## ABSTRACT

One method of controlling $NO_x$ in lean exhausts is reduction of $NO_x$ over metal-exchanged zeolite catalysts in presence of different reducing agents and if reduction of $NO_x$ can be carried out by CO and HC which are already present in a SI engine exhaust, then CO and HC can also be controlled simultaneously. Some novel catalysts have been developed from X-zeolite, commercially available in India, by ion-exchange with different transition metals, such as, copper, nickel, iron, vanadium and molybdenum. Catalysts have been tested under wide range of engine and exhaust conditions to study the effect of temperature, gas flow rate, air-fuel ratio and engine load on the performance of each of them. Back pressure developed across the catalyst bed and its consequent detrimental effects on engine performance have also been studied.

It is found that the conversion efficiencies of $NO_x$ or CO are influenced by mainly three parameters : A/F ratio of engine operation, catalyst temperature and gas flow rate through the catalyst bed. $NO_x$ and CO conversion efficiencies obtained over different catalysts exhibit peaks at a particular temperature depending on the testing conditions. Unlike noble metal catalysts, the metal exchanged X-zeolite catalysts maintain close to their respective peak performance through a wider range of A/F ratio and peak performance is obtained at slightly leaner A/F ratios. Increase in space velocity results in almost linear fall in both $NO_x$ and CO conversion efficiencies and tends to increase the temperature at which peak conversions occur and reduces the influence of temperature on conversion efficiency. Among different catalysts, the best performance have been exhibited by Cu-X catalyst by converting up to 72% of engine-out $NO_x$ and CO at an A/F ratio of 14.89 and SV of 22500 /h, while Ni-X and Fe-X catalyst exhibit slightly lower performance. Back pressure or pressure drop across the catalyst bed generally increases with increase in space velocity and is

associated with certain amount of power loss. Maximum power loss due to the back pressure is found to be only 0.4% at a SV of 67500 /h.

To investigate the performance of the catalysts in presence of urea, gravity-feed urea dosing system has been employed to inject urea dissolved in water into the stream of exhaust gas inlet to the catalyst bed. Up to a temperature of 160 °C, urea-dosing significantly enhances $NO_x$ conversion over Cu-X catalyst; however, there is a sharp fall in performance at temperatures higher than 160 °C and at temperatures greater than 300 °C, it is as good as Cu-X catalyst without any reducing agent. Deposition of ammonium carbonate and ammonium sulphate on Cu-X catalyst also improves $NO_x$ conversion considerably than the base Cu-X catalyst, although, up to a temperature of 200 °C, improvement is less than that with urea-dosing system. To specify the precise degree of accuracy of the experimental results, uncertainty analysis of the measured data has also been carried out.

A mathematical model has been developed for predicting the performance of a packed bed catalytic converter by considering heat and mass transfer and chemical kinetics. The model requires numerical solution of six coupled, nonlinear partial differential equations and these are solved by using *finite difference equation* technique. Some of the chemical kinetics parameters, which are not available in the literatures, have been estimated from experimental data by using optimization technique. Experimental results for one set of the test conditions have been employed for obtaining the reaction kinetic parameters which are used further in predicting the results for other test conditions. $NO_x$ and CO conversion efficiencies predicted by the model conform well with those obtained experimentally. Average deviation of experimental result has been observed to be less than 5% of the predicted value.