CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

The brief conclusions of this study were as follows :

1. Metallosilicates as ZSM-5 (Al-silicate), Fe-silicate, and Cu-silicate were prepared by the rapid crystallinzation method and they gave the same XRD patterns that of MFI structure. This indicates that the metallosilicates also have the pentasil pore opening structure, the cation(Pt, Cu, and Fe)-exchanged metallosilicates catalysts have the same crystalline structure, the pentasil pore opening structure as the parent metallosilicates. The total surface area of catalyst was not affected by the metal loading on the catalyst.

2. H-forms of metallosilicates showed activity and selective reduction of NO with propane, even in the presence of excess oxygen. The activities of NO reduction are in order of H-form > Cu/H-form > Pt/H-form in the temperature range of 150 - 600 ^{o}C. The conversions of NO on H-form and Cu/H-form metallosilicates were higher than on Pt/H-form metallosilicates. On the other hand, the conversion level of propane on H-form and Cu/H-form metallosilicates were lower than that of Pt/H-form metallosilicates.

3. The catalytic activity on metal ion-exchanged ZSM-5 as Cu/H-ZSM-5, and Fe/H-ZSM-5 have been selected to be the suitable catalysts to compare with metal incorporated MFI-type silicates as H-Fe-silicate, and H-Cu-silicate for the reduction of NO with propane in an oxidizing atmosphere.

4. It is observed that Cu/H-ZSM-5 and Cu/Na-ZSM-5 catalysts using various copper salts with the same amount of HCl for ion-exchange have the same amount of copper contents in their structures. The difference of copper salts(anion) do not show such effects for the increase of level of copper ion-exchange.

5. For copper ion-exchange with each form of ZSM-5, amount of copper content increased with increment of pH value of mother solution by addition of ammonia solution. Na form of ZSM-5 was highest copper content at pH range of 7 - 10 among NH_4-, and H form of ZSM-5.

6. The level of copper ion-exchange was affected by cause of time and temperature. At 80 ^{o}C and 12 h of ion-exchange was suitable condition for copper loading into Na-ZSM-5.

7. Cu/H-ZSM-5, Cu/NH_4-ZSM-5, and Cu/Na-ZSM-5 catalysts were examined for reduction of NO by propane with the presence of excess oxygen. It is found that the temperature of maximum activity decreased increasing of copper content in each of catalyst.

8. The high copper content, Cu-MFI-105 having Cu = 4.05 wt.% and the low copper content, Cu/Na-ZSM-5 with 0.1275 wt.% of copper were tested for removal of NO with propane under excess oxygen condition. NO conversion on Cu-MFI-105 was higher than that of Cu/Na-ZSM-5 at temperature range of 150 -300 ^{o}C. On the other hand, at temperature higher than 300 ^{o}C the NO conversion was reversed. The oxidation of propane of Cu-MFI-105 was higher than that of Cu/Na-ZSM-5 at low temperature range.

9. Cu/Na-ZSM-5 and Cu-MFI-105 catalysts were the most active for oxygen sensitivity of NO reduction by propane. On the contrary, Cu/NH_4-ZSM-5 catalyst was the lowest oxygen sensitivity of reduction of NO by propane. The temperature of maximum NO conversion of Cu/NH_4-ZSM-5 catalyst hardly depended on variation of oxygen concentrations.

10. The reduction activities of NO in NO + C_3H_8 system on Cu ion-exchanged ZSM-5 catalysts showed that higher activities was affected markedly by remaining cations such as NH_4^+, H^+, and Na^+. Cu/NH_4-ZSM-5 catalyst was the most active for the reduction of NO in NO + C_3H_8 system(without oxygen) among the prepared catalysts. This indicates that NH_4^+ ion is effective remaining cation for reduction of NO. On the other hand, the reduction activities of NO in NO + O_2 + C_3H_8 reaction depended on the copper content of catalysts. Since NO or NO_2 may be directly reduced by hydrocarbons or CO formed from the combustion of hydrocarbons, thus to obtain the deep insight on reaction mechanism, further study are suggested :

1. Study the reaction of nitric oxides for the systems of NO + CO; NO + hydrocarbons; NO_2 + CO; NO_2 + hydrocarbons; and NO decomposition.

2. Study the catalytic performance of Cu ion-exchanged ZSM-5 on the oxidation of NO to NO_2.

3. Investigate the effect of types of hydrocarbons for NO reduction on Cu ion - exchanged ZSM-5 catalysts.

4. Acidity assessment of Cu ion-exchanged ZSM-5 catalysts.

5. Determine the mechanism model of effect of remaining cation.

6. Comparison of effect of Cu ion-exchanged and incorporated method with the same amount of copper content in catalysts.