Low-Cost CuX Catalyst from Blast Furnace Slag Waste for Low-Temperature NH_3-SCR

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The presence of nitrogen oxides (NOx) in industrial flue gas is a major concern due to their negative impact on the environment and human health [1]. Selective catalytic reduction with NH_3 (NH_3-SCR) is the primary technology for reducing and controlling NOx emissions [2]. As one of the primary solid wastes generated from blast furnace iron production, blast furnace slag (BFS) contains an adequate quantity of Al_2O_3 and SiO_2 that could serve as raw material for zeolite synthesis. Zeolite X with low Si/Al ratio was successfully prepared by the seed-hydrothermal method [3].

In this study, we investigated the low-temperature NH_3-SCR activity and surface acidity of a series of Cu-exchanged zeolite X (derived from blast furnace slag) catalysts with various Cu/Al ratios (mole ratio of Cu/Al=0.13, 0.28, 0.4, 0.45, 0.46, 0.47). Based on the NH_3-SCR performance of these CuX catalysts, the CuX-0.28 catalyst exhibited the highest NH_3-SCR activity across the entire temperature range, exhibiting NO conversion above 93% from 150 ^{o}C to 400 ^{o}C and N_2 selectivity higher than 91%. The catalytic tests towards the oxidation of NH_3 revealed that NH_3 was oxidized to NO or N_2O above 300 ^{o}C. NH_3-TPD measurements showed that the CuX-0.28 catalyst had the highest surface acidity in the series and most of surface acidity was attributed to Lewis acid sites. During in situ DRIFTS of the NH_3-SCR reaction, both Lewis and Brønsted acid sites were identified on the CuX-0.28 catalyst, with Lewis acid sites playing the primary role in the NH_3-SCR reaction.

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