Valorisation of high acid value waste cooking oil into biodiesel *via* supercritical methanolysis

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Biodiesel has attracted a significant attention as a promising replacement for petroleum diesel fuel. It is a sustainable fuel that is synthesised from renewable resources. It has numerous advantages over petroleum diesel including biodegradability, higher cetane number and lower aromatic contents. In addition, biodiesel significantly reduces the emission of greenhouse and toxic gases including carbon dioxide, unburned hydrocarbons, particulate matters and carbon monoxide. The valorisation of waste cooking oil (WCO) is a key factor in reducing the cost of biodiesel. The conventional production of biodiesel from high acid value feedstock involves an essential pre-treatment step where esterification of free fatty acids (FFAs) takes place. In this study, biodiesel production from high acid value WCO (18 mg KOH/g oil) has been studied. A non-catalytic technique for biodiesel production using supercritical technology has been implemented without any pre-treatment steps. The influences of four reaction parameters on biodiesel production, i.e. methanol to oil (M:O) molar ratio, temperature, pressure and time, have been investigated. Response Surface Methodology (RSM) *via* Central Composite Design (CCD) has been used to assess the effect of reaction variables on the yield of biodiesel and conversion of FFAs. Two quadratic models have been developed representing the process responses function in the reaction variables. Analysis of Variance (ANOVA) has been used to assess the adequacy of the predicted model. Optimisation of reaction variables has been performed resulting in 97.7% yield of biodiesel and 98.5% conversion of FFAs at M:O molar ratio, temperature, pressure and time of 26:1, 263 °C, 110 bar and 16 min, respectively. The predicted optimum conditions have been validated experimentally.

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