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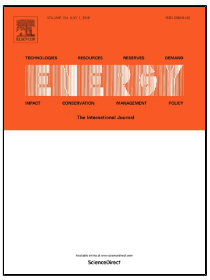

Biodiesel production from castor oil in Egypt: process optimisation, kinetic study, diesel engine performance and exhaust emissions analysis

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Biodiesel production from castor oil in Egypt: process optimisation, kinetic study, diesel engine performance and exhaust emissions analysis

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ABSTRACT

In this study, biodiesel production from castor oil has been investigated. Five independent variables including; methanol to oil (M:O) molar ratio, catalyst concentration, reaction temperature, time and stirring rate have been chosen to investigate their effect on biodiesel yield. Response Surface Methodology (RSM) *via* Rotatable Central Composite Design (RCCD) has been used to evaluate the influence of the independent variables on the reaction response. Analysis of variance (ANOVA) has been used to investigate the adequacy of the predicted model. The optimum conditions for 97.82% biodiesel yield have been achieved at M:O molar ratio of 5.4:1, potassium hydroxide (KOH) catalyst concentration of 0.73%, temperature of 64^{o}C, time of 2.5 h and stirring rate of 320 rpm. The predicted optimum conditions have been validated with 0.59% relative error from experimental results. The kinetic calculations concluded that reaction is pseudo second order with reaction rate constant, activation energy and frequency factor of 0.16 M^{-1} min^{-1}, 21.95 kJ/mol and 6.02 M^{-1} min^{-1}, respectively. Finally, a case study investigating the performance and emissions on a direct injection (DI) diesel engine fuelled by biodiesel/petro-diesel blends (5, 10, 15 and 20% v:v) has been performed concluding significant reduction of greenhouse and toxic gases.

KEYWORDS

Biodiesel, Castor oil, Optimisation, Response surface methodology, Diesel engine performance, Exhaust emissions analysis.

HIGHLIGHTS

- Effect of transesterification reaction variables has been examined.
- Reaction optimal conditions have been predicted using Response Surface Methodology.
- Kinetics of the overall transesterification reaction have been studied.
- Diesel engine performance and emissions of biodiesel/petro-diesel blends have been investigated.

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