

THE EFFECT OF H₂C₂O₄ AND NaOH TREATMENT ON THE CHARACTER OF WONOSARI NATURAL ZEOLITE AS A NICKEL METAL SUPPORT CATALYST FOR HYDROCRACKING OF CASTOR OIL INTO BIOFUEL

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ABSTRACT

The chemical activation and metal loading of natural zeolite were reported to be effective in improving the catalytic activity of natural zeolite. In this work, the Si/Al ratio, acidity and morphology of zeolite were investigated. The effect of H₂C₂O₄ and NaOH treatment on the character of Wonosari natural zeolite (ZA) as a nickel metal support catalyst for hydrocracking of castor oil into biofuel had been evaluated.

Wonosari natural zeolite (ZA) was activated with H₂C₂O₄ solution under concentration variation of 0.5, 1, 1.5, and 3 M for 4 and 6 h (ZAA0.5-4, ZAA0.5-6, ZAA1-4, ZAA1-6, ZAA1.5-4, ZAA1.5-6, and ZAA3-4). Based on the XRF analysis, the highest Si/Al ratio (12.53) was achieved by ZAA3-4. The ZAA3-4 was then treated by 1 M NaOH (ZAA3-4D). The Ni metal was loaded on the ZAA3-4D by wet impregnation using salt precursor of Ni(NO₃)₂·6H₂O produced Ni/ZAA3-4D catalyst. The Ni/ZAA3-4D catalyst was calcined at 450 °C for 3 h under the N₂ gas flow and then reduced at 400 °C for 2 h under the H₂ gas flow. The ZAA3-4, ZAA3-4D, and Ni/ZAA3-4D were characterized using FT-IR, XRF, SEM-EDX, XRD, TEM and acidity test using adsorption of ammonia vapor. The hydrocracking of castor oil was done at temperature of 550 °C, the catalyst/feed weight ratio of 1:100 with 20 mL/min H₂ gas flow for 2 h. The hydrocracking products were analyzed using Gas Chromatography-Mass Spectroscopy (GC-MS).

The results showed that the Si/Al ratio of ZAA3-4D and Ni/ZAA3-4D catalyst was 8.5 and 5.19 respectively. The Ni/ZAA3-4D catalyst showed Ni content of 4.59% (w/w) with the highest crystallinity at 2θ=25.86° and the acidity of 2.2 mmol g⁻¹. The Ni/ZAA3-4D catalyst was the best catalyst, that produced liquid fraction of 76.32% (w/w) and selectivity towards gasoline fraction, diesel oil fraction and organic fraction were 13.03, 5.86, and 57.41% (w/w) respectively.

Keywords: Castor oil, hydrocracking, wet impregnation, Wonosari natural zeolite

**PENGARUH PERLAKUAN H₂C₂O₄ DAN NaOH TERHADAP
KARAKTER ZEOLIT ALAM WONOSARI SEBAGAI KATALIS
PENGEMBAN LOGAM NIKEL UNTUK HIDRORENGKAH MINYAK
JARAK MENJADI BIOFUEL**

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INTISARI

Aktivasi kimia dan pengembanan logam pada zeolit alam dilaporkan efektif dalam meningkatkan aktivitas katalitik zeolit alam. Pada studi ini, rasio Si/Al, keasaman dan morfologi zeolit diselidiki. Pengaruh perlakuan H₂C₂O₄ dan NaOH terhadap karakter zeolit alam (ZA) Wonosari sebagai katalis pengembanan logam nikel untuk hidrorengkah minyak jarak menjadi biofuel telah dievaluasi.

Zeolit alam Wonosari (ZA) diaktivasi dengan larutan H₂C₂O₄ dengan variasi konsentrasi 0,5, 1, 1,5, dan 3M selama 4 dan 6 jam (ZAA0.5-4, ZAA0.5-6, ZAA1-4, ZAA1-6, ZAA1.5-4, ZAA1.5-6, dan ZAA3-4). Berdasarkan analisis XRF, rasio Si/Al tertinggi (12,53) dicapai oleh ZAA3-4. Kemudian ZAA3-4 perlakuan dengan 1M NaOH (ZAA3-4D). Logam Ni diembankan pada ZAA3-4D dengan impregnasi basah menggunakan prekursor garam Ni(NO₃)₂·6H₂O menghasilkan katalis Ni/ZAA3-4D. Katalis Ni/ZAA3-4D dikalsinasi pada suhu 450 °C selama 3 jam di bawah aliran gas N₂ dan direduksi pada 400 °C selama 2 jam di bawah aliran gas H₂. ZAA3-4, ZAA3-4D, dan Ni/ZAA3-4D dikarakterisasi menggunakan FT-IR, XRF, SEM-EDX, XRD, TEM dan uji keasaman menggunakan adsorpsi uap amonia. Hidrorengkah minyak jarak dilakukan pada temperatur 550 °C, rasio berat katalis/umpan 1: 100 dengan aliran gas H₂ 20 mL/menit selama 2 jam. Produk hidorengkah dianalisis menggunakan *Gas Chromatography-Mass Spectroscopy* (GC-MS).

Hasil penelitian menunjukkan bahwa rasio Si/Al katalis ZAA3-4D dan Ni/ZAA3-4D berturut-turut adalah 8,5 dan 5,19. Katalis Ni/ZAA3-4D menunjukkan kandungan Ni sebesar 4,59% (b/b) dengan kristalinitas tertinggi pada 2θ=25,86° dan keasaman 2,2 mmol g⁻¹. Katalis Ni/ZAA3-4D merupakan katalis terbaik yang menghasilkan fraksi cair 76,32% (b/b) dan selektivitas terhadap fraksi bensin, minyak solar, dan organik berturut-turut sebesar 13,03, 5,86, dan 57,41% (b/b).

Kata kunci: Minyak jarak, hidorengkah, impregnasi basah, zeolit alam Wonosari