CHAPTER V

CONCLUSIONS AND SUGGESTIONS FOR FUTURE WORK

5.1 Conclusions

The result of preliminary experiment in this study demonstrates that additions of substrate as well as unacclimated sludge are apparently necessary to enhance the PCE removal efficiency. In the dechlorination experiment, 60 mg VSS of unacclimated sludge / kg-soil (approximately 0.1 g.) and soil consisting of 85.3% sand: 11.6% silt: 3.1% clay were mixed together to make a soil slurry. Different values of PCE removal efficiency were obtained when different substrates were fed into the soil slurry contained in anaerobic reactor. All experiments were carried out in triplicate. Of firstly, the concentration of carbohydrate and lipid wastes were selected from the experiment using food grade substrates i.e. glucose and soybean oil, as electron donors for PCE dechlorination. PCE was added in the soil slurry to prepare 100 mg-PCE/ kg-soil contaminated soil. After 24 days incubation period, 99.47 % PCE removal efficiencies were observed to be the greatest for glucose substrate of 10,000 mg-glucose/kg-sludge concentration. TCE and DCE production in this case were approximately 84.8 and 18.77 mg/kg-soil, respectively. 79.81 mg/kg-soil of chloride production and approximately 6.2 ml gas production were also observed simultaneously while other intermediates i.e. VC, ethene, ethane were not found in this case. For soybean oil substrate, 99.05% PCE removal efficiencies were observed to be the highest one with loading concentration of 5,000 mg-Soybean oil/ kg-sludge

The observation of TCE, DCE, chloride and gas production were also tested and the results were 71.12 mg/kg-soil, 8.94 mg-kg-soil, 72.18 mg-kg-soil and 5.0 ml, respectively. Other intermediates i.e. vinyl chloride, ethene, ethane were not detected in this experiment. Next, selected concentrations for the two types of food grade substrates were then applied to the dechlorination experiment using waste materials, including molasses, used edible oil and oil waste as the electron donors. 5,000 and 10,000 mg-glucose/ kg-sludge were selected to apply for molasses concentration while 500 and 5,000 mg-soybean oil/ kg-sludge were selected as the concentration of oil waste and used oil in the next experiments. The best three substrates for PCE removal efficiency were found to be waste oil from Leo Food (5,000 mg/kg-sludge, 99.46%), used lard (500 mg/kg-sludge, 99.41%) and used soybean oil (5,000 mg/kg-sludge, 99.46%). Used lard at lowest concentration (500 mg/kg-sludge) was determined as the best choice of waste due to its enough high level of PCE removal efficiency (99.41%) and lowest material cost ($0.125^{*}\ 10^{-3}$ baht/ reactor) which should be applied to the next experiment. In addition, the existing of intermediates were observed as following 18.96 mg/kg-soil of TCE, 53 mg/kg-soil of chloride production and 2.8 ml gas production. Then, the ability of 500 mg/kg-sludge used lard for removing PCE of different concentrations was examined. At various PCE concentrations which were 100, 150, 200 and 250 mg-PCE/kg-soil, 500 mg-used lard/kg-sludge could provide sufficient electron donors for PCE reductive dechlorination process in which 80.68% to 99.1% PCE removal were observed. On the other hand, at the highest PCE concentration (500 mg-PCE/kg-soil), PCE removal efficiency was decreased to 37.3%. Highly PCE concentration was though to be toxic

for bacterial cells sludge to soil ratio in the system should be increased to enhance the PCE removal efficiency when soil were contaminated by highly PCE.

The above results highlight the potential of using oil wastes as supplemental substrates for removing PCE from the contaminated soil. Instead of the food grade carbohydrade and lipid substrates, edible oil wastes, especially used lard, was considered as the cost effective electron donor for dechlorination of 100-250 mg-PCE/kg-soil contaminated soil. It was also thought to be preferable than the carbohydrate substrates for long term remediation because of the complex structure and high content of hydrogen. Continuous releasing of hydrogen for longer period can be expected from used lard and other oil wastes. The dechlorination system using lard as the substrate also have the potential to be applied for hazardous waste contaminated sites for the removal of other chlorinated compounds. However, for the on-site remediation, the addition of used lard should be carefully done in the close system to prevent the contamination of groundwater and to maintain an anaerobic condition. Additionally, methane gas should be recovered during the treatment process and reused for other purposes. This performance will prevent the contribution of green house gas to the environment as well as add value to the by-product output.

5.2 Suggestions for Future Work

In the soil slurry reactors, used wastes i.e. used soybean oil, used lard, oil waste from food industry, and molasses act as the diffusion sources of primary substrates, and the released hydrogen atom would enhance the reductive dechlorination processes. Because hydrogen atoms were released from wastes continuously therefore wastes can remain active for a long period of time in the real situation. Wastes provided the highly efficiency of PCE removal and used lard had high ability to enhance the PCE dechlorination. Results of this study will aid in designing a system for field application. This system would also have the potential to be applied for hazardous waste contaminated sites to biodegrade other chlorinated compound.

The following issues which have certain effects on the dechlorination process should be investigated for future study;

1. Because of PCE removal efficiency was decreased when the contaminated PCE in site increased and the highly PCE concentration may kill bacteria in the soil slurry reactors. Therefore, there should be varied ratios of sludge to soil for highly contaminated soil. The highly sludge to soil ratio will enhance the surviving bacteria in system.

2. Because wastes can remain active for a long period of time in the real situation therefore the future experiment should be designed to investigate the ability of carbon source in long term dechlorination of PCE.

3. PCE dechlorination will be investigated in the future experiment when the properties of soil sample, sources of sludge and other wastes as carbon source will be varied.

4. Larger scale reactors should be carried out in order to prove that the system can apply to the real situation.

5. There should be investigated all intermediates i.e. DCEs, VC, ethene and ethane in soil slurry and gas to ensure the completion of bioremediation strategies.

This work only proves that we can decrease the amount of PCE in contaminated soil slurry reactors via reductive dechlorination process. The application as biobarrier may be done in the future.