Ethanol synthesis from syngas via DME carbonylation: Catalysts and fluidized-bed reactor application

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A multi-step conversion of syngas to ethanol via dimethyl ether (DME) carbonylation to methyl acetate (MA) was investigated using novel ferrierite-based heterogeneous catalyst and its application to fluidized-bed reactor with two-phase segregation was studied. The ethanol can be synthesized through multi-step reactions such as (1) syngas conversion to DME, (2) DME carbonylation to MA, and (3) hydrogenation of MA to ethanol. In the present study, an integrated fluidized-bed reactor application using two-phase segregation phenomena with two different catalyst-beds having different particle densities or sizes was proposed to simplify the process by integrating two multi-step reactors. For a heterogeneous catalyst development, ordered mesoporous Cu/Al2O3 catalyst was applied for a direct syngas conversion to DME, and ferrierite zeolite was applied for DME carbonylation to MA as well. To apply compact fluidized-bed reactor, a simulation of two catalyst-bed fluidization was carried out, and optimal Umf (minimum fluidization velocity) and particle sizes of each catalyst-bed was selected.