CHAPTER I

INTRODUCTION

1.1 Background

At present, water pollution has been recognized as a serious environmental problem. The major sources of pollutants are manufacturing processes, especially in chemical industry. In recent years, many researchers are interested in applying the "photocatalytic decomposition process" to the treatment of hard-to-biodegrade organic pollutants in industrial wastewater (Kusvuran *et al.*, 2005). The advantages over other traditional methods are its high potential for high-level degradation of organic compounds under ambient condition within a short period with negligible formation of undesirable byproducts (Devipriya *et al.*, 2005). For example, Black 5, methylene blue, and lignin can be degraded by titanium dioxide (TiO_2) under UV irradiation in 1 hour though some byproducts from lignin decomposition may be presented (Viriya-empikul, 2004). TiO_2 is the most popular photocatalyst employed in practical applications due to its relatively low price, non-toxicity, high chemical stability, etc. The aqueous suspension of TiO_2 nanoparticles could exhibit capability to decompose many organic substances in wastewater. However, the problem of catalyst loss due to elutriation with exhaust stream is still unsolved. A suitable continuous reactor for the photocatalytic decomposition process is indispensable. In a rotating-drum contact reactor, TiO_2 is immobilized on the outer surface of the partially submerged drums for water purification and Zhang *et al.*, (2001) have shown that the reactor can decompose phenol rapidly under the sunlight. In this study, a simple rotary drum filtering reactor is proposed for photocatalytic decomposition without loss of TiO_2 powder while it can recover TiO_2 powder from the slurry. As mentioned above, phenol is chosen as pollutant because it is used as solvents or reagents in various industrial processes and is hardly biodegradable.

Finally, in the real treatment system, the performance of TiO_2 cake in degrading the phenol is investigated to determine the photocatalytic decomposition and mineralization.

1.2 Objectives of study

The objective of this research is to design and develop a rotary drum filtering reactor for investigating the effects of the operating conditions, namely, rotating speed of the drum and filtration velocity, on phenol removal.

1.3 Scopes of research

1. Investigation of phenol decomposition and mineralization by two types of TiO_2 nanoparticles (see Table 1.1) in a shaker-type photoreactor and choosing the better photocatalyst to apply in rotary drum filtering reactor system.

2. Design and construct a lab-scale rotary drum filtering reactor system.

3. Investigation of phenol decomposition and mineralization by TiO_2 cake in a rotary drum filtering photoreactor while varying the following parameters:

3.1 Rotating speed: 5 – 30 rpm.

3.2 Filtration velocity: 0.52 – 0.84 cm min^{-1}.

4. Analyze the decomposition of aqueous phenol by HPLC (Shimadzu, Class VP) and TOC analyzer (Shimadzu TOC V_{CPH}).

Table 1.1 Physical characteristics of titania samples. (Viriya-empikul, 2004)

Code name	T1$^{\Delta}$	N1$^{\Diamond}$
Crystal phase	Anatase	Anatase
TiO_2 content (wt.%)	98	(Apatite coated)
Average crystallite size (nm)	30	400-500
Particle shape	Sphere	Sphere, cylinder
BET surface area ($m^2\ g^{-1}$)	56-59	64

$^{\Delta}$ Titania sample is provided by Prof. Yasushige Mori of Doshisha University, Kyoto, Japan.

$^{\Diamond}$ Apatite-coated titania sample is provided by Nonami Science (Thailand) Co., Ltd.

1.4 Expected benefits

The expected benefit from this research is the knowledge to design the rotary drum filtering reactor and understanding of the effects of the operating conditions, which are the rotating speed of the drum and the filtration velocity, on phenol removal. In addition, this novel reactor for wastewater treatment should bring about numerous advantages, including energy savings.