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Use of 4-dodecylbenzenesulfonic acid catalyst on the methanolysis of the rapeseed oil in meso-integral baffled reactor

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This study investigates the use of 4-dodecylbenzenesulphonic acid (DBSA) as a catalyst for fatty acid methyl ester (FAME) production from rapeseed oil, using a mesoscale oscillatory baffled reactor ("meso-OBR") as a screening platform. The effects of oscillatory mixing intensity, methanol-to-oil molar ratio, catalyst to oil molar ratio and residence time on the conversion to FAME were evaluated. The reaction conditions were optimised using the Design of Experiments (DoE) methodology. A Box-Behnken design with one block, three variables (methanol to oil molar ratio, catalyst to oil molar ratio and residence time) and three replicates of the central point was used. A response surface model was able to predict the FAME conversion over a broad range of operating conditions. ANOVA analysis revealed that the catalyst to oil molar ratio and residence time were more significant than the methanol to oil molar ratio. 100% conversion of rapeseed oil to FAME was achieved under mild reaction conditions 6.5:1 methanol to oil molar ratio, 0.48:1 of catalyst to oil molar ratio and 120min. The DBSA catalyst allowed operation at a significantly lower molar ratio than in conventional acid catalysis: below 7:1, as opposed to the 9:1 typically used with sulphuric acid. Furthermore, the degree of agitation required was greatly reduced, due to its behaviour as a surfactant. Only 180 min was required to accomplish the reaction compared with 19hr that for sulphuric acid. Finally, very little DBSA catalyst was required (0.18wt %), compared to sulphuric acid (0.5 wt. %), under the reaction conditions investigated here. The significant reductions in excess methanol and degree of agitation would significantly reduce operating costs, and the substantial reduction in reaction time would significantly reduce reactor size, and therefore capital cost.

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