Pharos University in Alexandria

Faculty of Engineering

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Production of Biojet Fuel using Hydrodynamic Cavitation Reactor

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ABSTRACT

Designing and implementing rotor-stator hydrodynamic cavitation reactor to produce biodiesel from castor oil as a first step to produce bio-jet. Response surface methodology based on one-factor-at-a-time design of experiments was employed for modelling and optimizing the biodiesel yield and the impact of the decrease in feedstock viscosity, density, and total acid number (TAN). The predicted optimum parameters of 8.15:1 M:O, 1499 rpm, 29.38 min, 48.43°C, and a KOH catalyst concentration of 0.74 wt.% resulted in a 96% biodiesel yield with a concomitant decrease in viscosity, density, and TAN of approximately 95%, 5.12%, and 90.02%, respectively. According to the results of the kinetic calculations, the reaction is pseudo-second order, with the activation energy, frequency factor, and reaction rate constant being 0.23 $M^{-1}min^{-1}$, 18.77 kJ/mol, and 6.32 $M^{-1}min^{-1}$, respectively. By designing and implementing the modified Teflon rotor-stator hydrodynamic cavitation reactor in order to model and optimize the biodiesel yield, response surface methodology based on 1/2 fraction-three-levels face center composite design of three levels-five experimental factors was used. The predicted ideal operating parameters were found to be 52.51°C, 1164.8 rpm rotor speed, 27.43 min, 8.4:1 methanol to oil molar ratio, and 0.89% KOH concentration. That yielded 95.51% biodiesel of 99% fatty acid methyl ester content, with a relatively low energy consumption and high cavitation yield of 6.09×10^{5} J and 12×10^{-3} g/J, respectively. The fuel properties of the produced biodiesel and bio-petro-diesel blends were good, comparable to international standards and the marketed Egyptian petro-diesel.