

## CHAPTER V

### CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 Conclusions

1. The first –order kinetic reaction model provides a satisfactory fit to the experimental data for calculating the dissolution rate constants of two asphaltenes with and without fractionation using toluene in heptane or in pentane.
2. At low toluene percentages in solvent mixture, both the dissolution rate constant and the percentage of asphaltene dissolution stayed approximately constant when the content of toluene increased. On the other hand, dramatic increases in asphaltene dissolved were observed when 50 % and 40% of toluene were used for NM1 and NM5 asphaltenes, respectively.
3. The dissolution rates of asphaltene sample were in the mass transfer limited region at the studied flow rates of 0.2 to 30 ml/min. Above 25 ml/min, the asphaltene dissolution rates slightly increased with the flow rate. The product of mass transfer coefficient and area of the experimental systems increased with the flow rate of solution mixture.
4. The higher the polar fraction, the lower the dissolution rate constant and also the lower percentage of asphaltene dissolution were observed. Using 70 % toluene in heptane at 5 ml/min, the most polar fraction, F70/30, had the lowest dissolution rate constant while the least polar fraction, F90/10, had the highest value. The high polar fractions of both NM1 and NM5 asphaltenes required a higher percentage of toluene in solvent mixture for complete dissolution than the low polar fraction.
5. The s-shaped solubility curve was obtained from the solubility measurement. For percentage of toluene lower than critical point,

solubilities of both asphaltene samples were not significantly different. However, the asphaltene solubilities increased rapidly with increasing the percentage of toluene above the critical point. NM5 asphaltene had higher solubility than NM1 asphaltene for any given percentage of toluene in solvent mixture. The higher polar fraction also had lower solubility than the lower polar fraction.

6. Both solubility and the dissolution rate constant of both asphaltene samples using toluene/heptane mixture were higher than toluene/pentane.
7. The prediction of molecular weights of both NM1 and NM5 asphaltenes from the solubility data gave satisfactory results. The higher the polar fraction, the higher the molecular weight of asphaltene was obtained. Moreover, the molecular weight predicted from toluene/heptane was higher than that of toluene/pentane.
8. One can predict the solubilities of unfractionated asphaltene from the solubility values of its fractionated samples. The result showed that the solubility values of both unfractionated asphaltenes (NM1 and NM5) behave as a summation of its fractions.

## **5.2 Recommendations**

1. Determination of the metal content characterization of each polar fraction should be carried out in order to explain why the low polar fraction has higher dissolution rate constant and solubility than the high polar fraction.
2. The determination of asphaltene surface area is required in order to re-calculate the exact value of mass transfer coefficient.
3. The measurement of asphaltene molecular weight using Py-GC/MS or GPC is recommended in order to check the reliability of the asphaltene molecular weight prediction model.