ABSTRAK

Keterbatasan bahan bakar fosil dan meningkatnya kepedulian lingkungan mendorong pengembangan biodiesel sebagai bahan bakar alternatif berkelanjutan. Penelitian ini mengkaji pengaruh katalis heterogen berbasis biomassa, yaitu daun pepaya, cangkang telur, dan abu sekam padi, terhadap densitas, viskositas, dan nilai kalor biodiesel dari minyak jelantah melalui proses transesterifikasi. Metode yang digunakan berupa eksperimen laboratorium dengan kondisi tetap, meliputi rasio molar minyak–metanol 1:8, konsentrasi katalis 4% berat minyak, suhu 60°C, dan waktu reaksi 60 menit, dengan katalis dipreparasi melalui proses pengeringan dan penghalusan. Sifat fisik biodiesel dianalisis menggunakan piknometer, viskometer Oswald, dan bomb kalorimeter. Hasil penelitian menunjukkan bahwa jenis katalis memengaruhi mutu biodiesel, di mana katalis daun pepaya dan abu sekam padi menghasilkan densitas tertinggi sebesar 1,188 g/mL, sedangkan katalis cangkang telur terendah sebesar 1,162 g/mL, serta viskositas tertinggi diperoleh pada katalis daun pepaya sebesar 15,14 cSt dan terendah pada katalis cangkang telur sebesar 13,70 cSt. Secara umum, katalis heterogen berbasis limbah lokal berpotensi digunakan sebagai katalis ramah lingkungan dalam produksi biodiesel, meskipun masih diperlukan optimasi agar karakteristik biodiesel memenuhi standar SNI 7182:2015 dan ASTM D6751 serta mendukung pengembangan katalis hijau yang berkelanjutan.

Kata kunci: biodiesel, minyak jelantah, katalis heterogen, daun pepaya, cangkang telur, abu sekam padi, transesterifikasi, densitas, viskositas, nilai kalor.

ABSTRACT

The limitation of fossil fuels and increasing environmental awareness have encouraged the development of biodiesel as a sustainable alternative fuel. This study investigates the effect of biomass-based heterogeneous catalysts, namely papaya leaves, eggshells, and rice husk ash, on the density, viscosity, and calorific value of biodiesel produced from waste cooking oil through a transesterification process. The research method employed laboratory-scale experiments under fixed operating conditions, including an oil-to-methanol molar ratio of 1:8, a catalyst concentration of 4 wt% of oil, a reaction temperature of 60°C, and a reaction time of 60 minutes, with catalysts prepared through drying and grinding processes. The physical properties of biodiesel were analyzed using a pycnometer for density, an Oswald viscometer for viscosity, and a bomb calorimeter for calorific value. The results show that the type of heterogeneous catalyst significantly affects biodiesel quality, where papaya leaf and rice husk ash catalysts produced the highest density of 1.188 g/mL, while the eggshell catalyst yield ed the lowest density of 1.162 g/mL. The highest viscosity was obtained using the papaya leaf catalyst at 15.14 cSt, whereas the lowest viscosity was recorded for the eggshell catalyst at 13.70 cSt. Overall, biomass-based heterogeneous catalysts derived from local waste materials show strong potential as environmentally friendly catalysts for biodiesel production; however, further optimization is still required to ensure that biodiesel properties fully comply with the Indonesian National Standard (SNI 7182:2015) and international standard (ASTM D6751) while supporting the development of sustainable green catalysts.

Keywords: *biodiesel, waste cooking oil, heterogeneous catalyst, papaya leaves, eggshell, rice husk ash, transesterification, density, viscosity, calorific value.*