Conversion of Coal-Derived, CO-Rich Syngas to DME using a Hybrid Catalysts in a Slurry Reactor

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This study investigated one-step dimethyl ether (DME) synthesis from coal-derived, CO-rich syngas over the hybrid catalyst comprising a methanol synthesis catalyst ($Cu/ZnO/Al_2O_3$) and a methanol dehydration catalyst (γ-Al_2O_3). The liquid-phase DME synthesis was carried out in a slurry reactor that provided good mixing and excellent heat removal. Reaction temperature and pressure showed a similar positive effect on DME synthesis. A lower gas hourly space velocity (GHSV) caused a higher CO conversion, but a lower DME space time yield (STY). The excessive content of γ-Al_2O_3 had an adverse effect on both CO conversion and DME STY. Among various H_2:CO ratios, the maximum DME STY (13.5 mol/kg-cat/hr) was observed at a H_2:CO ratio of 1.0. CO_2 in the feed syngas had a negative effect on DME synthesis. After operation of 5 hr, CO conversion and DME STY showed a slight decline due to the evaporation of mineral oil with suspended catalysts and the catalyst deactivation. The results obtained in this study can be used as basic data for the design and operation of a large scale bubble column reactor and for further application to a three-phase fluidized bed reactor.