Experimental Studies of Selective Catalytic Reduction of NO_x with NH_3 on Cu-ZSM-5 Foam Catalysts

A thesis submitted

in partial fulfillment for the award of the degree of

Doctor of Philosophy

by

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June 2023

Abstract

Selective Catalytic Reduction (SCR) is one of the most promising technologies for reducing after-exhaust NO_x emissions. Cu zeolites generally provide high SCR conversion rates at temperatures $\lessapprox$ 350°C. The limitations associated with powdered catalysts, such as low mass diffusion and high pressure drop, can be minimized to a certain extent by replacing them with structured catalysts. The foam catalysts exhibit superior characteristics, such as a high surface-to-volume ratio, porosity, and tortuosity, which improve the mass diffusion and lower the pressure drop.

In this study, α-alumina foam was prepared using a thermo-foaming technique. The procedure followed during this research for the preparation of the Cu-ZSM-5 zeolite coating over alumina foam through in situ hydrothermal and dip-coating methods is also presented in detail. A self-supporting foam catalyst of Cu-ZSM-5 is prepared using a freeze-casting emulsion method.

A comprehensive experimental study was conducted to understand the mass transfer and pressure drop characteristics of the foam catalysts. Correlations for the mass transfer coefficient and friction factor were derived for the foam catalyst and validated against the available data in the literature reviewed. A detailed investigation of key SCR reactions, such as the standard SCR, fast SCR, slow SCR, NO oxidation, NH_3 oxidation, and NO_2 decomposition, was also carried out in this research. The inhibitory effects of the feed reactants were studied by varying the feed concentration. A detailed investigation of the impact of the inhibition effect of NO_2 and NH_3 on the SCR reaction at low temperatures is also presented. Numerical analysis of real engine catalytic convertor is explored to conclude the inferences from SCR chemistry.