ABSTRAK

Tiara Ramadhani, NIM 4213210021 (2021). Sintesis Katalis Bifungsional Co-Mo/Biochar Cangkang Sawit dan Uji Aktivitasnya Pada Reakasi Hidrodeoksigenasi (HDO) Bio-Oil Cangkang Sawit.

Bio-oil dari limbah cangkang kelapa sawit sangat potensial sebagai sumber energi terbarukan namun memiliki keterbatasan berupa densitas tinggi, viskositas besar, serta kandungan oksigen yang tinggi yang menyebabkan sifat kimianya menjadi kurang stabil. Karena itu diperlukan proses *upgradin*g melalui reaksi HDO dengan menggunakan katalis yang efektif untuk meningkatkan mutu bio oil sebagai bahan bakar. Penelitian ini bertujuan untuk menyintesis, mengkarakterisasi dan menguji efektivitas katalis bifungsional Co-Mo/biochar dari limbah cangkang kelapa sawit pada reaksi hidrodeoksigenasi (HDO) *bio-oil*. Biochar dihasilkan melalui proses pirolisis cangkang kelapa sawit pada suhu 550 ℃ selama 2 jam, dilanjutkan proses aktivasi menggunakan KOH 2M dan HCl 1M. Biochar teraktivasi lalu diembankan logam Co dan Mo dengan metode impregnasi basah secara refluks pada suhu 80 ℃ selama 5 jam, sehingga diperoleh katalis Co-Mo/biochar. Katalis Co-Mo/biochar dikarakterisasi menggunakan XRD, FTIR, BET, dan SEM-EDX. Data menunjukkan katalis Co-Mo/biochar bersifat amorfus dengan luas permukaan 203,064 m^2/g, serta partikel logam terdispersi merata pada permukaan biochar. Uji aktivitas katalis dilakukan pada reaksi HDO *bio-oil* cangkang sawit dengan kondisi optimum diperoleh pada suhu 325°C. Produk *bio-oil* hasil HDO menunjukkan peningkatan sifat fisikokimia, dengan densitas menurun dari 1,103 g/cm^3 menjadi 0,937 g/cm^3 (biochar teraktivasi) dan 0,924 g/cm^3 (Co-Mo/biochar); viskositas berkurang dari 6,72 cSt menjadi 1,36 cSt (biochar teraktivasi) dan 1,42 cSt (Co-Mo/biochar); serta bilangan asam turun signifikan dari 188,66 mg KOH/g oil menjadi 32,66 mg KOH/g oil (biochar teraktivasi) dan 23,56 mg KOH/g oil (Co-Mo/biochar). Analisis GC-MS memperlihatkan peningkatan fraksi hidrokarbon serta penurunan senyawa oksigenat seperti metoksi dan furan. Katalis Co-Mo/biochar mampu meningkatkan *yield* fase cair *bio-oil* hingga 80,04 wt% dengan selektivitas produk fenolik 65% dan senyawa metoksi sebesar 14,31%. Dengan demikian, katalis bifungsional Co-Mo/biochar berpotensi sebagai alternatif efektif dalam *upgrading bio-oil* menuju bahan bakar cair yang lebih stabil dan ramah lingkungan.

Kata kunci: Katalis, Cangkang Kelapa Sawit, Hidrodeoksigenasi, Biochar, Co-Mo.

ABSTRACT

Tiara Ramadhani, NIM 4213210021 (2021). Synthesis of Bifunctional Co-Mo/Biochar Catalyst from Palm Kernel Shell and Its Activity Test in the Hydrodeoxygenation Reaction of Palm Kernel Shell Bio-Oil

Bio-oil derived from oil palm shell waste has great potential as a renewable energy source; however, it faces limitations such as high density, high viscosity, and elevated oxygen content, which contribute to its chemical instability. Therefore, an upgrading process through a hydrodeoxygenation (HDO) reaction using an effective catalyst is required to improve the quality of bio-oil as a fuel. This study aims to synthesize, characterize, and evaluate the effectiveness of a bifunctional Co-Mo/biochar catalyst derived from oil palm shell waste in the HDO reaction of bio-oil. Biochar was produced through pyrolysis of oil palm shells at 550 °C for 2 hours, followed by activation using 2 M KOH and 1 M HCl. The activated biochar was then impregnated with Co and Mo metals using the wet impregnation method under reflux at 80 °C for 5 hours to obtain the Co-Mo/biochar catalyst. The catalyst was characterized using XRD, FTIR, BET, and SEM-EDX analyses. The results indicated that the Co-Mo/biochar catalyst exhibited an amorphous structure with a surface area of 203.064 m^2/g, and the metal particles were uniformly dispersed on the biochar surface. The catalytic activity was evaluated through the HDO reaction of bio-oil derived from palm shells, with the optimum condition obtained at 325 °C. The upgraded bio-oil showed improved physicochemical properties: density decreased from 1.103 g/cm^3 to 0.937 g/cm^3 (activated biochar) and 0.924 g/cm^3 (Co-Mo/biochar); viscosity was reduced from 6.72 cSt to 1.36 cSt (activated biochar) and 1.42 cSt (Co-Mo/biochar); while the acid number significantly decreased from 188.66 mg KOH/g oil to 32.66 mg KOH/g oil (activated biochar) and 23.56 mg KOH/g oil (Co-Mo/biochar). GC-MS analysis showed an increase in hydrocarbon fractions and a reduction in oxygenated compounds such as methoxy and furan derivatives. The Co-Mo/biochar catalyst enhanced the liquid-phase bio-oil yield up to 80.04 wt%, with product selectivity toward phenolic compounds at 65% and methoxy compounds at 14.31%. Therefore, the bifunctional Co-Mo/biochar catalyst demonstrates strong potential as an effective alternative for bio-oil upgrading toward a more stable and environmentally friendly liquid fuel.

Keywords: Catalyst, Palm Kernel Shell, Hydrodeoxygenation, Biochar, Co-Mo