

SINTESIS KARBON MESOPORI DARI LIMBAH KAYU MERBAU (*Intsia spp.*) SEBAGAI PENGEMBAN Ni, Co, Mo, NiMo DAN CoMo UNTUK KATALIS HIDRORENGKAH α -SELULOSA

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INTISARI

Sintesis karbon mesopori dari limbah kayu merbau (*Intsia spp.*) sebagai pengemban Ni, Co, Mo, NiMo dan CoMo untuk katalis hidrorengkah α -selulosa telah dilakukan. Tujuan penelitian ini adalah mendapatkan kondisi optimum preparasi karbon mesopori secara pirolisis, memperoleh karakteristik karbon hasil modifikasi jenis logam, memperoleh data aktivitas dan selektivitas berdasarkan jenis katalis logam serta rasio umpan terhadap katalis dan mengetahui umur katalis pada reaksi hidrorengkah *bio oil* α -selulosa. Bio oil α -selulosa sebagai senyawa rujukan untuk material lignoselulosa yang berpotensi sebagai sumber energi terbarukan. Tahap preparasi menghasilkan dua belas sampel hasil variasi temperatur dan lama karbonisasi, serta satu sampel variasi perlakuan hidrotermal. Preparasi optimum untuk menghasilkan karbon sebagai pengemban logam dilakukan melalui karbonisasi tanpa pra-perlakuan hidrotermal, yaitu pada temperatur pirolisis 700 °C selama 2 jam (C72), berkaitan data luas permukaan dan ukuran pori optimal. Impregnasi logam Ni, Co, Mo, NiMo dan CoMo dilakukan menggunakan metode impregnasi basah. Material karbon dan katalis yang dihasilkan dikarakterisasi dengan XRD, uji keasaman berdasarkan absorpsi uap basa amonia, titrasi Boehm, FT-IR, GSA, SEM-EDX. Katalis Ni/C72, Co/C72, Mo/C72, NiMo/C72 dan CoMo/C72 dipelajari aktivitas dan selektivitasnya pada reaksi hidrorengkah α -selulosa. Produk hidrorengkah dikarakterisasi menggunakan GC-MS. Nilai selektivitas senyawa hidrokarbon tertinggi diperoleh pada penggunaan katalis NiMo/C72 dengan rasio 20:1, berdasarkan tahap optimasi jenis logam dan rasio umpan terhadap katalis. Penentuan umur katalis dilakukan menggunakan katalis NiMo/C72 dengan rasio 20:1 pada reaksi hidrorengkah sebanyak lima kali penggunaan tanpa adanya proses regenerasi katalis. Katalis pada uji umur katalis dikarakterisasi menggunakan TEM, sedangkan kemampuan konversi produk cair digunakan untuk menentukan umur katalis.

Data luas permukaan, volume total pori, rerata diameter pori dan keasaman berdasarkan absorpsi gas ammonia, masing-masing pada C72 dan NiMo/C72 sebesar 330,312 dan 259,295 ($\text{m}^2 \cdot \text{g}^{-1}$), 0,227 dan 0,152 ($\text{cm}^3 \cdot \text{g}^{-1}$), 2,758 dan 2,355 (nm), serta 2,963 dan 3,021 ($\text{mmol} \cdot \text{g}^{-1}$). Proses *up grading bio oil* melalui hidrorengkah diperoleh secara optimal menggunakan katalis NiMo/C72 pada rasio 20:1. Keefektifan katalis dipelajari melalui peningkatan jumlah golongan senyawa yang diharapkan, yaitu menjadi sebesar 35,105% b/b berupa alkohol, furan, fenol dan hidrokarbon (diketahui bahwa produk golongan yang diharapkan dari proses pirolisis sebesar 8,762% b/b). Selain itu, mampu mengurangi golongan senyawa yang tidak diharapkan, yaitu menjadi sebesar 28,181% b/b berupa gula-anhidro, aldehid, keton dan asam (diketahui bahwa jumlah produk yang tidak diharapkan dari proses pirolisis sebesar 51,291% b/b). Umur katalis NiMo/C72 pada rasio 20:1

yaitu selama 6,240 jam, dengan mempertimbangkan asumsi adanya pengaruh hidrorengkah termal/tanpa katalis.

Kata kunci: karbon mesopori, kayu merbau, pengemban logam, hidrorengkah, α -selulosa

**SYNTHESIS OF MESOPOROUS CARBON FROM MERBAU WOOD
WASTE (*Intsia spp.*) AS SUPPORT OF Ni, Co, Mo, NiMo, AND CoMo FOR
CATALYZING α -CELLULOSE HYDROCRACKING**

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ABSTRACT

Synthesis of mesoporous carbon from merbau wood waste (*Intsia spp.*) as support of Ni, Co, Mo, NiMo, and CoMo for the catalyst of hydrocracking α -cellulose has been carried out. The purpose of this study was to obtain the optimum conditions for the preparation of mesoporous carbon by pyrolysis, to achieve the modified carbon characteristics using the kind of metal, to obtain the activity and selectivity based on the type of metals doped and the ratio of feed to, and to achieve the age of the catalyst in the α -cellulose hydrocracking reaction. Bio oil of α -cellulose as a reference compound for lignocellulosic material which has the potential as a renewable energy source. The preparation stage produced twelve samples of variations in temperature and duration of carbonization, as well as one sample of variations in hydrothermal treatment. The optimum preparation to produce carbon as metal support carried out by pyrolysis conditions at a temperature of 700 °C for 2 hours (C72) due to the optimal surface area and the size of pore data. The impregnation of Ni, Co, Mo, NiMo, and CoMo metals was carried out using the wet impregnation method. The resulting carbon and catalyst materials are characterized by XRD, acidity test based on ammonia base vapor absorption, Boehm titration, FT-IR, GSA, SEM-EDX. The Ni/C72, Co/C72, Co/C72, NiMo/C72, and CoMo/C72 catalysts were studied for their activity and selectivity in the α -cellulose bio oil hydrocracking reaction. The hydrocracking products were characterized using GC-MS. The highest value of selectivity for hydrocarbons was obtained when using the NiMo/C72 with a ratio of 20:1, based on the type of metals doped and the ratio of feed to the catalyst. The determination of the catalyst age was carried out using a NiMo/C72 catalyst with a ratio of 20:1 in the hydrocracking reaction for five times without the catalyst regeneration process. The catalyst in this step was characterized using TEM, while the conversion ability of the liquid product was used to determine the catalyst age.

The surface area, total pore volume, mean pore diameter, and acidity based on the absorption of ammonia gas, respectively at C72 and NiMo/C72 were 330.312 and 259.295 (m².g⁻¹), 0.227 and 0.152 (cm³.g⁻¹), 2.758 and 2.355 (nm), and 2.963, and 3.021 (mmol.g⁻¹). The process of upgrading bio oil through hydrocracking was obtained optimally using a NiMo/C72 catalyst at a ratio of 20:1. The effectiveness of the catalyst was studied by increasing the desired number of compound groups of 35.105% w/w in the form of alcohol, furans, phenols, and hydrocarbons (it is known that the desired group products from the pyrolysis process are 8.762% w/w). In addition, it can reduce undesired compound groups, was 28.181% w/w in the form of anhydro-sugars, aldehyde, ketones, and acids (it is known that the number of undesired products from the pyrolysis process was

51.291% w/w). The lifetime of the NiMo/C72 catalyst at a ratio of 20:1 was 6.240 hours, taking into account the assumption that there is an effect of thermal cracking/no catalyst.

Keywords: mesopore carbon, merbau wood, metal support, hydrocracking, α -cellulose