Syngas conversion to ethanol or acetic acid via DME carbonylation to methyl acetate: Catalysts and fluidized-bed reactor application

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An indirect syngas conversion to acetic acid (or ethanol) through multi-step reactions via dimethyl ether (DME) carbonylation to methyl acetate (MA) was investigated in terms of the heterogeneous catalysts and fluidized-bed reactor application. The acetic acid (AA) or ethanol can be synthesized through the multi-step such as (1) syngas conversion to DME, (2) DME carbonylation to MA, and (3) hydration of MA to AA or hydrogenation of MA to ethanol which is similar with the BP-SasBre process [**1**].

In the present investigation, the integrated fluidized-bed reactor application using a layer-inversion technology with two different catalyst-beds having different particle densities [**2**] was proposed to simplify the process by integrating two multi-step reactors as shown in **Figure 1**. Based on the proposed reaction schemes with activity tests, AA or ethanol can be produced with a maximum yield of 60%, which is much higher than the direct synthesis method of AA or ethanol from syngas due to a less formation of byproducts [**3,4**]. For a heterogeneous catalyst development, ordered mesoporous Cu/Al_2O_3 catalyst was applied for syngas conversion to DME [**5**] as shown in **Figure 2**, and Ferrierite zeolite was applied for DME carbonylation to MA as reported from our group [**6**]. To apply to compact fluidized-bed reactor (layer-inversion), a simulation of two catalyst-bed fluidization by a layer-inversion technology was carried out, and optimal U_{mf} (minimum fluidization velocity) and particle sizes of each catalyst-bed was selected. The production of AA or ethanol by multi-step reactions from syngas seem to be alternative and efficient routes to replace conventional commercialized processes.

As shown in **Figure 1** and **2**, the ordered mesoporous Cu/Al_2O_3 was found to be highly stable by suppressing aggregation of copper nanoparticles due to an enhanced confinement effects, and a high crystallinity and acidity of Ferrierite prepared by using a seeding material can also enhance the conversion of DME to MA with a high selectivity as well.

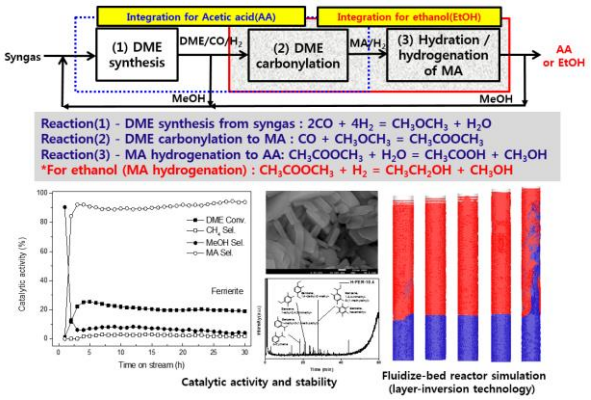

Figure 1. Proposed multi-step reactions of syngas conversion to AA or ethanol using a compact fluidized-bed reactor

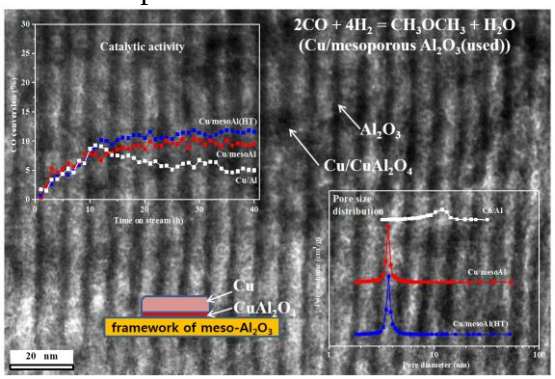

Figure 2. Stability of the ordered mesoporous Cu/Al_2O_3 for syngas conversion to DME

A process integration of syngas conversion to AA or ethanol is under investigation to optimize the catalyst as well as reactor using the simulation tools of reactors and processes.

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