CHAPTER I
INTRODUCTION

1.1 Motivations

The advanced oxidation processes, based on the generation of very reactive free radicals, are relatively new technologies involving the degradation of organic components in water (István Ilisz et al., 2004).

Recently, it has been demonstrated that the TiO_2/UV technique can lead to effective removal of soluble organic matter and this process can be considered as a potential alternative to conventional methods of treatment. The major advantages of these photocatalytic processes include the relatively mild reaction conditions and their success in decomposing several toxic as well as refractory pollutants (N.N. Rao et al., 2003).

However, titanium dioxide (TiO_2) has weak points that have low adsorption activity leading to low photocatalytic degradation efficiency. Various treatment strategies are applied for the removal of toxic organic pollutants from water. The traditional technologies based on adsorption, frequently involving the use of activated carbon, are easily applicable processes for the removal of contaminants in water. Activated carbons are usually found to be fairly effective in extracting organic materials from water. Additionally, activated carbon is a non-selective adsorbent which adsorbs almost all the natural organic matter present in water (Amjad H. El-Sheikh et al., 2004).

Owing to activated carbons having high efficiency in adsorption; this research was focused on preparation and application of TiO_2/AC composite. By deposition TiO_2 on activated carbon, the adsorption ability of TiO_2 might be enhanced and the photocatalytic efficiency might be increased. There are many methods in synthesizing the TiO_2/AC composite, such as chemical vapour deposition (CVD), direct air-hydrolysis (DAH), high temperature impregnation (HTI) (Amjad H. El-Sheikh., 2004), and sol-gel technique (Dong-Keun Lee., 2004). Sol-gel technique is the most common method of producing TiO_2/AC composite and it is accepted to be the practical process to control the structure of a material on a nanoscale (Dong-Keun Lee et al., 2004).

In this research, the selected contaminant to test adsorption and photocatalytic ability of TiO_2/AC was 2-chlorophenol (2-CP). 2-CP was represents important water

pollutants and has been named as priority pollutants by the US-EPA (M.A. Callahan, 1979). 2-CP was widely used in chemical intermediates, pesticides etc., and also found in drinking and ground water (Greenpeace Report, 1992). The stability of the C-Cl bond in halo hydrocarbons is responsible for their toxicity (N.N. Rao et al., 2003) and highly stable. Their greater solubility in fatty materials compared to water can lead to significant risks of bioaccumulation in animals and humans (Greenpeace Report, 1992).

In general, the practical way to remove of 2-CP is photocatalytic (TiO_2/UV) degradation (N.N. Rao., 2003; István Ilisz, 2002). However the commercial TiO_2 powder used in the previous works exhibited the limitation in the active surface area, and the improper crystal structure. Thus, the aim of this research was to synthesize the TiO_2/AC composite for better efficiency in 2-CP removal using the photocatalysis process as indicated above.

1.2 Objectives:

The major objective of this work was to develop the new composite material as TiO_2/AC for hazardous waste removal application. Preparation and characterization of titanium dioxide/ activated carbon composite material with proper properties (high surface areas and proper crystal structure), high adsorption and high photocatalytic activity were performed. Consequently, the 2-CP removal application using the obtained TiO_2/AC was investigated.

Thus, minor objectives in this study include:

- To investigate the effect of molar ratios on properties of TiO_2/AC composite material.
- To investigate the effect of different types of TiO_2 composite on adsorption behavior and photocatalytic activity of TiO_2 composite material
- To investigate the effect of calcination temperatures on properties, adsorption behavior and photocatalytic activity of TiO_2/AC composite material.
- To obtain the adsorption isotherm of TiO_2/AC composite in 2-CP removal.

- To obtain the photocatalytic kinetic behavior of TiO_2/AC composite in 2-CP removal.

1.3 Hypotheses:

- Photocatalysis efficiency in 2-CP removal using TiO_2/AC composite was controlled by TiO_2/AC properties includes surface area, TiO_2 structure, etc.
- Different molar ratios of TiO_2 to AC and calcination temperatures were the major factors controlling TiO_2/AC composite properties in the preparation process.
- Different molar ratios of TiO_2 to AC, type of TiO_2 and calcination temperatures were an important parameter affecting to properties and the efficiency of adsorption and photocatalytic reaction of TiO_2/AC composite.

1.4 Scope of the study:

All experiments in this research were conducted on laboratory scale. The scopes of this research were as following:

1. TiO_2/AC composite were prepared by sol-gel technique.
2. Different molar ratios of TiO_2 to AC, type of TiO_2 and calcination temperatures of TiO_2/AC composite were used to controlled properties of TiO_2/AC composite.
3. The studies characteristics of TiO_2/AC composite were based on adsorption and photocatalysis purposes only. Major properties to study included surface areas and ratio of anatase to rutile.
4. The studies of mineralization of 2-CP photolysis degradation by total organic carbon (TOC) and Gas Chromatography/Mass Spectrometer (GC/MS) only.

1.5 Expected outcome:

- Obtain the novel TiO_2/AC composite.
- Knowledge in controlled properties of TiO_2/AC composite for adsorption and photocatalytic process.
- Knowledge in adsorption and photocatalytic activity of TiO_2/AC composite on 2-CP removal.