Catalytic deoxygenation of glycerol to 1-propanol over zeolite and supported Ni catalysts in sequential bed system

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Glycerol is a low-value by-product from the production of biodiesel. The conversion of glycerol to more valuable products is of interest. The catalytic deoxygenation of glycerol to 1-propanol in sequential bed system was studied. In the upper bed, H-ZSM-5 (Si/Al ratio 12.5) was used as a catalyst for the dehydration of glycerol. From the first bed, acrolein is a major product and hydroxyacetone is a minor product with the yield of 80% and 15%, respectively. In the lower bed, 20 wt.% Ni on various supports (Ni/Al_2O_3, Ni/SiO_2, Ni/TiO_2, Ni/LDH, Ni/MgO, and Ni/C) were used for the hydrogenation of acrolein and co-products. The results suggest that propionaldehyde is an intermediate which further yield the desired 1-propanol from acrolein. Moreover, propionaldehyde could also react with water yielding propanoic acid. In addition, the interaction between metal on various supports demonstrates the different catalytic performances. The hydrogenation activities of the catalyst are in the order of: Ni/Al_2O_3 > Ni/TiO_2 > Ni/LDH > Ni/SiO_2 > Ni/MgO > Ni/C. The high activity of Ni/Al_2O_3 is due to the high Ni dispersion on the catalyst surface. The reaction temperature in the range of 120-200°C suitable for promoting the acrolein hydrogenation. However, the catalytic deactivation was observed due to the deposition of high molecular product over the catalyst.

Keywords: 1-Propanol; Deoxygenation; Glycerol; H-ZSM-5; Ni