Comparison of catalytic performance of Novozyme 435 and Purolite D5081 for the esterification pre-treatment of used cooking oil for biodiesel production

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Used cooking oil (UCO) can be used as a feedstock to produce biodiesel. However, this raw material contains a significant amount of free fatty acids (FFAs). Oils and fats with a high FFAs content cannot be directly used in a base-catalysed transesterification reaction. The FFAs react with the alkali catalyst to form soap. The saponification process forms a stable emulsion and leads to difficulties in process separation and reutilisation of catalyst. In this work, an esterification pretreatment process by heterogeneous catalysis has been investigated using an ion-exchange resin (Purolite D5081) and an immobilised enzyme (Novozyme 435).

The reactions were carried out in a jacketed batch reactor with a reflux condenser. An acid-base titration method was used to monitor the FFA concentration during the experiments. A gas chromatography – mass spectrometry method was used to monitor the fatty acid methyl ester (FAME) concentration. The optimum conditions for the ion-exchange resin catalyst are: a methanol to oil mole ratio of 6:1, a catalyst loading of 1.25 wt% and a temperature of 60 °C giving a conversion of 92%. The optimum conditions for the immobilised enzyme are: a methanol to oil mole ratio of 0.4:1, a catalyst loading of 1.00 wt% and a temperature of 50 °C giving a conversion of 90%. A comparison of the conversion trends for both catalysts is shown in Figure 1.

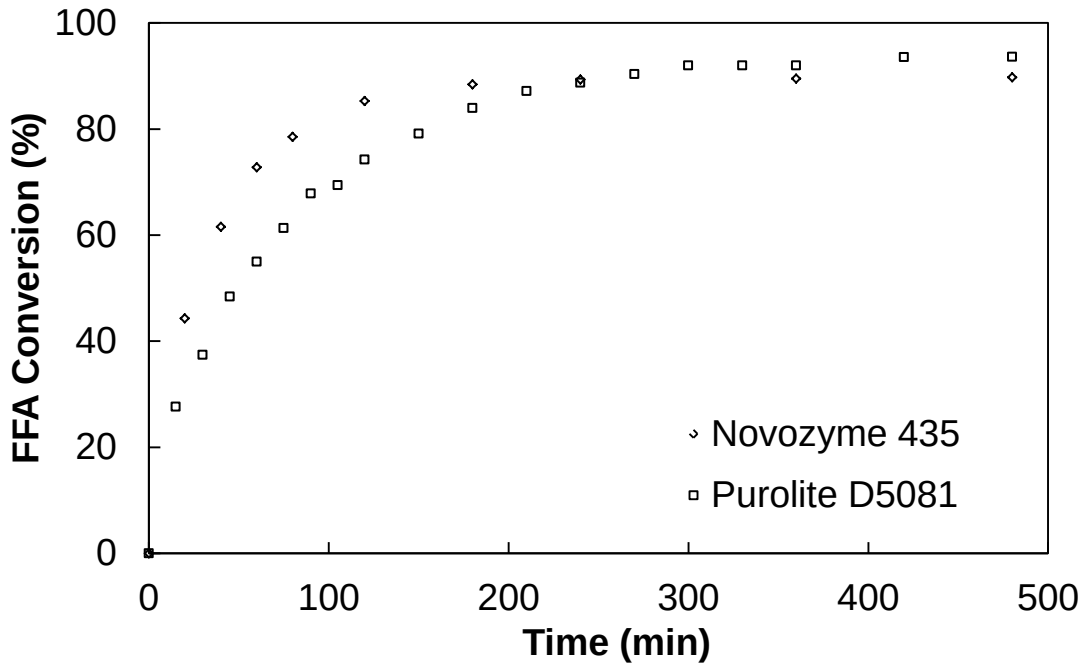

Figure 1: Comparison of conversion for Novozyme 435 and Purolite D5081 at the optimum reaction conditions

From this work it has been found that much lower concentration of methanol could be used for esterification reaction with Novozyme 435, which will improve process safety and reduce the environmental impact of the process. In addition it has been found that high conversions are possible with Novozyme 435 at 30 °C, which signify that in warmer countries it may be possible to run the process without additional heating. Novozyme 435 has also been found to catalyse additional transesterification side reactions leading to the formation of additional biodiesel which could be used to improve the process efficiency.