

## CHAPTER VI

### CONCLUSIONS AND RECOMMENDATIONS

This thesis has dealt with studies on catalytic conversion of liquefied petroleum gas to aromatic hydrocarbons using metal-containing MFI-type zeolite catalysts. The following conclusions of this study were drawn:

1. Metallosilicate as Al-silicate (ZSM-5), Zn-silicate, Ga-silicate, Zn.Al-silicate, and Ga.Al-silicate were prepared by the rapid crystallization method and they gave the same XRD patterns of MFI structure. This indicates that the metallosilicates and the metal (Zn, Ga, and Pt) ion-exchanged ZSM-5 also have the same crystalline structure, the pentasil pore opening structure, as ZSM-5. The total surface area of catalyst was not affected by the metal loading on the catalyst.
2. For various metals-ion-exchanged ZSM-5, both zinc exchanged  $\text{NH}_4$ -ZSM-5, Zn/ $\text{NH}_4$ -ZSM-5, and gallium exchanged H-ZSM-5, Ga/H-ZSM-5, gave better catalytic performance for propane aromatization than the metal non loaded ZSM-5.
3. The presence of aluminium in zeolite framework, Zn/ $\text{NH}_4$ -ZSM-5 or Ga/H-ZSM-5, contributes significantly for the higher activity and selectivity of propane conversion to aromatics. The catalytic performances of Zn/ $\text{NH}_4$ -ZSM-5 and Ga/H-ZSM-5 predominate their counterparts without Al, i.e. Zn-silicate or Ga-silicate.
4. The  $\text{NH}_4$ -Zn.Al-silicate catalyst with Si/Zn ratio of 150 and Si/Al ratio of 40 was the optimum composition of zinc-containing MFI-type zeolite catalyst for propane aromatization, and can be prepared in only one-step crystallization.

5. The H-Ga.Al-silicate catalyst with Si/Ga ratio of 155 and Si/Al ratio of 40 exhibited the highest activity and selectivity for propane conversion to aromatics, and can be prepared in only one-step crystallization.

6. Both NH<sub>4</sub>-Zn.Al-silicate and H-Ga.Al-silicate can be effectively employed with the aromatization of LPG, propane and butane mixtures, irrespective of the composition range there between.

7. NH<sub>4</sub>-Zn.Al-silicate ion-exchanged with Pt, Pt/NH<sub>4</sub>-Zn.Al-silicate showed no significant improvement in catalyst life. This was ascribed to the role of the existing Al on hydrogen transfer to prevent the coke formation which was comparable to the same role of Pt. As Zn also played the major role on olefins hydrogenation, the competitive reactions between olefins and hydrogen addition to the coke precursors were believed to take place. Such effect may cause the promoting role of Pt on coke prevention be adversely affected.

8. For H-Ga.Al-silicate, Ga in combination with Al already caused the synergistic effect on coke prevention by facilitating the hydrogen transfer to the coke precursors on the catalyst surface. Such concerted effect of Ga and Al should be even better than Pt and thus Pt/H-Ga.Al-silicate slightly decreased the catalytic performances.

From this study, the recommendations for further research are as follows:

1. Study the extensive performances of NH<sub>4</sub>-Zn.Al-silicate and H-Ga.Al-silicate for aromatics production from the other range of hydrocarbons, naphtha(C<sub>5</sub>-C<sub>12</sub>), for example.

2. Determine the type of acidity, Bronsted and Lewis, in  $\text{NH}_4\text{-Zn.Al-silicate}$  and  $\text{H-Ga.Al-silicate}$  for the better understanding of the key factors for aromatics synthesis.

3. Develop the stability of  $\text{NH}_4\text{-Zn.Al-silicate}$  to be able to compete with  $\text{H-Ga.Al-silicate}$ .