CHAPTER I
INTRODUCTION

Organic compounds in wastewaters are responsible for most of the water and soil pollution problems. The most widely used method to treat the wastewaters is a biological process. However, the biological processes usually require considerably long treatment time to break down organic pollutants in comparison to physical and chemical treatment methods. In addition, a number of organic compounds known as nonbiodegradable (such as some detergents) cannot be treated biologically and some toxic organics may kill active micro-organisms (Chen and Ray, 1999). Chemical processes such as chemical oxidation are effective in treating wastewaters containing nonbiodegradable organics. But using air as an oxidizing agent requires high temperature and pressure resulting in a high operating cost (Handcock, 1999). On the other hand, using chlorines often generates by-products such as chloroamines from the reaction of chlorine with ammonia. A physical treatment method such as carbon adsorption requires a secondary treatment for the spent activated carbon, and the air stripping process transforms water pollution into air pollution (Robertson, 1996).

The photocatalytic process, part of a process known as Advanced Oxidation Technologies (AOTs), is a promising alternative because this process can oxidize a number of nonbiodegradable organics into less toxic compounds. The products from this process are mostly carbon dioxide, water and other inorganic compounds. Moreover, it can be operated at room temperature and atmospheric pressure (De Lasa *et al.*, 1992). The common characteristic of all AOTs is the generation of a very reactive free radical, principally hydroxyl radical (Litter, 1999). The photocatalytic process starts with illumination of light at an appropriate wavelength to a photocatalyst that is normally considered a semiconductor. The catalyst, which is activated with

photo energy, will produce electrons and holes that easily migrate to the catalyst surface and initiate the redox reaction. The most commonly used photocatalysts are oxides or sulfides of metals such as TiO_2, ZnO and CdS. However, ZnO has a restricted range of stability in aqueous solution while CdS increases the toxicity due to CdS photocorrosion (Reutergardh and Iangphasuk, 1997). Unlike ZnO and CdS, TiO_2 has been proven to be one of the most suitable catalysts because it is stable over a wide range of pH and inexpensive (Robertson, 1996).

In this study, 4-chlorophenol was chosen as a model pollutant because its structure is similar to aromatic compounds that are difficult to be degraded biologically. This organic compound is widely used in the textile and pharmaceutical industries. Four catalysts used in this work were TiO_2, Pt/TiO_2, TiO_2-SiO_2 and Pt/TiO_2-SiO_2. All catalysts were prepared by the sol-gel method. Silica was chosen as a support for TiO_2 because previous studies have shown that adding silica increased the thermal stability of TiO_2. So, it can be calcined at higher temperature, resulting in increasing the initial rate of a chlorinated hydrocarbon, trichloroethylene, decomposition (Jung and Park, 2000). Platinum was chosen because it was found that a higher decomposition rate of phenol was obtained over platinum containing catalyst (Brezova *et al.*, 1997). The sol-gel method was chosen because the catalyst prepared by this method has a high surface area and the homogeneous structure can be controlled in the case of mixed oxide such as TiO_2-SiO_2 (Ward and Ko, 1995). Effects of other parameters such as amount of catalyst, initial pH of 4-chlorophenol solution and calcination temperature on the degradation rate were also studied.