# PREFACE

Diesel lean-burn engines conquered increasing concern of greenhouse gas (GHG) emissions and fuel economy over conventional gasoline stoichiometric (A/F=14.7) engines. Lean-burn engines operate under (excess oxygen) conditions of A/F ratio ~ 20-25. A good economy based approach that saves 30-35% fuel consumption and low carbon emission are the main motive for their notable recognition and applications in various fields like transportation, agriculture, defence, power generation, mining, construction, etc. However, emissions of nitrogen oxides (NOx) and particulate matter (PM) are the main issues from such engines. These pollutants have drastic impact on human health, environment, vegetation, global warming and climate change. To meet the stringent legislations, control of the PM and NOx emissions are essential. Two separate units, diesel particulate filter (DPF) and selective catalytic reduction (SCR) of NOx are mandatory for total control of emissions. The PM can be controlled by DPF with an appreciably high reduction (~99%) efficiency. Diesel engines contribute ~58% of the total NOx emissions. The SCR is one of the best technologies which requires an efficient catalyst and suitable reductant for its effective performance. Hence, reducing NOx is more complicated than PM elimination from the exhaust. Therefore, the prime objective of the present work was to develop an efficient catalyst and select a suitable reductant for vehicular NOx emissioncontrol.

NOx are a primary pollutant, typically contain ~95%NO, ~4.5%$NO_2$ and ~0.5%$N_2O$. NOx are the precursor for photochemical formation of more toxic secondary pollutants in the atmosphere such as PAN, PAH, ground level ozone, smog, etc. Alarmed by the adverse impacts of NOx emissions, Government agencies have enforced stringent legislations which are becoming stricter day by day. The SCR technology is the most appropriate mature technology with high NOx removal efficiency for diesel and lean burn engines. The main challenge is to find a catalyst system that is active at low temperature, where there is no conversion of NOx occurs due to low activity at low temperature.

The SCR tests were performed in a fixed-bed glass tubular reactor under the following operating conditions: 200 mg catalyst, 500 ppm NO, 0.1% $NH_3$/ 1000 ppm $C_3H_8$or LPG/1% $H_2$-1000 ppm $C_3H_8$, 8% $O_2$ in Ar, total flow rate of 100 mL/minand temperature ambient to 450°C. The inlet and outlet gases of the reactor were analysed by Eco Physics CLD 62 chemiluminescence NO/NOx analyzer and online GC. Two separate GCs equipped with porapak Q/ capillary columns and FID/TCD/ECD detectors were used to analyse the CO, $CO_2$, hydrocarbons/$H_2$, $N_2O$ respectively.

The outline of the thesis is as follows:

Chapter 1 includes introduction of the work briefly along with literature review. The outcome of literature survey complies the objectives of the present research work.

Chapter 2 comprises the experimental part which includes catalyst preparation, experimental set up and catalyst characterization (XRD, XPS, SEM, EDX, FTIR, and BET) in details.

Chapter 3shows catalyst characterization results from XRD, XPS, FTIR, SEM-EDX and BET surface area.

Chapter 4 shows the results and discussion for the choice of catalyst preparation methods, selection of calcination strategies of catalyst precursors, optimization of catalyst loading on support ($\gamma$-$Al_2O_3$) and optimization of promoter (Rh) for NO reduction in the temperature range of ambient to 450°C.

Chapter 5 reports the kinetics study of NO reduction using $H_2$-$C_3H_8$over the best catalyst.

Chapter 6 states the conclusions based on the experimental results and future scopeof thepresent research work.