

Carbon Dioxide Hydrogenation to Methanol over Cu/ZnO-SBA-15 Catalyst: Effect of Metal Loading

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Abstract : Utilization of CO₂ as a carbon source to produce valuable chemicals is one of the important ways to reduce the global warming caused by increasing CO₂ in the atmosphere. Supported metal catalysts are crucial for the production of clean and renewable fuels and chemicals from the stable CO₂ molecules. The catalytic conversion of CO₂ into methanol is recently under increased scrutiny as an opportunity to be used as a low-cost carbon source. Therefore, series of the bimetallic Cu/ZnO-based catalyst supported by SBA-15 were synthesized via impregnation technique with different total metal loading and tested in the catalytic hydrogenation of CO₂ to methanol. The morphological and textural properties of the synthesized catalysts were determined by transmission electron microscopy (TEM), temperature programmed desorption, reduction, oxidation and pulse chemisorption (TPDRO), and N₂-adsorption. The CO₂ hydrogenation reaction was performed in microactivity fixed-bed system at 250 °C, 2.25 MPa, and H₂/CO₂ ratio of 3. Experimental results showed that the catalytic structure and performance was strongly affected by the loading of the active site. Where, the catalytic activity, methanol selectivity as well as the space-time yield increased with increasing the metal loading until it reaches the maximum values at a metal loading of 15 wt% while further addition of metal inhibits the catalytic performance. The higher catalytic activity of 14 % and methanol selectivity of 92 % were obtained over Cu/ZnO-SBA-15 catalyst with total bimetallic loading of 15 wt%. The excellent performance of 15 wt% Cu/ZnO-SBA-15 catalyst is attributed to the presence of well disperses active sites with small particle size, higher Cu surface area, and lower catalytic reducibility.

Keywords : hydrogenation of carbon dioxide, methanol synthesis, metal loading, Cu/ZnO-SBA-15 catalyst

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