World Academy of Science, Engineering and Technology
International Journal of Chemical and Materials Engineering
Vol:12, No:04, 2018

Promotional Effects of Zn in Cu-Zn/Core-Shell Al-MCM-41 for Selective Catalytic Reduction of NO with NH3: Acidic Properties, NOx Adsorption Properties, and Nature of Copper

Authors : Thidarat Imyen, Paisan Kongkachuichay

Abstract : Cu-Zn/core-shell Al-MCM-41 catalyst with various copper species, prepared by a combination of three methods—substitution, ion-exchange, and impregnation, was studied for the selective catalytic reduction (SCR) of NO with NH3 at 300 °C for 150 min. In order to investigate the effects of Zn introduction on the nature of the catalyst, Cu/core-shell Al-MCM-41 and Zn/core-shell Al-MCM-41 catalysts were also studied. The roles of Zn promoter in the acidity and the NOx adsorption properties of the catalysts were investigated by in situ Fourier transform infrared spectroscopy (FTIR) of NH3 and NOx adsorption, and temperature-programmed desorption (TPD) of NH3 and NOx. The results demonstrated that the acidity of the catalyst was enhanced by the Zn introduction, as exchanged Zn(II) cations loosely bonded with Al-O-Si framework could create Brønsted acid sites by interacting with OH groups. Moreover, Zn species also provided the additional sites for NO adsorption in the form of nitrite (NO2–) and nitrate (NO3–) species, which are the key intermediates for SCR reaction. In addition, the effect of Zn on the nature of copper was studied by in situ FTIR of CO adsorption and in situ X-ray adsorption near edge structure (XANES). It was found that Zn species hindered the reduction of Cu(II) to Cu(0), resulting in higher Cu(I) species in the Zn promoted catalyst. The Cu-Zn/core-shell Al-MCM-41 exhibited higher catalytic activity compared with that of the Cu/core-shell Al-MCM-41 for the whole reaction time, as it possesses the highest amount of Cu(I) sites, which are responsible for SCR catalytic activity. The Cu-Zn/core-shell Al-MCM-41 catalyst also reached the maximum NO conversion of 100% with the average NO conversion of 76 %. The catalytic performance of the catalyst was further improved by using Zn promoter in the form of ZnO instead of reduced Zn species. The Cu-ZnO/core-shell Al-MCM-41 catalyst showed better catalytic performance with longer working reaction time, and achieved the average NO conversion of 81%.

Keywords : Al-MCM-41, copper, nitrogen oxide, selective catalytic reduction, zinc
Conference Title : ICC 2018 : International Conference on Chemistry
Conference Location : New York, United States
Conference Dates : April 19-20, 2018