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OPTIMIZATION OF USED EDIBLE OIL TRANSESTERIFICATION USING RESPONSE SURFACE METHODOLOGY AND BOX-BEHNKEN DESIGN

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Abstract

Biodiesel, an effective substitute for conventional diesel, offers numerous advantages, including biodegradability, reduced greenhouse gas emissions, sulfur emissions, and particle emissions, as well as low toxicity and excellent lubricity. However, it is important to note that engine modification may be necessary for its direct use in conventional diesel engines, contrary to some claims. Biodiesel is typically produced through transesterification, with waste cooking oil being a cost-effective and promising raw material sourced from sustainable vegetable oils and animal fats. This study employs the Box Behnken design methodology to optimize process factors for converting waste cooking oil into biodiesel. The parametric range explored includes the catalyst amount (1 to 1.5% wt.), temperature (40 to 60°C), methanol to oil ratio (6 to 10), and reaction time (60 to 100 minutes). The factorial level of optimization was 3. The optimized values for transesterification parameters were found to be a catalyst amount of 1.01% wt., a reaction temperature of 41°C, a methanol-to-oil ratio of 7.8:1, and a reaction time of 61 minutes using three level of factorial design. Gas Chromatography (GC) was used for the analysis of fatty acid methyl esters (FAME), the essential components of biodiesel, confirming their formation in this study. The predicted yield using these parameters was 99.33%, which closely matched the actual yield of 98.39%. These results demonstrate the reliability and accuracy of the regression model, validating its use for process optimization. Overall, this study highlights the effectiveness of Response Surface Methodology in predicting and optimizing transesterification for biodiesel production, providing valuable insights into the advancement of sustainable fuel technologies.

Key words: biodiesel, edible oil, homogeneous catalyst transesterification, response surface methodology

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