CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

In this study, the effects of three types of surfactants, nonionic surfactant (Tween 80), anionic surfactant (SDS) and mixed surfactants (Tween 80 and SDS), on the solubilization and biodegradation of petroleum hydrocarbons in the oil sludge obtained from PTT PLC were studied by using two types of microorganisms; indigenous bacteria consortia originally present in the sludge and *Pseudomonas aeruginosa* isolated from the petroleum-contaminated sites in Thailand. The experiments were firstly conducted in batch liquid system and could be divided into 2 parts: solubilization and biodegradation. In the solubilization studies, the effect of the three surfactant s ystems on the solubility of hydrocarbons was examined at various surfactant concentrations and reported as %enhanced solubilization as compared with the control by using both Total Petroleum Hydrocarbon (TPH) extraction technique and GC/MS analysis. In the biodegradation studies, the biodegradation of hydrocarbons in the oil sludge was quantified as the TPH degradation and compared with the degradation in the control experiments (no addition of surfactant).

From the solubilization studies, it was found that the addition of surfactant greatly enhanced the solubilization of hydrocarbons in the oil sludge. The enhancement of the hydrocarbon solubilization increased with increasing surfactant concentration and reached its maximum value at a specific concentration or optimal concentration well above the critical micelle concentration of each surfactant. SDS was shown to have greater effect on the solubilization of hydrocarbons in the sludge than Tween 80 but the maximum solubilization occurred at much higher concentration. Apparently, the mixed-surfactant system provided the highest enhancing effect on the solubilization of hydrocarbons in the sludge. The degree of enhancement of the solubilization of hydrocarbons could be related to their water solubility, which nonpolar solutes are generally less soluble in the surfactant micelles than polar compounds. Therefore the solubilization capacity is in the following order: aromatic > cyclic aliphatic > linear aliphatic as observed in this study.

From the batch liquid biodegradation studies, it was clearly shown that the biodegradation of hydrocarbons in the sludge by both indigenous bacteria and *P. aeruginosa* was greatly enhanced by the addition of surfactant for all three surfactant systems as compared to the control (no surfactant addition). Similar to the solubilization, the highest biodegradation was achieved in the culture having the mixed-surfactant system followed by SDS and Tween 80 in the single-surfactant system. After the batch study, the biodegradation of hydrocarbons in the oil sludge was further studied in the semi-batch bioreactor (500 ml working volume) using a fill-and-draw operation. 50 ml of sample was withdrawn from the reactors each day and then the same volume of MSM containing different amounts oil sludge and surfactant was filled back into the reactors. In this study, 4 different oil sludge and surfactant loadings were used in this semi-batch bioreactor. The cultures were cultivated in the bioreactor for 10 days of which sample was analyzed on daily basis. In addition, in one reactor (reactor 5), glucose was added in order to examine its effect on growth and hydrocarbon biodegradation in the bioreactor. The results showed that, for both cultures, the growth and biodegradation of hydrocarbons obtained in the test reactors were significantly higher than those of the control reactor in the absence of surfactant. The addition of glucose was found to result in a higher growth but not the hydrocarbon biodegradation.

Upon completion of the study, although several conclusions can be drawn but there are still a few issues need to be further investigated. For example, the growth of the bacterial culture in the semi-batch reactor was still considerably low which should be enriched to get a better growth and biodegradation. In addition, the bioreactor could be enlarged in order to study the surfactant-enhanced biodegradation of hydrocarbons in the oil sludge at a larger scale (e.g., 3-5 liters).