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PRE-ESTERIFICATION OF USED COOKING OIL USING A LEWIS ACIDIC ZIRCONIUM-OXINE SOLID ACID CATALYST TO MINIMISE SAPONIFICATION IN BIODIESEL PRODUCTION

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Biodiesel production using used cooking oil is a great alternative for the global energy demand, although a major problem of used cooking oil is that it contains a high amount of free fatty acids (FFA) originating from heating during multiple cycles of cooking. In the presence of excess FFA, used cooking oil undergoes saponification during the conventional transesterification step, where the oil source is reacted with methanol in the presence of a base catalyst. Saponification significantly decreases the net yield of final biodiesel produced. Hence, FFA should be minimised to a level recommended by biodiesel production guidelines, before the transesterification step. This is achieved through the introduction of a pre-esterification step, where FFA are converted to their methyl esters using an acid catalyst. This research was focused on the synthesis of economically feasible, solid acidic transition metal catalysts, Zr-oxine and nitrated Zr-oxine, in an attempt to minimise saponification of biodiesel production. Two types of cooking oils, domestically used oil (DUO) and industrially used oil (IUO), were used for this study. Initial FFA content of both types, DUO and IUO was determined using a titrimetric method, which showed a significantly higher FFA content than recommended. Optimum pre-esterification reaction time, temperature, and catalytic dose were determined by reacting DUO in the presence of Zr-oxine and measuring the percentage FFA reduction. Thereafter, both DUO and IUO were pre-esterified under optimised conditions with nitrated Zr-oxine. The results revealed that the FFA content of DUO was reduced by 48.34% and 36.27% in the presence of nitrated Zr-oxine and Zr-oxine, respectively. The final FFA level after the pre-esterification in the presence of nitrated Zr-oxine was 0.43 mg KOH g^{-1}, well within the recommended standards for biodiesel production. More importantly, biodiesel produced by esterifying the DUO using nitrated Zr-oxine showed no saponification at all. This result encourages the potential applicability of Lewis acidic Zr-oxines in the utilisation of used cooking oil for biodiesel production.

Keywords: Biodiesel production, Pre-esterification, Saponification, Solid acid catalyst, Wasted cooking oil, Zr-oxine