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Catalysis, kinetics and reaction engineering

Influence factors on activity of Ru-Zn catalysts in selective hydrogenation of benzene☆

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Abstract

Selective hydrogenation of benzene is an atom economic green route to produce cyclohexene. The control of Zn species is the key to the catalytic performance of Ru-Zn catalysts. The influences of ZnO crystals on selective hydrogenation of benzene were explored. A series of Ru-Zn catalysts with different Zn contents and ZnO morphologies were prepared by changing the amount of NaOH in the co-precipitation process. The catalysts were characterized by N_2 physisorption, X-ray powder diffraction (XRD), inductively coupled plasma optical emission spectrometer (ICP-OES), scanning electron microscope (SEM), temperature-programmed reduction (H_2-TPR) and Malvern laser particle size analyzer. It is found that with increasing the amount of NaOH, the Zn content first increased then decreased, and the ZnO crystals changed from relatively thicker pyramidal-shaped crystals to slimmer needle-shaped crystals. The catalyst had the highest Zn content (22.1%) and strongest interaction between ZnO crystals and Ru particles at pH 10.6 of the solution after reduction. As a result, it had the lowest activity. The activity of Ru-Zn catalysts is affected by both the Zn content and the interaction between ZnO crystals and Ru particles. The effect of reduction time was also investigated. Prolonging the reduction time caused no significant growth of ZnO crystals but the aggregation of catalyst particles and growth of Ru nanocrystals, thus resulting in the decrease of catalytic activity.

Keywords: ZnO morphology; benzene; selective hydrogenation; co-precipitation; cyclohexene

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