

KONVERSI LIMBAH SARUNG TANGAN LATEKS MENJADI BAHAN BAKAR GASOLIN MELALUI PIROLISIS-HYDROTREATMENT BERBANTUAN GELOMBANG MIKRO MENGGUNAKAN KATALIS Ni/ZSM-5, Mo/ZSM-5, DAN NiMo/ZSM-5

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INTISARI

Melimpahnya limbah sarung tangan lateks laboratorium yang belum diolah secara optimal serta meningkatnya kebutuhan bahan bakar kendaraan bermotor mendorong pengembangan metode konversi limbah berbasis polimer lateks untuk mendukung keberlanjutan energi. Penelitian ini melaporkan sintesis katalis nikel, molibdenum, dan nikel–molibdenum terimpregnasi pada ZSM-5 (Ni/ZSM-5, Mo/ZSM-5, dan NiMo/ZSM-5) menggunakan metode hidrotermal serta penerapannya dalam konversi produk cair hasil pirolisis limbah sarung tangan lateks laboratorium menjadi bahan bakar gasolin. Katalis dikarakterisasi menggunakan FTIR, XRD, XRF, XPS, NH₃-TPD, SAA, dan SEM-EDX *mapping*. Limbah sarung tangan lateks laboratorium dipirolisis dalam reaktor berpemanas gelombang mikro dengan variasi daya 100, 200, 400, 600, dan 800 W serta waktu iradiasi 10, 15, 20, 25, dan 30 menit, menghasilkan jumlah produk cair tertinggi pada 800 W selama 30 menit. Produk cair yang diperoleh digunakan sebagai umpan dalam proses *hydrotreatment* menggunakan reaktor yang sama dengan rasio katalis terhadap umpan 1:100 (b/b) dan laju alir gas H₂ sebesar 20 mL/menit. Produk cair hasil *hydrotreatment* dianalisis menggunakan GC-MS untuk menentukan *yield* gasolin (C₅-C₁₂). Katalis NiMo/ZSM-5 menunjukkan kinerja terbaik yang didukung oleh luas area spesifik tertinggi sebesar 203,60 m²/g, menghasilkan produk cair sebesar 78,18% (b/b) dan *yield* gasolin 76,39% (b/b) pada daya 800 W selama 40 menit. Katalis ini juga menunjukkan kemampuan *reusability* yang baik selama lima kali siklus *hydrotreatment*, dengan *yield* gasolin pada penggunaan kelima sebesar 42,98% (b/b). Katalis bekas setelah penggunaan kelima kemudian diregenerasi dan digunakan kembali dalam *hydrotreatment* menghasilkan *yield* gasolin sebesar 63,74% (b/b). Penelitian ini membuktikan potensi teknologi gelombang mikro sebagai metode yang menjanjikan untuk produksi bahan bakar berbasis limbah secara berkelanjutan.

Kata kunci: gelombang mikro, konversi katalitik, nikel–molibdenum, pengolahan limbah lateks, ZSM-5.

CONVERSION OF LATEX GLOVE WASTE INTO GASOLINE FUEL VIA MICROWAVE-ASSISTED PYROLYSIS-HYDROTREATMENT USING Ni/ZSM-5, Mo/ZSM-5, AND NiMo/ZSM-5 CATALYSTS

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ABSTRACT

The abundance of laboratory latex glove waste that has not been optimally treated, together with the increasing demand for transportation fuels, has driven the development of conversion methods for latex-based polymer waste to support energy sustainability. This study reports the synthesis of nickel, molybdenum, and nickel–molybdenum catalysts impregnated on ZSM-5 (Ni/ZSM-5, Mo/ZSM-5, and NiMo/ZSM-5) via a hydrothermal method and their application in the conversion of liquid products derived from the pyrolysis of laboratory latex glove waste into gasoline-range fuels. The catalysts were characterized using FTIR, XRD, XRF, XPS, NH₃-TPD, specific surface area analysis (SAA), and SEM–EDX mapping. Laboratory latex glove waste was pyrolyzed in a microwave-heated reactor at power levels of 100, 200, 400, 600, and 800 W and irradiation times of 10, 15, 20, 25, and 30 min, yielding the highest liquid product at 800 W for 30 min. The resulting liquid product was subsequently used as feedstock in a hydrotreatment process conducted in the same reactor with a catalyst-to-feed ratio of 1:100 (w/w) and a hydrogen gas flow rate of 20 mL/min. The hydrotreatment products were analyzed by GC–MS to determine the gasoline yield (C₅–C₁₂). The NiMo/ZSM-5 catalyst exhibited the best performance, supported by the highest specific surface area of 203.60 m²/g, producing 78.18 wt% liquid product and a gasoline yield of 76.39 wt% at 800 W for 40 min. This catalyst also demonstrated good reusability over five hydrotreatment cycles, with a gasoline yield of 42.98 wt% in the fifth cycle. The spent catalyst after the fifth cycle was regenerated and reused in the hydrotreatment, resulting in a gasoline yield of 63.74 wt%. Overall, this study demonstrates the potential of microwave-assisted technology as a promising and sustainable method for waste-based fuel production.

Keywords: catalytic conversion, latex waste treatment, microwave, nickel–molybdenum, ZSM-5.