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A comparative study of homogeneous base catalysts and process conditions for high biodiesel conversions from high free fatty acid rapeseed oil using a mesoscale oscillatory baffled reactor

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Homogenous base catalysis of biodiesel production from feedstock that contains high free fatty acids (FFA) content would require a pre-treatment step to reduce the FFA level. Drying of such feedstock is required if it has high water content. All these add to the costs of biodiesel production from high FFA and water triglyceride source, hence the need to investigate process conditions which could allow for direct base-catalyzed methanolysis of such low quality feedstock. This study investigated the comparative catalytic activities of alkali-metal hydroxide and methoxide as homogeneous base catalysts for transesterification of rapeseed oil containing high levels of FFA and water. The investigation was carried out using a mesoscale oscillatory baffled reactor in a continuous mode. The oscillatory mixing conditions in the reactor ensured that the reactions were kinetics-controlled. The operating conditions investigated were: Methanol to rapeseed oil molar ratios (4:1-13:1), catalyst loadings (0.5-2 wt%), FFA (0.061 wt%) and water 0.05 wt% (contents of the rapeseed oil, reaction temperature (40-60 °C), and residence times (3-16 min). Design of the experiment was used to optimize the reaction conditions. Complete conversions were achieved under wide range of moderated reaction conditions. Overall, the $NaOCH_3$ catalyst showed higher catalytic activity than NaOH under the same operating conditions, i.e. the turnover frequency of the $NaOCH_3$ was more than that of NaOH catalyst under all the reaction conditions. Our findings demonstrate that there are optimal process conditions that could be exploited for continuous productions of biodiesel at high conversions from low quality oleaginous feedstock that contain up to 5 wt% FFA and 3 wt% water.

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