CHAPTER V

CONCLUSION AND RECOMMENDATION

5.1 Conclusions

Waste lubricating oil can be used as raw material for converting to liquid fuels such as gasoline, kerosene and light gas oil by using Fe/AC, $CoMo/Al_2O_3$ and HZSM-5 catalysts. The main purpose of this present research is to study the effects of temperature, initial hydrogen pressure, reaction time and amount of catalysts on product yields and product distributions and obtain the optimum condition for cracking of waste lubricating oil over various catalysts. Kinetic study, mechanism and reaction pathway of catalytic cracking reaction were also investigated. The conclusions of this study can be listed in the following.

5.1.1 Conclusions of experimental design and analysis

2^3 factorial design was used to determine the parameter effect on liquid yield. Three factors consisted of temperature, initial pressure of hydrogen and amount of catalyst. Reaction time was kept at 60 minutes. It was found that temperature and amount of catalyst were the main effects on liquid yield. Increasing of the reaction temperature and amount of catalyst decreased the liquid yield. Initial hydrogen pressure was not significant influence on liquid yield from cracking of waste lubricating oil over Fe/AC, $CoMo/Al_2O_3$ and HZSM-5 catalysts.

5.1.2 Conclusions of univariate experiment

The results showed that the product compositions were affected by temperature, catalyst content and reaction time. Conversion and yield of gasoline, kerosene and light gas oil were favored at high temperature and catalyst content. High conversion of waste lubricating oil and maximum amount of gasoline, kerosene and light gas oil were observed at 425 °C, initial hydrogen pressure of 5 bar, and reaction time of 60 minutes with 5 wt% of Fe/AC and $CoMo/Al_2O_3$ catalyst and 1 wt% of HZSM-5.

Liquid product essentially consisted of fuel range hydrocarbon and chemical such as C_7-C_{20} of n-paraffins, C_8-C_{10} of iso-paraffins and aromatic compounds e.g., toluene, ethyl benzene and xylene.

The performance of the catalysts for the production of liquid fuels can be described as follow:

1. Yield of gasoline : Fe/AC > $CoMo/Al_2O_3$ > HZSM-5
2. Overall yield of gasoline, kerosene and light gas oil : Fe/AC > $CoMo/Al_2O_3$ > HZSM-5
3. Conversion of waste lubricating oil : Fe/AC > $CoMo/Al_2O_3$ > HZSM-5

The results show that Fe/AC was the effective catalyst for the production of liquid fuels, particularly gasoline. It would appear from these results that with Fe/AC, the amount of gasoline was highest compared with $CoMo/Al_2O_3$ and HZSM-5. In addition, Fe/AC catalyst was also highly selective for the formation of C_7 to C_{15} paraffin hydrocarbon.

Moreover, catalytic cracking processes over three types of catalyst were higher efficiency than thermal cracking process because the latter process gave the high amount of gas whereas low yield of oil product and light hydrocarbons.

5.1.3 Conclusions of kinetic study

It is evident from the present study that the catalytic cracking of waste lubricating oil with the three types of catalyst follow the first order reaction kinetic. The activation energies have been found of 122.98, 86.88 and 82.87 kJ/mol for cracking reaction with Fe/AC, CoMo/Al_2O_3 and HZSM-5, respectively.

In conclusion, we have found a new process for conversion of waste lubricating oil to liquid fuels using cracking catalysts. Oil product and amount of light hydrocarbon such as gasoline, kerosene and light gas oil were higher than that of thermal cracking process.

5.2 Recommendations

The recommendations for further research may be given as follows:

1. Study effect of raw material on product yield and composition in liquid product, for example use different source of waste lubricating oil such as automotives, hydraulic or cutting oil.

2. Catalytic cracking experiments should be conducted in a continuous system, i.e., fixed bed reactor.

3. Improve the efficiency of cracking catalyst for increasing yield of gasoline and other liquid fuels, for example loaded metal on zeolite catalyst.