

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

In this research, the effects of nonionic surfactant (Tween 80) on the solubilization and biodegradation of petroleum hydrocarbons in the crude oil sludge obtained from PTT PLC were studied by using the sequencing batch reactor (SBR) with 50 ml fill and draw operation. Firstly, the sequencing batch reactors were designed and constructed and then the microorganism or the mixed culture of indigenous bacteria consortia originally present in the crude oil sludge was cultivated inside the bioreactors as an oil sludge degrader for 1 liter. The experiments were divided into 2 parts: solubilization and biodegradation. In the solubilization studies, the effect of a nonionic surfactant system on the solubility of hydrocarbons was examined at various surfactant concentrations and reported as %enhanced solubilization and the ratio between the amounts of solubilized carbon with the amounts of nonionic surfactant as compared with the control (no addition of surfactant). Then, the most optimized concentration of nonionic surfactant (0.1% w/v) was brought to apply at the higher scale. The effects of mixing were also studied at various agitation speeds and the best condition was chosen to use in the biodegradation study and the extents of solubilized hydrocarbon in the aqueous phase were analyzed by GC/MS. In the biodegradation studies, the several of oil sludge loading were fed into the SBR system. The biodegradation of hydrocarbons in the oil sludge was analyzed by Total Petroleum Hydrocarbon (TPH) extraction technique quantifying as the TPH degradation and compared with the degradation in the control experiments. The TOC, COD and growth of the microorganism was measured and calculated to find the best optimum oil sludge loading to the SBR process.

From the solubilization studies, it was found that the addition of surfactant greatly enhanced the solubilization of hydrocarbons in the oil sludge 9 times higher than the control. 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. Nevertheless, the nonionic surfactant system provided the best optimization on the solubilization of hydrocarbons in the crude oil sludge at the concentration of 0.1% w/v. The enhancement of the solubilization of hydrocarbons was related to their water solubility, which nonpolar solutes are generally less soluble in the surfactant micelles than polar compounds. The results from GC/MS showed that the %enhanced-solubilization of alkane, naphthalene was 100% and steadily decreased when the number of polycyclic aromatics hydrocarbon (PAHs) increased. PAHs more than 3 rings were hard to solubilized into the aqueous phase i.e. pyrene or chysene, which the %enhanced-solubilization was 60-70% compared to no-addition of surfactant.

From the biodegradation studies in SBR process, 6 different crude oil sludge loading (1-10 g/L.d) with the addition of nonionic surfactant were fed into the bioreactors and it was clearly shown that the biodegradation of hydrocarbons in the crude oil sludge was greatly enhanced by the addition of nonionic surfactant system as compared to the control. The highest percent removal efficiency was achieved at about 90% at the oil loading 1 and 2 g/L.d. Beyond the oil loading 2 g/L.d, the removal efficiency gradually decreased and 50% oil removal was gained at the highest oil loading. From the optimum oil loading, the highest amount of oil loading, which the system could tolerance, was the oil loading that not excess 5.25 g/L.d. This phenomenon can elaborate that the microorganisms required quite a long time to degrade the hydrocarbons from crude oil sludge. Low oil sludge loading seems to be the suitable condition for this SBR process. In the environmental concern, it was very good in treating toxic chemicals to be non-toxic chemicals but it was not quite practical in the business way because a long time biodegradation was required.

5.2 Recommendations

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 temperature seems to have the effect on the rate of biodegradation. This study did not control the effect of temperature but used the room temperature as a condition. The temperature of this research might be swayed from 24 to 32 degree Celsius and it might change the biodegradation efficiency. For this reason, the bioreactor should have the temperature controller in order to control and increase the efficiency of surfactant-enhanced biodegradation of crude oil sludge in the SBR process making it more accurate than this research.