Process intensification of 2-ethylhexyl caprylate/caprate synthesis via a pulsed loop reactor: multi-objective optimization

ABSTRACT

This work proposes the optimization of 2-ethylhexyl (2-EH) caprylate/caprate synthesis in a pulsed loop reactor, and the energy efficiency of the reactor was assessed. 2-EH caprylate/caprate can be used as a biodegradable base fluid. Only 0.4 wt% catalyst concentration was used in the reaction. The face-centred central composite design (FCCD) experiment coupled response surface methodology (RSM) has been implemented to screen independent parameters. The optimization process showed that vacuum pressure was the most influential factor followed by oscillation speed, temperature and time. The maximum conversion of 98 % and yield of 89 % were achieved under optimal conditions of 78 °C, 10 mbar, 20 min and 155 rpm. Meanwhile, energy balance calculation indicated that the usage of low vacuum pressure not only significantly reduced the total heat duty from 1381 kJ (1 atm) to 823 kJ (10 mbar) but also alleviated the reaction temperature from 172 °C (1 atm) to 78 °C (10 mbar). The calculation also demonstrated that the reflux-stirred tank reactor produced a lower conversion and yield of ester yet 6 kJ higher total heat duty compared to the pulsed loop reactor, indicating a cost-saving with the pulsed loop reactor.

Keyword: 2-ethylhexyl ester; Pulsed loop reactor; Optimization; Transesterification; Drilling fluid