CHAPTER 1

INTRODUCTION

Nowadays, numerous industries have spread out to every part of the world. Industrial discharges of wastewater streams are the primary release of trichloroethylene (TCE) into the environment, which includes aquatic system, soil, and air. Many industries including wood furniture manufacturer use TCE as a solvent to remove grease from metal parts. It is also used as a solvent in other industries. Exposure to TCE could be harmful to human health depending on the level of exposure. Based on limited studies conducted in humans, TCE is reasonably anticipated to be a human carcinogen. TCE could evaporate easily but it persists in the soil and in ground water[1-2].

TCE could be treated by many techniques, but, each method has its shortcomings. Granular Activated Carbon (GAC) adsorption and air stripping are commonly used; however, neither technology results in the direct destruction of the organic contaminant. TCE could also be treated by biological degradation, but it takes time and has problem of microbial activity tapering off over time[3]. In order to solve these problems, Advanced Oxidation Processes (AOPs) is a possible solution with reasonable short reaction time and cost. Fenton's reagent is an AOP, which was firstly observed by H. J. H Fenton in 1894[4]. It can produce hydroxyl radical, known as one of the most reactive oxidizing agent, second only to elemental fluorine in its reactivity as shown in Table 1.1. In general, the oxidant has been capable of achieving high treatment efficiencies (e.g.> 90%) for unsaturated aliphatic (e.g. TCE) with very fast reaction rates (90 % destruction in minutes)[5]. Thus, Fenton's reagent is one of the most effective technologies to remove organic pollutants from aqueous solutions. However, because of the sensitivity of Fenton's reagent to the conditions and pollutant in wastewater, it is recommended that the reaction always be characterized through laboratory treatability tests before proceeding to plant scale[5]. The conditions that may affect Fenton's reagent are iron concentration, H_2O_2 concentration, iron type, temperature, pH, and reaction time. The last four factors could be fixed and controlled easily.

Table 1.1 Relative oxidation power of the reactive species

Reactive Species	Relative Oxidation Power (Cl_2=1.0)
Fluorine	2.23
Hydroxyl radical	2.06
Atomic oxygen (singlet)	1.78
Hydrogen peroxide	1.31
Perhydroxyl radical	1.25
Permanganate	1.24
Hypobromous acid	1.17
Chlorine dioxide	1.15
Hypochlorous acid	1.10
Hypiodous acid	1.07
Chlorine	1.00
Bromine	0.80
Iodine	0.54

Source: US peroxide, 2001

Therefore, before using the Fenton's reagent, the ratio of H_2O_2: Fe^{2+}: TCE should be optimized, since these three are most affecting the treatment efficiency.

Titanium dioxide is one of the most powerful semi-conducting materials. It could usually be used as a photocatalytic substance[6-15]. Due to its properties of being able to transfer electrons through its surface, some evidences have shown that TiO_2 surfaces can effectively stabilize redicals and radical ions. Thus, photogenerated surface-associated redox intermediates may have a longer lifetime than the same intermediates chemically generated in the solution. The prolonged lifetime results in a greater chance for the occurrence of chemical reaction[8-11, 16].

The objective of this research is to optimize the conditions for using Fenton's reagent with and without the present of TiO_2 to treat TCE in wastewater with the intention to determine the optimal ratio of H_2O_2, Fe^{2+}, and TCE. The results of this work could possible use for treatment of TCE in wastewater to prevent TCE from releasing to the environment.