CHAPTER 1

INTRODUCTION

1.1 Motivations

In October 2002, the 7,101,845,354 baht of organic chemicals is imported to Thailand [1]. From the data, the use of chemicals by manufacturing and agricultural industries in Thailand is quite high. 4-Nitrophenol is among the most common organic toxic persistants in industrial and agricultural wastewater from the production of dyestuffs, pesticides and various intermediate products for organic synthesis. It is considered by the United States of America Environmental Protection Agency (EPA) to be a hazardous waste and priority toxic pollutant and it is desirable to less than 20 ppb in water reservoirs [2]. 4-Nitrophenol is toxic to plant, animal and human health. Animals studies suggest that 4-nitrophenol may cause a blood disorder. Acute exposure of 4-nitrophenol may lead to methemoglobin formation, liver and kidney damage, anemia, skin and eye irritation, and systematic poisoning [17].

Due to its harmful effects, wastewater containing phenolic compounds must be treated before being discharged to receiving water bodies. Secondary biological treatment processes are commonly used for domestic and industrial wastewater, but they cannot treat phenolic wastewater at high concentrations successfully. Therefore, new treatment technologies are still constantly being researched and developed. Research efforts include chemical oxidation [4], biological degradation [5], solvent extraction [6], and adsorption. Although many different adsorbents [7-8] have been tested to remove nitrophenol from wastewater, activated carbon [9-10] is still the most widely used adsorbent to this end. One of the great advantages in using activated carbon is that it is able to remove toxic substances present at very low concentrations, which with other processes would be much more complex and costly. Direct addition of powder activated carbon to remove nitrophenol is quite efficient, but the carbon loss as wasted sludge is rather significant. Therefore, granular activated carbon is usually used in fixed-bed adsorption processes because of ease of operation and no carbon loss problem [11].

Although activated carbon is very effective for wastewater treatment, the unit cost of employing activated carbon in wastewater treatment plants is very high. Since the applications of and demand for activated carbon being increasing dramatically, the methods for lowering activated carbon production cost and improving regeneration techniques to prolong the life of the activated carbon have become important topics for current research. One study concluded that regeneration of the exhausted activated carbon on-site is the most economical and applicable method for lowering operation cost [12]. Among these, the thermal regeneration method currently is the most promising technique in regenerating the spent activated carbon but not on-site treatment [13,14]. Other regeneration methods including the chemical treatment and biological treatment methods are still being investigated and developed [15].

This research focuses on using chemical treatment methods for regeneration of activated carbon . The chemical reagent used for regeneration is Fenton's reagent. The reasons for this method are :

1. Fenton's reaction might degrade toxic contaminant to a less harmful state when reaction occurs. Therefore wastewater from regenerating activated carbon is less contaminanted.

2. The chemical treatment method can be used in the on-site treatment.

1.2 Objectives

1.2.1 To study 4-NP adsorption and desorption from Granular Activated Carbon.

1.2.2 To study the efficiency of Fenton's reaction for regeneration of 4-NP adsorbed Granular Activated Carbon.

1.3 Hypotheses

1.3.1 Optimal ratio of 4-NP: H_2O_2: Fe^{2+} can overcome the transport resistance and induce the oxidation of 4-NP adsorbed in Granular Activated Carbon.

1.3.2 Generated heat and pH of Fenton's oxidation process can accelelate the desorption rate of 4-NP from Granular Activated Carbon.

1.3.3 Granular Activated Carbon can be reused after regeneration by Fenton's process.

1.4 Scopes of Work

This research studies the adsorption of 4-NP using GAC and the regeneration of GAC using Fenton's reagent oxidation.

1.4.1 Synthetic wastewater of 4-NP was applied with purity and reverse osmosis (RO) water in all experiments.

1.4.2 Three types of GAC (Carbokarn co., Ltd) are coconut shell, palm shell and bituminous coal bases with the same mesh number of 8-16 and the properties of them are nearly the same.

1.4.3 The remained phenol after adsorbed by GAC were to achieve effluent standard (< 1 mg/l).

1.5 Advantage of this work

The treatment of 4-NP by GAC technique will be developed and practically used in industrial wastewater treatment. The results from the experiment can be further developed to treat other contaminants that can be adsorbed by GAC and regenerated by Fenton's reagent.