as a reactor container. The final product also undergo evaluation on FAME yield by using GC-FID and the data shows that the result different are ~0.5 to ~1.0% only. The properties of biodiesel also comply with ASTM D6751-2 and EN14142 standard method. Most significantly, this study has explored the viability of K_2CO_3 and KOH supported onto Al_2O_3 have a novel value and can be produced with very low cost. This heterogeneous catalyst is stable and suitable to be used in the industrial scale.

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CHAPTER ONE
INTRODUCTION

1.1 Background of study

Cooking oil produced from palm tree or scientifically *Elaeis guineensis* has been used by human since back to 5000 years ago. From crude palm oil (CPO), the oil will undergo certain process until become refined, bleached, and deodorized palm oil (RBDPO) as a final product that we called as cooking oil. Waste cooking oil (WCO) generated everyday using cooking oil after frying protein, carbohydrates, or fibres. WCO usually mix oil with black coloured appearance, high residue, high water content and have pungent smell because of the presence of another compound. The WCO usually has thrown away through sink or drain caused the oil will solidify and clogged the pathway, wastewater cannot pass through and flooded happens. It increases the cost to maintenance the system and will polluted the water. To make used of WCO to the better version, the one way is to convert WCO to biodiesel for combustion fuels. Naturally, biodiesel is using vegetable oil or animal fats and react chemically with the catalyst and alcohol through esterification or transesterification process to produce fatty acids methyl ester (FAME). (Fereidooni & Mehrpooya, 2017; Nang et al., 2009).

Biodiesel is much more eco-friendly and non-toxic towards environment compare to existing diesel (Rashid & Anwar, 2008). The example of oil that been used to produce biodiesel are red palm oil (RPO), sunflower, canola, soybean, palm kernel (PKO), crude palm kernel (CPKO) and WCO (Lokman et al., 2015; Lokman NolHakim et al., 2021).

1.2 Biodiesel

Naturally, biodiesel is produced by using vegetable oil or animal fats and react chemically with the catalyst and alcohol through esterification or transesterification process to produce fatty acids methyl ester (FAME). (Fereidooni & Mehrpooya, 2017; Nang et al., 2009). Biodiesel are much more eco-friendly and non-toxic towards