

## CHAPTER V

### CONCLUSION

The zeolite beta catalyst with gel mole composition of  $1\text{SiO}_2$ :  $0.0083\text{ Al}_2\text{O}_3$ :  $0.73\text{ TEAOH}$  :  $19\text{ H}_2\text{O}$  ( $\text{Si}/\text{Al} = 60$ ) and Al-HMS catalyst with various Si/Al mole ratios in gel mole composition of  $1\text{SiO}_2$ :  $0.0125\text{ Al}_2\text{O}_3$ :  $0.25\text{ HDA}$ :  $8.3\text{ EtOH}$ :  $100\text{ H}_2\text{O}$  were successfully synthesized. The XRD patterns of catalysts showed the characteristic peaks of zeolite beta and Al-HMS, respectively.  $^{27}\text{Al}$ -MAS-NMR spectra indicated most of the aluminum atoms remained in the tetrahedral oxygen coordination at framework positions for zeolite beta. For Al-HMS catalyst, non-framework aluminium was also obtained. By applying the optimal condition for ammonium treatment with  $1\text{M NH}_4\text{Cl}$  solution, the highest relative intensities of tetrahedral Al to octahedral Al on Al-HMS were observed. Adsorption-desorption isotherm of nitrogen on zeolite beta and Al-HMS exhibited a pattern of type I and type IV which is a typical shape for micropores and mesopores, respectively. The BET specific surface area in the mesopores decreased with the increasing of aluminum content. The  $\text{NH}_3$ -TPD profiles indicated the number of acidity. The number of acid sites of zeolite beta were 0.721. The number of acid sites of Al-HMS with Si/Al mole ratio in gel of 40, 60, and 200 were 0.295, 0.249, and 0.213, respectively. The number of acid sites decreased when aluminum content in Al-HMS catalyst decreased.

The catalytic cracking of HDPE and PP were compared with thermal cracking. The catalytic cracking gave higher conversion than thermal cracking due to the influence of acid sites of catalyst accelerated the degradation of polymer by carbocation mechanism. For zeolite beta/Al-HMS mixed catalysts, the activity depended on proportion of mesoporous materials. With increasing amount of mesoporous, the conversion and the selectivity to liquid product for PP cracking increased. The large pore size of Al-HMS allowed large polymer molecules to access active site inside pore and broke the long polymeric chain from ends into small unit. In contrast, the selectivity to liquid products was not different in HDPE cracking. Conversion and selectivity to gas product decreased with increasing mesoporous proportion. Because the acidity of zeolite beta played an important role than pore size

of catalyst. At 10% weight of catalyst, the highest conversion and selectivity to liquid products were observed for PP cracking and also the highest conversion and selectivity to distillate oil were performed for HDPE cracking. With increasing reaction temperature, degradation rate were faster. Therefore, the optimal condition for PP cracking was 95%Al-HMS in mixed catalyst, 10%weight of catalyst and reaction temperature at 380°C whereas for HDPE was 5%Al-HMS in mixed catalyst, 10%weight of catalyst and reaction temperature at 410°C. The regeneration of catalyst was acceptable for 1-2 cycles due to a high conversion of PP and HDPE cracking over 80%. However, the structure of mesopore Al-HMS should be aware for reuse of catalyst.

#### **The suggestions for future work**

1. To synthesize a small pore size catalyst which its pore size can degrade heavy oil into distillate oil.
2. To investigate the efficiency of zeolite beta/Al-HMS mixed catalyst for catalytic cracking of mixed plastic containing HDPE, LDPE, PP.
3. To identify the components of liquid products individually.