

PREPARASI KATALIS NiFe/ γ -Al₂O₃ TEREDUKSI GAS H₂ ATAU NaBH₄ UNTUK *HYDROTREATMENT* MINYAK LARVA BLACK SOLDIER FLY (*Hermetia illucens*) MENJADI BIOAVTUR

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INTISARI

Preparasi katalis NiFe/ γ -Al₂O₃ dengan bantuan gelombang ultrasonik untuk proses *hydrotreatment* minyak larva Black Soldier Fly (*Hermetia illucens*) menjadi bioavtur telah dilakukan. Penelitian ini bertujuan untuk mempelajari pengaruh reduksi H₂ dan NaBH₄ terhadap kinerja katalis serta menganalisis reusabilitas katalis dalam proses *hydrotreatment* minyak larva BSF menjadi bioavtur. Impregnasi katalis dilakukan dengan menyemprotkan prekursor logam Ni dan Fe ke γ -Al₂O₃ dilanjutkan ultrasonikasi. Katalis dikalsinasi dengan gas N₂ pada temperatur 500 °C kemudian direduksi dengan gas H₂ atau NaBH₄. Karakterisasi katalis menggunakan instrumen XRD, FTIR, SEM-EDX, NH₃-TPD, dan XPS. Aktivitas kedua katalis diuji melalui proses *hydrotreatment* minyak larva BSF dalam reaktor *stainless steel semi-batch* dengan pemanas ganda pada rentang temperatur 100–600 °C dengan kenaikan 25 °C serta laju alir gas H₂ 20 mL menit⁻¹. Produk cair dianalisis dengan GC-MS dan FTIR sementara *spent* katalis dianalisis dengan SEM-EDX.

Hasil penelitian menunjukkan bahwa karakteristik katalis NiFe/ γ -Al₂O₃/H₂ dan NiFe/ γ -Al₂O₃/NaBH₄ secara berturut-turut memiliki kandungan logam Ni sebesar 7,38 dan 6,61%, logam Fe sebesar 4,55 dan 1,76% dengan spesies logam Ni, NiO, Fe₂O₃, dan Fe₃O₄, serta keasaman 1,5021 dan 2,0931 mmol g⁻¹. Total konversi dan selektivitas terbaik diberikan katalis NiFe/ γ -Al₂O₃/NaBH₄ mencapai 33,87 dan 84,98% sementara NiFe/ γ -Al₂O₃/H₂ hanya 21,16 dan 82,54%. Katalis NiFe/ γ -Al₂O₃/NaBH₄ menunjukkan stabilitas relatif stabil setelah pemakaian berulang sebanyak tiga kali dengan total konversi dan selektivitas 31,89 dan 83,53% untuk *reuse* 2 serta 25,65 dan 82,95% untuk *reuse* 3.

Kata kunci: bioavtur, *hydrotreatment*, katalis NiFe/ γ -Al₂O₃, minyak larva BSF, NaBH₄, reduksi

PREPARATION OF NiFe/ γ -Al₂O₃ CATALYST REDUCED BY H₂ GAS OR NaBH₄ FOR HYDROTREATMENT OF BLACK SOLDIER FLY (*Hermetia illucens*) LARVAE INTO BIOAVTUR

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ABSTRACT

Preparation of NiFe/ γ -Al₂O₃ catalyst with the help of ultrasonic waves for the hydrotreatment process of Black Soldier Fly (*Hermetia illucens*) larvae oil into bioavtur has been carried out. This study aims to study the effect of H₂ and NaBH₄ reduction on catalyst performance and analyze the reusability of the catalyst in the hydrotreatment process of Black Soldier Fly larvae oil into bioavtur. Catalyst impregnation was carried out by spraying Ni and Fe metal precursors onto γ -Al₂O₃ followed by ultrasonication. The catalyst was calcined with N₂ gas at a temperature of 500 °C then reduced with H₂ or NaBH₄. Catalyst characterization used XRD, FTIR, SEM-EDX, NH₃-TPD, and XPS instruments. The activity of both catalysts was tested through the hydrotreatment of Black Soldier Fly (*Hermetia illucens*) larval oil in a semi-batch stainless steel reactor with double heaters at a temperature range of 100-600°C with a 25°C increment and a H₂ gas flow rate of 20 mL.min⁻¹. The liquid product was analyzed by GC-MS and FTIR, while the spent catalyst was analyzed by SEM-EDX.

The results showed that the NiFe/ γ -Al₂O₃/H₂ and NiFe/ γ -Al₂O₃/NaBH₄ catalysts had Ni metal contents of 7.38 and 6.61%, Fe metal contents of 4.55 and 1.76%, respectively, with Ni, NiO, Fe₂O₃, and Fe₃O₄ metal species, and acidity of 1.5021 and 2.0931 mmol g⁻¹, respectively. The best total conversion and selectivity for the NiFe/ γ -Al₂O₃/NaBH₄ catalyst reached 33.87 and 84.98%, respectively, while NiFe/ γ -Al₂O₃/H₂ only achieved 21.16 and 82.54%. The NiFe/ γ -Al₂O₃/NaBH₄ catalyst showed relatively stable stability after three repeated uses with total conversion and selectivity of 31.89 and 83.53% for reuse 2 and 25.65 and 82.95% for reuse 3.

Keywords: bioavtur, BSF larvae oil, hydrotreatment, NaBH₄, NiFe/ γ -Al₂O₃ catalyst, reduction