CHAPTER – VI

SUMMARY AND CONCLUSIONS

Over the years, there has been a substantial increase in air pollution caused by the vehicular exhaust emissions due to addition of more and more vehicles on roads to meet the transportation demand. The increasing incidences of asthma, other respiratory diseases and certain types of cancer have been linked to the pollutants emitted from vehicles such as carbon monoxide, oxide of nitrogen and volatile organic compounds.

Carbon Monoxide is a poisonous pollutant emitted in large quantity from automotive exhaust which needs to be transformed into harmless CO₂ needed for photosynthesis by vegetations. Therefore, in vehicular emission control, the catalytic oxidation of CO is of prime importance. Catalytic converter is the device to control the exhaust emissions from vehicles to meet future auto-exhaust emission standards. The three-way catalytic converter has effectively reduced emissions of these pollutants from automobiles.

Catalysts has tremendous scope in air pollution control, e.g. in abatement of industrial odors, organic vapors and flue gases, reduction of oxides of nitrogen to nitrogen gas, purification of air in domestic and working environment and treatment of automobiles exhaust.

Noble metal catalysts (Pt, Pd, Rh) are predominantly used in automotive pollution control in three way catalytic converter. However, the high cost and scarcity of noble metals and on urgent need for maintaining clean air together present a large challenge and opportunity for development of low cost alternatives such as transition metal oxide catalysts.

If the efficiency and durability of non noble metal catalysts in exhaust environment can be improved, they could also become a better alternative to precious noble metal catalysts. Present study is an attempt in the same direction.

In the present work supported and unsupported CuO/CeO₂/ZrO₂ catalysts for the CO oxidation, with a special attention to the reaction mechanism, and the influence of
catalyst composition on the properties of the system have been evaluated and discussed. In this work an attempt has been made to review the various preparation methods of these copper based catalytic systems and the properties of related catalysts in light of the preparation methods have been discussed.

From the observations made in the study, the following important conclusions can be drawn:

1. From the results of activity and characterization of the different precursors, it is found that CuO obtained from Cu(NO$_3$)$_2$.3H$_2$O precursor is most active than the CuO obtained from other precursors copper sulphate and copper oxalate.

2. Considering the above, the effect of support - $\gamma$-Al$_2$O$_3$ on the activity of CuO catalyst has been studied. The activity of the catalysts prepared by different alumina loading on copper was studied and compared. From the results it is clear that 20% alumina loading on copper was found to be the optimum value.

3. The optimum calcination temperature of precursors of copper alumina catalyst is found to be 500°C.

4. The four methods, Co Impregnation Method (CI), Citric acid Sol Gel method (SG), Urea gelation co precipitation method (UG) and Urea nitrate Combustion method (UC) have been used to prepare $\gamma$-Al$_2$O$_3$ supported Cu–Ce–Zr catalysts. Catalysts are prepared keeping ratio $[Cu/ (Cu+Ce+Zr)] = 1/10$ and $Ce/ Zr = 1.35$) constant and varying the composition of $\gamma$-Al$_2$O$_3$ from 0 to 30%.

5. The optimum composition of $\gamma$-Al$_2$O$_3$ on Cu–Ce$_{5.17}$–Zr$_{3.83}$O$_x/$$\gamma$-Al$_2$O$_3$ catalysts is found to be 15%.

6. A compact and versatile laboratory tubular reactor has been used for conducting the studies. The characterization of these catalysts prepared by four methods has been studied by XRD, TGA, SEM and BET surface area. Also, from the results it is concluded that the catalyst Cu–Ce$_{5.17}$–Zr$_{3.83}$O$_x/$$\gamma$-
Al₂O₃ (15%) prepared by citric acid sol gel method shows the highest catalytic activity.

7. From the comparison of methods of preparation, it is found that sol gel is the best method. The ranking order of the preparation methods of catalysts is as follow:

Citric acid Sol Gel method > Co impregnation method > Urea gelation co precipitation method > Urea nitrate Combustion method.

8. The effect of promoter K₂O is studied and it is found that optimum concentration of K₂O in catalysts is 6%.

9. The final developed catalyst does not show any deactivation on continuous run hours under experimental conditions in the present investigation.

10. Kinetic studies for the oxidation of CO to CO₂ have been carried using the best catalyst having highest activity. Using power law rate equation following kinetic equation is obtained:

\[ r_{obs} = 3.69 \times 10^8 \exp\left(\frac{75.51}{RT}\right) C_{CO}^{0.69} \text{gm mol/gm cat-hr} \]

11. The modified Langmuir-Hinshelwood kinetic model, for a single active site fits the experimental data very well in the present study.

SUGGESTIONS

The following suggestions can be given for further studies in the area of automotive exhaust pollution control in context of the novel catalyst used in the study:

1. The novel catalyst prepared using the four methods should also be evaluated for its efficiency in the conversion of hydrocarbons and NOₓ found in the automobile exhaust.

2. This novel catalyst need also be studied for its properties related to its suitability for application on the other support materials used in the manufacture of the automotive catalytic converter for the exhaust purification.
3. The catalyst systems tried should be studied in wash coated monolith structure for its application in vehicles to control the pollution.

4. An actual live test of catalyst systems should be studied on automobile exhaust converter for commercially exploitation of catalysts.

The present work and observations will be of practical utility to develop a substitute for noble metal catalysts to combat CO pollution caused by various processes in general and by automobile in particular.