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Parametric Study on the Deactivation of Supported Co_3O_4 Catalysts for Low Temperature CO Oxidation

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- 摘要
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摘要 This study focused on the influences of a variety of reaction parameters and guest molecules such as H_2O and C_3H_8 on the deactivation of supported Co_3O_4 catalysts for CO oxidation. Additionally, the physical features of and carbon deposition on some samples after the reaction under the chosen conditions were determined by BET and X-ray diffraction as well as by carbon analyses to deduce the precursors associated with catalyst deactivation. Activity maintenance profiles of the catalysts for CO oxidation at 100 ° C significantly depended on the support for Co_3O_4 nanoparticle dispersion, the loading, the preparation technique and the calcination temperature. The best on-stream performance was achieved using a 5% Co_3O_4/TiO_2 catalyst prepared by the incipient wetness method followed by calcination at 350 ° C. All the reaction parameters chosen here such as the reaction temperature, the feed gas composition of CO, O_2, H_2O, and C_3H_8, and the gas space velocity strongly influenced the extent of catalyst deactivation during CO oxidation and also the rate of catalyst deactivation. However, the deactivation behavior is very complicated. No appreciable changes in the surface area, the porosity, and the phase of the Co_3O_4 nanoparticles and their size occurred even for the samples that were severely deactivated. Significant deposition of carbon on the catalysts after the reaction was visible and it depended on the reaction parameters chosen here. Consequently, this extensive parametric study on the deactivation of catalysts during oxidation and with the chosen reaction parameters and guest gases can lead to an understanding of the deactivation precursors that are associated with carbonaceous species including carbonates and surface free carbon.

关键词： carbon monoxide oxidation supported cobalt oxides deactivation reaction parameters feed compositions

Abstract： This study focused on the influences of a variety of reaction parameters and guest molecules such as H_2O and C_3H_8 on the deactivation of supported Co_3O_4 catalysts for CO oxidation. Additionally, the physical features of and carbon deposition on some samples after the reaction under the chosen conditions were determined by BET and X-ray diffraction as well as by carbon analyses to deduce the precursors associated with catalyst deactivation. Activity maintenance profiles of the catalysts for CO oxidation at 100 ° C significantly depended on the support for Co_3O_4 nanoparticle dispersion, the loading, the preparation technique and the calcination temperature. The best on-stream performance was achieved using a 5% Co_3O_4/TiO_2 catalyst prepared by the incipient wetness method followed by calcination at 350 ° C. All the reaction parameters chosen here such as the reaction temperature, the feed gas composition of CO, O_2, H_2O, and C_3H_8, and the gas space velocity strongly influenced the extent of catalyst deactivation during CO oxidation and also the rate of catalyst deactivation. However, the deactivation behavior is very complicated. No appreciable changes in the surface area, the porosity, and the phase of the Co_3O_4 nanoparticles and their size occurred even for the samples that were severely deactivated. Significant deposition of carbon on the catalysts after the reaction was visible and it depended on the reaction parameters chosen here. Consequently, this extensive parametric study on the deactivation of catalysts during oxidation and with the chosen reaction parameters and guest gases can lead to an understanding of the deactivation precursors that are associated with carbonaceous species including carbonates and surface free carbon.

Keywords： carbon monoxide, oxidation, supported cobalt oxides, deactivation, reaction parameters, feed compositions

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