Activity, propene poisoning resistance and hydrothermal stability of copper exchanged chabazite-like zeolite catalysts for SCR of NO with ammonia in comparison to Cu/ZSM-5

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1. Introduction

Nitrogen oxides (NO\textsubscript{x}) from combustion of fossil fuel are a major source for air pollution and can cause photochemical smog, production of acid rain and respiratory problems to mankind [1]. It is known that over 50% of NO\textsubscript{x} emissions are from automotive sources, such as gasoline cars and diesel engine trucks, and over 40% of NO\textsubscript{x} are from stationary sources, such as power plants using fossil fuels. A most challenging research objective is to remove NO\textsubscript{x} from oxygen rich exhaust gas of diesel engines and design a practical diesel SCR catalyst system [2]. Several approaches have been proposed for lean-NO\textsubscript{x} abatement, each of them with its own specific sets of problems. The two technologies that seem to have clear advantages among the processes proposed are the selective catalytic reduction either with hydrocarbons (HC-SCR) or with ammonia (NH\textsubscript{3}-SCR), and lean-NO\textsubscript{x} traps (LNT). The selective catalytic reduction (SCR) of nitrogen oxides with NH\textsubscript{3} as reducing agent, where NH\textsubscript{3} is generated by thermal decomposition of urea, is presently considered as one of the most promising techniques for the removal of NO\textsubscript{x} from lean exhaust gases from diesel trucks.

There are several groups of catalysts reported in the literature, which are suitable for this reaction at different temperatures [3]. Noble metals, such as Pt, Pd, and Rh, were active in the selective reduction of NO\textsubscript{x} at low temperatures, but the N\textsubscript{2} product selectivity is poor at higher temperatures. These catalysts are less suitable for SCR because they catalyze not only the SCR reaction but also the oxidation of NH\textsubscript{3} to NO, N\textsubscript{2}O, and N\textsubscript{2} [4,5]. Metal oxides were also widely studied for this reaction. Among the various mixed metal oxides, V\textsubscript{2}O\textsubscript{5}–WO\textsubscript{3}/TiO\textsubscript{2} has been widely used since 1980s for reducing NO\textsubscript{x} emission from stationary power plants; however, concerns remain such as oxidation of SO\textsubscript{2}, stability of the catalyst and toxicity of vanadia [6,7]. Zeolite-based catalysts promoted (via ion exchange) by transition metals, such as Fe and Cu, are being considered for practical applications in diesel emission control due to their high activities and better stability at high temperatures [8–12]. These catalysts have high activities for NO decomposition [13] and selective catalytic reduction by hydrocarbons [14]. However, Cu/ZSM-5 and Fe/ZSM-5 are limited by their relatively low