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Modelling the production of biodiesel from non-edible oils (Jatropha curcas oil and Tobacco seed oil (TSO): a kinetic study

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Abstract

The significant increase in the primary energy demand and the effort to reduce harmful emissions related to the greenhouse gases enhanced the search for alternative energy. Production and modelling processes of biofuel from non-edible oil sources assist in the process development of an environmentally friendly fuel such as biodiesel. This work focused on the kinetic modelling of biodiesel synthesised from non-edible oils. Two types of non-edible oils (Jatropha curcas seed oil and Tobacco seed oil) were used in this study including the development of the kinetic behaviour of the transesterification reaction. A linear polynomial model was generated from experimental data found in literature in order to study the influence of operating parameters during biodiesel production. It was found that the temperature improves the yield of biodiesel; this is attributed to the fact that temperature affects the reaction rate constants; and the higher the reaction rate, the lower the activation energy required for a reaction to occur. The optimum conditions for the transesterification of Jatropha curcas seed oil are a temperature of 55 ^{0}C, methanol to oil ratio of 6:1, catalyst concentration of 1.2% KOH (by volume of oil), and agitation speed range of 0-250 rpm. Results from both the homogeneous and heterogeneous reactions of Jatropha curcas oil and tobacco seed oil were used to verify the theoretical kinetic and empirical models. It was found that both models describe the kinetic behaviour of transesterification with minor deviations in the estimated parameters. However, the use of empirical model in determining the reaction order, as opposed to the theoretical assumption, gave a second order with respect to oil triglycerides at a temperature of 60 ^{0}C. The theoretical kinetic model gave a first order with respect to oil triglycerides. In this case, the activation energy was found to be 71.83 kJ/mol and pre-exponential factor was found to be 2.48×10^{10}. More investigation should be done to describe the kinetic behaviour of biodiesel production from non-edible oil in order to confirm the correct reaction order and why there is change in reaction order when the temperature increases above 60°C.