**Optimising biodiesel production from waste cooking oil using supercritical methanol**

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Petroleum based fuels are considered as main sources of world’s energy including coal, natural gas and petroleum oil fractions. However, due to oil reserves limitation, unstable oil price and extensive emissions of greenhouse gases, which are the main cause of global warming, make the petroleum-based energy unreliable. Consequently, it is essential to find an alternative renewable, green and sustainable source of energy for fossil fuels replacement.

Biodiesel has been considered as an important renewable fuel in the worldwide markets, due its economic and environmental benefits. In spite of its lower heating value, biodiesel has its advantages over petroleum based diesel fuel: it is biodegradable and nontoxic, it provides free sulphur and aromatics combustion and it is a greener fuel as it emits lower carbon monoxide and hydrocarbon. Waste cooking oil (WCO) has been recognised as a significant feedstock for biodiesel production. It provides more sustainability for the product since it includes the transformation of waste to a valuable source of energy. However, free fatty acid (FFA) content is usually high in most of the WCOs, and hence they require pre-treatment before biodiesel processing. Biodiesel production under supercritical conditions of methanol tolerates feedstock with high FFA content. In addition, it is a noncatalytic process which optimise the catalyst preparation and separation costs, it operates the reaction with high conversion for both FFA and triglycerides within short period in comparison with the conventional catalytic reactions.

In an attempt to overcome the high FFA content in WCO, this work illustrates the applicability of biodiesel production using supercritical methanol in transesterification reaction. Response surface methodology (RSM) *via* Box Behnken Design (BBD) was employed to study the significance and interactive effect of methanol to oil (M:O) molar ratio, reaction temperature, pressure and time on biodiesel yield. A quadratic model equation has been obtained describing the interrelationships between dependent and independent variables to maximise the response variable (biodiesel yield). In addition, validity of the predicted model has been confirmed using Analysis of Variance (ANOVA) method. Using numerical optimisation technique, optimum conditions for maximum biodiesel yield (96%) has been concluded at a methanol to oil molar ratio of 36.8:1, reaction temperature, pressure and time of 267 oC, 226 bar and 22 minutes, respectively. Kinetic and thermodynamic data for overall transesterification reaction have been studied at a temperature range of 240-270 oC and the resulting reaction rate constant and activation energy are 0.0006 s-1 and 50.5 kJ/mol, respectively.

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