ONLINE ISSN : 1349-273X
PRINT ISSN : 1346-8804

Journal of the Japan Petroleum Institute
Vol. 48 (2005) , No. 4 pp.197-203

Dimethyl Ether Synthesis from Carbon Dioxide by Catalytic Hydrogenation (Part 3) Direct Synthesis Using Hybrid Catalyst by Recycling Process

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(Received: July 8, 2004)

A hybrid catalyst consisting of a methanol synthesis catalyst and a methanol dehydration catalyst was used for the direct synthesis of dimethyl ether (DME) from CO_2 and H_2.

Particle-shaped hybrid catalyst (MD-12) and pellet-shaped hybrid catalyst (MD-13) gave similar results for the DME synthesis. In the MD-13 hybrid catalyst, the activity of the methanol synthesis catalyst slightly decreased whereas the activity of the methanol dehydration catalyst did not decrease during the durability test for 2000 h at 563 K. One-path and recycling experiments for MD-13 were carried out using the bench plant. The methanol synthesis reaction was retarded due to the equilibrium restriction at elevated temperatures. In contrast, the methanol dehydration reaction was promoted with increase in temperature at 543-563 K. The combined yield of methanol and DME was slightly decreased whereas the DME selectivity was remarkably increased. The methanol synthesis reaction was promoted with increase in pressure at 4-8 MPa. However, the methanol dehydration reaction was less promoted. As a result, the combined yield of methanol and DME increased, and the DME selectivity decreased. This observation was consistent with the simulation of reaction rate. Higher reaction temperature and higher recycling rate as well as lower reaction pressure favored higher CO_2 conversion, combined yield of methanol

and DME, and DME selectivity.

Keywords: Carbon dioxide, Hydrogenation, Dimethyl ether, Direct synthesis, Hybrid catalyst

To cite this article:

Masaki Hirano, Toshinobu Yasutake and Kennosuke Kuroda, *Journal of the Japan Petroleum Institute*, Vol. **48**, No. 4, p.197 (2005) .

doi:10.1627/jpi.48.197

JOI JST.JSTAGE/jpi/48.197