

SINTESIS DAN KARAKTERISASI KATALIS CaO TERIMPREGNASI MATERIAL MAGNETIK-SiO₂ UNTUK TRANSESTERIFIKASI MINYAK KELAPA MENJADI METIL ESTER

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INTISARI

Penelitian ini telah berhasil menyintesis dan mengkaji karakterisasi katalis basa heterogen CaO termodifikasi material magnetik-SiO₂ (MM-SiO₂/CaO), serta mengevaluasi kinerjanya dalam konversi minyak kelapa (*coconut oil*) menjadi metil ester melalui proses transesterifikasi. Selain itu, penelitian ini juga menelaah pengaruh kondisi reaksi terhadap hasil konversi serta stabilitas katalis melalui uji penggunaan berulang.

Pelapisan silika pada material magnetik dilakukan melalui metode sol-gel menggunakan tetraetoksisilan (TEOS) sebagai prekursor dan setiltrimetilamonium bromida (CTAB) sebagai pengarah struktur mesopori. Material yang dihasilkan (MM-SiO₂) dengan persentase massa divariasi (10%, 20%, dan 30%) kemudian diimpregnasi CaO secara basah dan dikalsinasi pada suhu 800 °C selama 5 jam. Karakterisasi dilakukan dengan XRD, XRF, FTIR, SAA, dan FE-SEM EDX. Pengujian aktivitas katalitik pada reaksi transesterifikasi dilakukan dengan memvariasikan waktu reaksi, konsentrasi katalis, dan rasio mol minyak terhadap metanol.

Hasil penelitian menunjukkan bahwa katalis MM-SiO₂/CaO berhasil disintesis dengan penambahan MM-SiO₂ sebesar 10%, 20%, dan 30% terhadap massa CaO. Luas permukaan spesifik dan volume total spesifik MM-SiO₂/CaO meningkat seiring dengan bertambahnya persentase MM-SiO₂. Material 10% MM-SiO₂/CaO (10% MM-SiO₂/CaO) yang memiliki luas permukaan spesifik sebesar 7,60 m²/g, volume pori 0,0528 cm³/g, dan diameter pori rata-rata 27,77 nm merupakan katalis terbaik untuk transesterifikasi minyak kelapa. Pada kondisi optimum, katalis 10% MM-SiO₂/CaO menghasilkan metil ester sebesar 85,89% pada suhu 60 °C, konsentrasi katalis 3%, waktu reaksi 1 jam, dan rasio mol minyak terhadap metanol 1:15. Uji penggunaan berulang hingga tiga siklus menunjukkan bahwa katalis 10% MM-SiO₂/CaO masih memiliki stabilitas yang cukup tinggi, sebesar 61,9%. Dengan demikian, katalis MM-SiO₂/CaO yang dihasilkan tidak hanya menunjukkan aktivitas yang tinggi dalam produksi metil ester, tetapi juga memiliki stabilitas yang cukup menjanjikan untuk pengembangan lebih lanjut sebagai katalis pada produksi biodiesel berkelanjutan.

Kata kunci: kalsium oksida, material magnetik, minyak kelapa, silika, transesterifikasi

***SYNTHESIS AND CHARACTERIZATION OF CaO-IMPREGNATED
MAGNETIC MATERIAL-SiO₂ CATALYST FOR TRANSESTERIFICATION
OF COCONUT OIL INTO METHYL ESTER***

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ABSTRACT

A heterogeneous base catalyst, CaO modified with magnetic SiO₂ material (MM-SiO₂/CaO), was successfully synthesized and characterized, and its performance in the conversion of coconut oil into methyl ester via transesterification was evaluated. The effects of reaction conditions on conversion yield, as well as catalyst stability through reusability tests, were also investigated.

A silica coating on the magnetic material was prepared by the sol-gel method using tetraethyl orthosilicate (TEOS) as the precursor and cetyltrimethylammonium bromide (CTAB) as the mesoporous structure-directing agent. The resulting material was subsequently modified via wet impregnation of CaO and calcined at 800 °C for 5 hours. Characterization was performed using XRD, XRF, FTIR, SAA, and FE-SEM EDX. Catalytic activity in the transesterification reaction was evaluated by varying reaction time, catalyst concentration, and the oil-to-methanol molar ratio.

The results showed that MM-SiO₂/CaO catalysts were successfully synthesized with MM-SiO₂ loadings of 10%, 20%, and 30% relative to the CaO mass. The percentage increase led to an increase in the specific surface area and the total specific pore volume. The 10% MM-SiO₂/CaO catalyst, exhibiting a specific surface area of 7.60 m²/g, a pore volume of 0.0528 cm³/g, and an average pore diameter of 27.77 nm, resulted in the highest activity in the transesterification of coconut oil. The optimum condition of the 10% MM-SiO₂/CaO catalyst in methyl ester yield of 85.89% was achieved at 60 °C, with a catalyst concentration of 3%, a reaction time of 1 hour, and an oil-to-methanol molar ratio of 1:15. Reusability tests up to three cycles demonstrated that the 10% MM-SiO₂/CaO catalyst maintained relatively good stability, with a yield of 61.9%. Overall, the synthesized MM-SiO₂/CaO catalyst exhibited good catalytic activity and promising stability, indicating its potential for further development in sustainable biodiesel production.

Keywords: calcium oxide, coconut oil, magnetic material, silica, transesterification