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Investigation of Carbon Deposition over Ni-Based Catalysts Promoted with CeO_2 in Steam and Autothermal Reforming of Toluene

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Extended Abstract

In this study, we propose a method to prevent carbon deposition during the operation of a catalytic reactor to produce syngas by reforming of toluene, the main component of thinner. When hydrocarbons are used as fuel, carbon can be deposited on the catalyst surface depending on the operating conditions. In the case of aromatic compounds, carbon deposition is very severe. Carbon coke is a common catalyst deactivation substance which is generally deposited on a catalyst surface to lower the catalytic activity. Many researchers have attempted to suppress catalyst deactivation by carbon deposition in a heterogeneous catalytic reaction process using hydrocarbons as feedstock. However, in the reforming reaction, carbon may be produced not only on the surface of the catalyst but also for various reasons depending on the operating conditions. The typical reaction behavior is the pyrolysis reaction of hydrocarbons. Since aromatic hydrocarbons have a smaller number of hydrogen atoms than olefinic and paraffinic hydrocarbons, the decomposition of aromatic compounds be able produced carbon rather than producing light hydrocarbons. In the reforming reaction, there is a high possibility that a pyrolysis reaction occurs in a high-temperature region inside the reactor, which may cause problems in the reaction process due to the formation of carbon. Therefore, in this study, carbon deposition was prevented by autothermal reforming instead of steam reforming, and carbon deposition inhibition effect was confirmed with the catalytic promoters. To reduce carbon deposition on the surface of the catalyst, cerium nitrate and zirconium nitrate were added as precursors so that CeO_2 and ZrO_2 existed as complex oxides. The contents of these promoters were Mg, Ce and Zr oxides of 3 wt.%, 2 wt.% and 1 wt.%, respectively.

The surface of the catalyst used in the steam reforming reaction and the autothermal reforming reaction was analyzed. In collecting the catalyst used for the steam reforming reaction, a considerable amount of powder was included in the sample obtained. As a result of the XRD analysis of the pellet catalyst, carbon deposition was not observed. However, the formation of carbon was confirmed in the powder. On the other hand, the catalysts collected after autothermal reforming was not contained powder, and no carbon deposition was observed in the XRD analysis too. The results of this analysis indicate that carbon formation is less in the autothermal reforming reaction than in the steam reforming reaction. In a result of observation with a scanning electron microscope to confirm carbon deposition on the surface of the catalyst, fibrous carbon was observed after the steam reforming reaction. However, carbon deposition was never observed over the surface of the catalyst after the autothermal reforming reaction.

References

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