

## PREPARATION OF COBALT-SUPPORTED-SBA-15 CATALYSTS BY WET AND CO-IMPREGNATION METHODS FOR HYDROTREATING OF PYROLYZED $\alpha$ -CELLULOSE

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### ABSTRACT

Preparation of cobalt supported on SBA-15 catalysts had been done. Cobalt was impregnated on SBA-15 by the wet impregnation method using  $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  as a salt precursor in aqueous solution. For the co-impregnation method, ethylene glycol (EG) was added into the  $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  solution with a molar ratio (Co: EG) of 1:1 and was mixed with SBA-15. The synthesized Co/SBA-15 was calcined at 500 °C for 5 hours to produce CoO/SBA-15c and CoO/SBA-15w catalysts, followed by reduction by  $\text{H}_2$  gas at 400 °C for 3 hours and producing Co/SBA-15c and Co/SBA-15w catalyst. The catalysts were characterized using  $\text{NH}_3$  adsorption analyzer, Atomic Absorption Spectrophotometer (AAS), X-Ray Diffractometer (XRD), Transmission Electron Microscope (TEM), and Gas Sorption Analyzer (GSA). The prepared catalysts were used for hydrotreating of pyrolyzed  $\alpha$ -cellulose in the semi-batch reactor at 450 °C for 2 hours under  $\text{H}_2$  gas stream ( $20 \text{ cm}^3 \text{ min}^{-1}$ ). Kinetics of liquid production in the hydrotreating of pyrolyzed  $\alpha$ -cellulose using Co/SBA-15w catalyst had been studied.

The results showed that Co/SBA-15c has the best catalytic performance compared to the other catalysts with the acidity of  $7.42 \text{ mmole g}^{-1}$ ; Co content of 7.97%; specific surface area of  $432.263 \text{ m}^2 \text{ g}^{-1}$ ; conversion of liquid product of 70.37%. On the other hand, the Co/SBA-15w has the acidity of  $6.33 \text{ mmole g}^{-1}$ ; Co content of 6.43%; specific surface area of  $337.713 \text{ m}^2 \text{ g}^{-1}$ ; conversion of liquid product of 72.72%. Kinetic study showed that the formation of liquid product from hydrotreating of pyrolyzed  $\alpha$ -cellulose followed the first order model with a rate constant (k) of  $0.0095 \text{ min}^{-1}$ .

Keywords: Cobalt, SBA-15,  $\alpha$ -cellulose, Pyrolysis, and Hydrotreating

**PEMBUATAN KATALIS COBALT DIEMBANKAN PADA SBA-15  
DENGAN METODE IMPREGNASI BASAH DAN KO-IMPREGNASI  
UNTUK HYDROTREATING  $\alpha$ -SELULOSA TERPIROLISIS**

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**INTISARI**

Pembuatan katalis kobalt yang diembankan pada SBA-15 telah dilakukan. Kobalt di impregnasi pada SBA-15 menggunakan  $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  sebagai garam precursor pada pelarut air untuk metode impregnasi basah. Metode ko-impregnasi dilakukan dengan cara menambahkan etilen glikol pada larutan  $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  dengan rasio molar (Co:EG) 1:1 dan dicampur dengan SBA-15. Sampel Co/SBA-15 yang telah disintesis lalu dikalsinasi pada suhu  $500^\circ\text{C}$  selama 5 jam, menghasilkan katalis CoO/SBA-15c dan CoO/SBA-15w, dilanjutkan dengan reduksi menggunakan gas  $\text{H}_2$  pada suhu  $400^\circ\text{C}$  selama 3 jam dan menghasilkan katalis Co/SBA-15c dan Co/SBA-15w. Katalis-katalis tersebut dikarakterisasi menggunakan adsorpsi  $\text{NH}_3$  (total situs asam), Spektrofotometer Serapan Atom (SSA), *X-Ray Diffractometer (XRD)*, *Transmission Electron Microscope (TEM)*, dan *Gas Sorption Analyzer (GSA)*. Katalis yang telah dibuat digunakan untuk *hydrotreating*  $\alpha$ -selulosa terpirolisis pada reaktor *semi-batch* pada suhu  $450^\circ\text{C}$  selama 2 jam menggunakan aliran gas  $\text{H}_2$  ( $20\text{ cm}^3\text{ min}^{-1}$ ). Kinetika pembentukan produk cair pada *hydrotreating*  $\alpha$ -selulosa terpirolisis telah dipelajari.

Hasil penelitian menunjukkan bahwa katalis Co/SBA-15c merupakan katalis dengan performa terbaik dibanding katalis lainnya dengan keasaman sebesar  $7,42\text{ mmol g}^{-1}$ ; kandungan Co sebesar  $7,97\%$ ; luas area spesifik sebesar  $432,263\text{ m}^2\text{ g}^{-1}$ ; konversi produk cair sebesar  $70,37\%$ . Menggunakan Co/SBA-15w terdeteksi keasaman sebesar  $6,33\text{ mmol g}^{-1}$ ; kandungan Co sebesar  $6,43\%$ ; luas area spesifik sebesar  $337,713\text{ m}^2\text{ g}^{-1}$ ; konversi produk cair sebesar  $72,72\%$ . Studi kinetika menunjukkan bahwa pembentukan produk cair pada *hydrotreating*  $\alpha$ -selulosa terpirolisis menggunakan orde pertama dengan konstanta laju (k) sebesar  $0,0095\text{ min}^{-1}$ .

Keyword: Kobalt, SBA-15,  $\alpha$ -selulosa, Pirolisis, *Hydrotreating*