OPTIMIZATION AND KINETIC MODEL FOR TRANSESTERIFICATION OF WASTE COOKING OIL USING TUNGSTOPHOSPHORIC ACID CATALYST

AMIN TALEBIAN KIAKALAIEH

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Universiti Teknologi Malaysia

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TO MY BELOVED WIFE,
MY LOVING MOTHER AND MY BROTHER

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ABSTRACT

Transesterification of waste cooking oil with heterogeneous tungstophosphoric acid (TPA) catalyst and methanol was investigated. Response Surface Methodology (RSM) and Artificial Neural Network (ANN) were employed to study the relationships of process variables on free fatty acid conversion and for predicting the optimal conditions. The highest conversion was 88.6% at optimum reaction conditions of 65 ˚C reaction temperature, 70:1 molar ratio of methanol to oil, 10 %wt catalyst amount, and 14 h reaction time. The RSM and ANN could accurately predict the experimental results, with R^2 = 0.9987 and R^2= 0.985, respectively. The TPA catalyst exhibited good potential as a stable and active catalyst over four time's reusability. The reaction followed first-order kinetics and the calculated activation energy was Ea= 53.99 kJ/mol while the pre-exponential factor was A= $2.9x10^7$ min^{-1}. According to the biodiesel characterization results (ASTM D6751) the product of this study has high potential for using as a substitute for conventional catalyst in biodiesel production.

ABSTRAK

Transesterifikasi minyak masak terpakai dengan mangkin heterogen tungstophosphoric acid (TPA) dan metanol telah dikaji. Metodologi permukaan bertindakbalas (RSM) dan rangkaian neural tiruan (ANN) digunakan untuk mengkaji hubungan antara pemboleh ubah proses dan penukaran asid lemak bebas dan untuk mengkaji parameter optimum. Penukaran yang paling tinggi ialah dengan kadar 88.6 peratus, dengan keadaan optimum 14 jam masa tindak balas, suhu tindak balas 65 darjah Celcius, nisbah molar methanol dan minyak 70:1 dan 10% kepekatan mangkin. RSM dan ANN boleh meramal keputusan eksperimen dengan tepat; R^2 bagi RSM ialah 0.9987 dan R^2 bagi ANN ialah 0.985. Mangkin TPA mempunyai potensi tertinggi sebagai mangkin yang aktif dan stabil dan boleh digunakan berulang kali. Tindak balas ini mematuhi kinetik tertib pertama dan tenaga pengaktifan ialah Ea = 53.99 kJ/mol; factor pra-eksponen sama dengan $A= 2.9x10^7$ min^{-1}. Kajian ini dapat menghasilkan proses penghasilan biodisel dengan minyak masak terbuang dengan mangkin TPA heterogen yang mesra alam dan menepati piawaian ASTM D6751.