CHAPTER I

INTRODUCTION

1.1 Statement of problem

Chlorinated organic compounds, such as tetrachloroethene (PCE) and trichloroethene (TCE), are widely used in various industrial processes such as dry cleaning in textile industry, scouring of machines, and in fat extraction. Widespread contamination of these compounds in groundwater and soil (Hara and Ito, 2004; Holliger, 1995; Sponza, 2001) and suspicion of their risks as carcinogens (Hara and Ito, 2004) have given rise to various applications for remediation. Although physical and chemical processes are commonly used, bioremediation, however, has been growing because this technique offers the prospect of converting the contaminants into harmless products, rather than transferring them from one part of environment to another (Lee, 2002). Furthermore, these chlorinated compounds can be transformed through microbiological processes with a low cost of investment compared with other removal methods (Borden, 2003), such as soil vapor extraction, pump and treat by air stripping, and adsorption on granular activated carbon (Hinchee, 2002; Gao et al., 1997). Thus, bioremediation is the one of the most promising technologies for cleaning up groundwater and contaminated soil.

For biodegradation, PCE appears completely resistant to the metabolism by aerobic microorganism (Holliger, 1995; Lee, 2002) while it was found that an important class of PCE transformation occurs under anaerobic environments, namely anaerobic reductive dechlorination. During anaerobic processes, chlorine ion in PCE is replaced with hydrogen product received from the organic digestion process. At the end of the reductive dechlorination process, TCE and PCE will be dechlorinated into environmental friendly products such as ethane and ethene (Ferguson and Pietari, 1999).

Although performances of anaerobic reductive dechlorination have been studied by several researchers, the utilization of wastes as the electron donor for microorganism has not been examined. Food grade compound such as glucose is commonly used as electron donor substrate (He et al., 1998; Sponza, 2001) and recently, edible oil was also reported as an effective substrate for anaerobic reductive dechlorination (Hinchee, 2002; Borden et al., 2003). However, additional expense is required in order to purchase those chemical substances for soil and groundwater treatment. Therefore, this study is focus on using various wastes as the electron donor for anaerobic reductive dechlorination of PCE in soil.

1.2 Objectives

The goal of this research is to investigate the type and concentration of wastes i.e. molasses and used edible oil that can be applied as electron donor for tetrachloroethene (PCE) reductive dechlorination by unacclimated sludge. Utilization of waste as the electron donor for anaerobic reductive dechlorination has not been examined. The acquired knowledge would help reduce the cost of PCE bioremediation treatment. Specific objectives were:

1. To identify the optimum concentration of electron donors for PCE reductive dechlorination by unacclimated sludge.

2. To compare the effectiveness of wastes (molasses and used oil) with glucose and soybean oil for PCE reductive dechlorination.

3. To investigate the optimum concentration of PCE that can be dechlorinated when using appropriate wastes as electron donors.

1.3 Hypothesis

1. Molasses and used-edible oil can be used to enhance the PCE reductive dechlorination.

2. Unacclimated sludge can be used in PCE reductive dechlorination.

1.4 Scope of study

PCE reductive dechlorination: PCE reductive dechlorination was carried out in soil slurry system that was artificially contaminated with PCE.

Soil collection and preparation: Clean soil sample was collected from an agriculture site in Chiang Mai province. The soil was collected with a stainless steel grab sampler and analyzed for the initial PCE concentration using gas chromatography. PCE contaminated soil was prepared by spiking the soil with desired amounts of PCE before used.

Bacterial inoculums: Granular sludge was used as seed of anaerobic bacteria. The sludge was collected from a UASB wastewater treatment plant of Leo food industrial, Chiang Mai province and found to be free of PCE contamination.

Organic substrate: Used edible oil was collected from two locations in Chiang Mai province, local market and industry. For local market, used lard and used soybean oil were obtained from pa tong go shop at Ton pa yom market. For industry, oil waste was brought from the screening process of Leo food Industry that used palm oil to produce seasoning for instant noodle. Molasses were brought from sugar industry in Chiang Mai province. These wastes were used as carbon sources in anaerobic dechlorination process with concentrations related to the optimal concentration of glucose and soybean oil.

Condition: The experiment was carried out in 40-ml glass vials and 10-ml plastic syringes. The reactors were kept and shaken in dark at room temperature. Alkalinity ($NaHCO_3$ 500 mg/L) was added to maintain pH at 6-8.

Parameter: In the reactor, PCE reductive dechlorination will be monitored from the decreasing of PCE and the increasing of PCE dechlorination intermediates and chloride ion. The consumption of carbon sources will be measured from gas production.

Mineral salts medium (MSM): MSM used for degradation experiments was fed batch as the culture medium in the combination with various inorganic nutrient media, see APPENDIX B (Table B-1).

Quantification of PCE: Pre-study of extraction efficiency was done by adding hexane and 15% triton X-100 to soil slurry and then shake at 350 rpm for 2 hrs. Then, the solvent was frozen at -4°C to solidify the lower aqueous layer, after that anhydrous sodium sulfate was added to dewater the sample. Then the extract was injected to Gas Chromatography for analysis (APPENDIX D).