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Deactivation and Regeneration of Nickel-Based Catalysts for Steam-Methane Reforming

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- 摘要
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摘要 The deactivation of nickel catalysts used in Arak and Razi petrochemical complexes followed by catalyst regeneration was evaluated. The characterization of the different structures was made by powder X-ray diffraction (XRD), scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS), transmission electron microscopy (TEM), and carbon & sulfur analyzer. The Ni particle size was estimated from XRD patterns and TEM graphs. The agglomeration of nickel particle and the poison by sulfur components were recognized as the main reasons in deactivation of Arak and Razi catalysts, respectively. The activity of the used catalysts before and after regeneration was measured on methane steam reforming at a CH_4:H_2O ratio of 1:3 at 850 ^oC. The regeneration processes for Arak and Razi samples were performed with CO_2 as an oxidative atmosphere and steam as a regenerating agent, respectively. The results show that, (1) no residual sulfur components were on the regenerated Razi catalyst surface without changing the structure of the catalyst and the regenerated catalyst has gained 80% of its catalytic activity, and that (2) the nickel particle size of regenerated Arak specimen decreased remarkably as measured by Debye-Scherrer equation from XRD patterns. TEM images were in agreement with the XRD results and indicated a decrease in nickel particle size of regenerated catalyst. Additionally, in both regenerated catalysts all the coke on the surface of the support was eliminated after regeneration.

关键词： nickel catalyst steam reforming deactivation sintering sulfur poisoning regeneration

Abstract： The deactivation of nickel catalysts used in Arak and Razi petrochemical complexes followed by catalyst regeneration was evaluated. The characterization of the different structures was made by powder X-ray diffraction (XRD), scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS), transmission electron microscopy (TEM), and carbon & sulfur analyzer. The Ni particle size was estimated from XRD patterns and TEM graphs. The agglomeration of nickel particle and the poison by sulfur components were recognized as the main reasons in deactivation of Arak and Razi catalysts, respectively. The activity of the used catalysts before and after regeneration was measured on methane steam reforming at a CH_4:H_2O ratio of 1:3 at 850 ^oC. The regeneration processes for Arak and Razi samples were performed with CO_2 as an oxidative atmosphere and steam as a regenerating agent, respectively. The results show that, (1) no residual sulfur components were on the regenerated Razi catalyst surface without changing the structure of the catalyst and the regenerated catalyst has gained 80% of its catalytic activity, and that (2) the nickel particle size of regenerated Arak specimen decreased remarkably as measured by Debye-Scherrer equation from XRD patterns. TEM images were in agreement with the XRD results and indicated a decrease in nickel particle size of regenerated catalyst. Additionally, in both regenerated catalysts all the coke on the surface of the support was eliminated after regeneration.

Keywords： nickel catalyst, steam reforming, deactivation, sintering, sulfur poisoning, regeneration

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