CHAPTER I
INTRODUCTION

Environmental problem is a globally concerned topic because it has been spread throughout the world. One of the most commonly found problems is wastewater problems. The release of wastewaters to the environment is of great concern due to the coloration of natural waters, the toxicity, the mutagenicity, and carcinogenicity. Organic dyes belong to the largest groups of pollutants in wastewaters produced from textile and other industrial processes. A more complex environmental problem associated with the textile industry is that organic dyes are resistant to microbial degradation, and thus they can unavoidably be converted to the toxic or carcinogenic compounds. Especially, an abundant class of synthetically coloring organic compounds is azo dye, such as Acid Yellow and Acid Black, which is characterized by the presence of azo group (–N=N–) bound to aromatic rings (Yang *et al.*, 2004, and Liu *et al.*, 2005).

Technologies for the removal of dye pollutants have been increasingly investigated to solve these wastewater problems. There are several approaches frequently used for treatment of dye-containing wastewaters, such as physical methods (adsorption), biological methods (biodegradation), and chemical methods (chlorination and ozonation). However, the conventional processes for treatment of these effluents are insufficient to purify the significant quantity of wastewaters generated from the different operations of textile dyeing and washing. Some methods, such as coagulation, electrochemical oxidation, and active sludge, have recently been examined and proved to be effective. Other methods, such as flocculation, reverse osmosis, and adsorption on activated carbon, have also been investigated (Lachheb *et al.*, 2002). The drawback of these methods is incomplete destruction of the pollutant compounds, since they just transfer the compounds from aqueous to another phase, thus causing secondary pollution problem. Therefore, regeneration of adsorbent materials and post-treatment of solid-wastes, which are expensive operations, are desired (Ioannis *et al.*, 2003).

Among the new oxidation methods called "advanced oxidation processes" (AOPs), heterogeneous photocatalysis using TiO_2 as a photocatalyst appears as an emerging destructive technology due to its several advantages. Firstly, it destroys the

pollutants by decomposing or transforming into less harmful substances in the presence of UV and near-UV illumination. Secondly, non-toxic material can be used as semiconductor photocatalyst, such as titanium dioxide (TiO_2). Thirdly, this process can be operated at room temperature and atmospheric pressure. Fourthly, it leads to the total mineralization of most of the organic pollutants. Finally, the photocatalytic process is receiving increasing attention because of its low cost due to the use of sunlight as the source of irradiation. Moreover, TiO_2 photocatalyst is largely available, inexpensive, and non-toxic, and shows relatively high chemical stability, so the TiO_2-composed photocatalysis is a potential emerging technology for destroying dye pollutants. The primary photocatalytic processes occur upon irradiation of light with energy greater than or equal to the band gap of photocatalyst, and the electrons and holes are then generated and trapped on the photocatalyst surface, subsequently producing reactive oxygen species, such as $OH^{\bullet}$ and $O_2^{\bullet-}$ radicals, to degrade organic dye pollutants.

The photocatalytic degradation of azo dye by using nanocrystalline mesoporous-assembled TiO_2 has not been extensively investigated, so this research was focused on this kind of photocatalyst. In the previous work, Jantawasu (2008) studied the photocatalytic degradation of Methyl Orange by comparatively using nanocrystalline mesoporous-assembled TiO_2 and non-mesoporous-assembled TiO_2 photocatalysts. The results showed that the synthesized mesoporous-assembled TiO_2 calcined at 500°C gave the highest efficiency in the degradation of the Methyl Orange dye. The nanocrystalline mesoporous-assembled TiO_2 is therefore a promising photocatalyst because it possesses very small physical dimensions, large surface area and pore volume for reactant accessibility, uniform pore size distribution, and high volume fraction of atom located at the surface, which are very helpful for this application.

In this research, experimental investigation was performed on the photocatalytic degradation of a mixture of two azo dyes—Acid Yellow 23 (AY) with 1 azo group and Acid Black 1 (AB) with 2 azo groups—as model contaminants in textile wastewater, using mesoporous-assembled TiO_2 nanocrystal synthesized by a sol-gel process with the aid of a structure-directing surfactant and calcined at 500°C. The influence of various operational parameters affecting the photocatalytic degradation of mixtures of two azo dyes, including type of dye, initial dye

concentration, photocatalyst dosage, dissolved oxygen level, initial solution pH, and water hardness concentration, were studied.