

## CHAPTER V

### CONCLUSION

Mesoporous Al-MCM-41 molecular sieve has been synthesized by using different silica sources. The Al-MCM-41 catalyst with various Si/Al ratios prepared from a mixture of colloidal silica and 32 wt% sodium hydroxide solutions provides the highly ordered Al-MCM-41 with Si/Al ratio close to loaded value. XRD patterns of these catalysts show the characteristic peaks similar to that of MCM-41 reported by Beck *et al.* [52]. The intensity of the reflection peaks increase when the Si/Al ratio increases.  $^{27}\text{Al}$ -MAS-NMR spectra show that most of the aluminum atoms remain in tetrahedral oxygen coordination at framework positions. Considering the highest relative intensities of tetrahedral Al to octahedral Al, the optimal condition for ammonium treatment is 0.03M  $\text{NH}_4\text{Cl}$  solution. Morphology of the solid products depends on types of silica source according to SEM images. Adsorption-desorption isotherm of nitrogen on Al-MCM-41 exhibits a pattern of type IV which is a typical shape for mesopores. The specific surface area in the mesopores increases with the increasing of aluminum content. The  $\text{NH}_3$ -TPD profiles indicate the number of acidity. The number of acid sites decreases when aluminum content in catalyst decreases.

The catalytic cracking of HDPE and PP were chosen to test catalytic activity of Al-MCM-41 catalysts. The results show the catalytic cracking of the polymer process depended on physical characteristics of the catalysts and structural nature of the polymers. % Conversion and % yield by catalytic cracking are higher than thermal cracking. The value of % conversion increases when reaction temperature increases. The higher acidity causes higher efficiency in cracking HDPE to products and less residue was left in the catalytic reactor. The treated catalysts provide more liquid fraction yield and less gas fraction yield than the untreated catalysts. The %conversion for treated catalysts decreases when Si/Al ratio increases. The yield of liquid in PP cracking is higher than HDPE cracking. It is the effect of the number of

tertiary carbon atoms. The initial rate of liquid fraction formation at 400°C is much faster than that at 380°C and higher total volume of liquid fraction was obtained for the 400°C compared to that at 380°C.

The major component of gas fractions are propene and n-butane from HDPE cracking and propene from PP cracking. The distillate oil components are mainly in the range of C<sub>7</sub> to C<sub>8</sub>. The carbon number distribution over Al-MCM-41 was similar to that for commercial gasoline fraction hydrocarbon based on the boiling point range using n-paraffins as reference.

The regenerated Al-MCM-41 was tested for catalytic cracking of PP at 400°C. It was found that the structure of Al-MCM-41 is stable. XRD patterns of the hexagonal structure MCM-41 was still remained for the regenerated CS-Na-20 catalyst with almost the same crystallinity as the unused catalyst. The regenerated catalyst provided relatively higher yield of gas fraction and lower yield of liquid fraction comparing to the fresh catalyst. Distribution of gas fraction and liquid fraction are not significantly different using the fresh or the regenerated catalyst.

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

1. To compare Al-MCM-41 with zeolite and other mesoporous materials for catalytic cracking of HDPE and PP under the same condition.
2. To investigate the efficiency of Al-MCM-41 for catalytic cracking of mixed plastic containing HDPE, LDPE, PP, PS.