

Optimization of the Transesterification Process Using Natural Zeolite as a Catalyst in the Production of Crude Palm Oil (CPO) Biodiesel

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ABSTRACT

The transesterification process can be used to convert Crude Palm Oil (CPO) into biodiesel. This study aimed to determine the optimum conditions for the transesterification of CPO using natural zeolite as a catalyst. In addition, the study examined the effects of reaction time, catalyst concentration, and the quality of the biodiesel produced based on the Indonesian National Standard (SNI 7182:2015). The research employed a two-factor Completely Randomized Design (CRD), consisting of transesterification time (60, 75, and 90 minutes) and natural zeolite catalyst concentration (1%, 3%, and 5%). The data were analyzed using two-way Analysis of Variance (ANOVA), followed by Duncan's Multiple Range Test (DMRT) when significant differences were observed. The research stages included CPO extraction, FFA esterification, transesterification, biodiesel washing, and characterization of the biodiesel, including yield, density, acid value, kinematic viscosity, iodine value, FAME content, and water and sediment content. The results showed that a reaction time of 75 minutes produced the highest and most consistent biodiesel yield compared with reaction times of 60 and 90 minutes. The resulting biodiesel had a kinematic viscosity of 3.689 cSt, a density of 889.2 kg/m³, an acid value of 0.271 mg KOH/g, and an iodine value of 43.50 ± 0.28 g/100 g, all of which complied with the requirements of SNI 7182:2015. However, the FAME content was only 9.28%, which was far below the minimum standard requirement of 96.5%, while the water and sediment content was 0.1%, exceeding the maximum allowable limit. These findings indicate that the transesterification and biodiesel purification processes using natural zeolite as a catalyst have not yet been fully optimized and require further improvement.

Keywords: *Biodiesel, CPO, Heterogeneous Catalyst, Natural Zeolite Transesterification,*