

KATALIS KOBALT TERIMPREGNASI PADA γ -Al₂O₃ TERAKTIVASI GELOMBANG ULTRASONIK UNTUK *HYDROTREATMENT* MINYAK NYAMPLUNG (*Calophyllum inophyllum* L.) MENJADI BIOAVTUR

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INTISARI

Preparasi dan aplikasi katalis kobalt terimpregnasi pada γ -Al₂O₃ teraktivasi gelombang ultrasonik untuk *hydrotreatment* minyak nyamplung (*Calophyllum inophyllum* L.) menjadi bioavtur telah dilakukan. Penelitian ini bertujuan untuk mempelajari pengaruh reduktor gas hidrogen (H₂) dan asam sitrat terhadap aktivitas katalis Co/ γ -Al₂O₃ serta stabilitas katalis dalam penggunaan berulang pada proses *hydrotreatment* minyak nyamplung menjadi bioavtur. Preparasi katalis Co/ γ -Al₂O₃ dilakukan dengan impregnasi kering larutan prekursor kobalt(II) nitrat heksahidrat (Co(NO₃)₂·6H₂O) dari limbah baterai Li-NMC ke penyangga γ -Al₂O₃ yang dilanjutkan dengan sonikasi. Katalis Co/ γ -Al₂O₃ dikalsinasi dengan gas nitrogen (N₂) selama 3 jam pada suhu 500 °C kemudian direduksi oleh gas H₂ dan larutan asam sitrat (C₆H₈O₇) hingga dihasilkan katalis Co/ γ -Al₂O₃/H₂ dan Co/ γ -Al₂O₃/CA. Katalis Co/ γ -Al₂O₃/H₂ dan Co/ γ -Al₂O₃/CA kemudian dikarakterisasi dengan instrumen XRD, FTIR, SEM-EDX, NH₃-TPD, dan XPS. Uji aktivitas katalis dilakukan dengan reaktor *stainless-steel* semi-batch. Proses *hydrotreatment* minyak nyamplung dilakukan pada rentang temperatur 200–600 °C dengan kenaikan 20 °C dan dialiri gas H₂ dengan laju alir 20 mL/menit. Produk cair hasil proses *hydrotreatment* dianalisis dengan instrumen FTIR dan GC-MS.

Berdasarkan hasil penelitian, konversi produk cair, selektivitas, dan *yield* bioavtur tertinggi dihasilkan oleh katalis Co/ γ -Al₂O₃/CA berturut-turut sebesar 45,19%; 79,71%; dan 36,02%. Sementara itu, konversi produk cair, selektivitas, dan *yield* bioavtur dari katalis Co/ γ -Al₂O₃/H₂ berturut-turut sebesar 39,50%; 68,59%; dan 27,10%. Keasaman total katalis Co/ γ -Al₂O₃/CA lebih tinggi dibandingkan katalis Co/ γ -Al₂O₃/H₂, secara berturut-turut sebesar 6,15 mmol g⁻¹ dan 2,09 mmol g⁻¹. Katalis Co/ γ -Al₂O₃/CA memiliki performa yang menjanjikan setelah uji *reuseability* dengan konversi produk cair pada penggunaan kedua dan ketiga, secara berurutan sebesar 41,02% dan 35,09%.

Kata kunci: asam sitrat, bioavtur, γ -Al₂O₃, *hydrotreatment*, minyak nyamplung

COBALT CATALYST IMPREGNATED ON γ -Al₂O₃ ACTIVATED BY ULTRASOUND WAVES FOR HYDROTREATMENT OF NYAMPLUNG OIL (*Calophyllum inophyllum* L.) INTO BIOAVTUR

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ABSTRACT

Preparation and application of cobalt catalyst impregnated on γ -Al₂O₃ activated by ultrasound waves for hydrotreatment of nyamplung (*Calophyllum inophyllum* L.) oil into bioavtur have been conducted. This research aims to study the effect of hydrogen gas (H₂) and citric acid reducing agents on the activity of the Co/ γ -Al₂O₃ catalyst, as well as the catalyst's stability during reuseability test in the hydrotreatment process of nyamplung oil into bioavtur. The preparation of the Co/ γ -Al₂O₃ catalyst was carried out by dry impregnation of a cobalt(II) nitrate hexahydrate (Co(NO₃)₂·6H₂O) precursor solution derived from Li-NMC battery waste onto a γ -Al₂O₃ support, followed by sonication. The Co/ γ -Al₂O₃ catalyst was calcined with nitrogen (N₂) gas for 3 hours at 500 °C, and then reduced using H₂ gas and citric acid (C₆H₈O₇) solution to produce Co/ γ -Al₂O₃/H₂ and Co/ γ -Al₂O₃/CA catalysts. The Co/ γ -Al₂O₃/H₂ and Co/ γ -Al₂O₃/CA catalysts were then characterized using XRD, FTIR, SEM-EDX, NH₃-TPD, and XPS instruments. The catalyst activity test was conducted using a semi-batch stainless-steel reactor. The hydrotreatment process of nyamplung oil was carried out in a temperature range of 200–600 °C with 20 °C increments and flowed with H₂ gas at a flow rate of 20 mL/min. The liquid product from the hydrotreatment process was analyzed using FTIR and GC-MS instruments.

Based on the research results, the highest liquid product conversion, selectivity, and biojet fuel yield were produced by the Co/ γ -Al₂O₃/CA catalyst at 45.19%; 79.71%; and 36.02%; respectively. Meanwhile, the liquid product conversion, selectivity, and bioavtur yield from the Co/ γ -Al₂O₃/H₂ catalyst were 39.50%; 68.59%; and 27.10%; respectively. Total acidity of the Co/ γ -Al₂O₃/CA catalyst was higher than that of the Co/ γ -Al₂O₃/H₂ catalyst, at 6.15 mmol g⁻¹ and 2.09 mmol g⁻¹, respectively. The Co/ γ -Al₂O₃/CA catalyst demonstrated promising performance after the reusability test, with liquid product conversion in the second and third uses at 41.12% and 35.09%, respectively.

Keywords: bioavtur, citric acid, γ -Al₂O₃, hydrotreatment, nyamplung oil