Chapter I

Introduction

1.1 Introduction

Metal industry is one of major industries in Thailand such as molding and melting metal, electroplating, and car manufacturing industries, etc, that chromium is main waste from these factories (Schrank et al., 2002). Chromium (VI) is a highly toxic heavy metal as well as highly soluble substance over a wide range of pH conditions. It is used in a variety of industrial processes, consisted of wood treating, plating, and tanning as well as in the power industry. Naturally chromium occurs in the trivalent form, Chromium (III), and has limited solubility (except in extremely acidic conditions). Failure to treat Chromium (VI) contamination in a quick manner, results in larger future expenditures as groundwater plumes continue to spread, unless remediate. All of them are very hazard to the human-being life

Now, the problems related to the environmental protection became one of the main problems of the world. The methods employed for the removal of chromium waste are chemical precipitation, reverse osmosis, ion exchange, foam flotation, electrolysis, adsorption on coal or activated carbon, etc. However, most of these treatments require high energy, produces toxic liquid or solid byproducts, or involves dosing with additional chemicals is becoming less favorable for present day waste managements whereas the photocatalytic process found to be superior to all.

The photocatalytic processes show interesting features. Usually there is no need to add chemical reactants which could generate secondary pollution phenomena. Many studies proved that a large number of pollutants could be oxidized or reduced in this way (Herrmann, 1999). These studies, however, were done in slurry reactors where small size catalyst particles were suspended in liquid phase. This solution presents some problems: scattering and absorption on the solid particles limit the penetration of the UV (ultraviolet) light and the efficiency of the reactor. Moreover, the purified water must be filtered to separate the catalyst particles. To overcome

these problems, preparations of thin film have been developed by different techniques, for example chemical vapor deposition, chemical spray pyrolysis, electrodeposition and the sol-gel method (Ding et al., 2001; Srikanth et al., 2001). Many researches have focused on preparation by the sol-gel process since this method is very simple, easy to operate and can be applied to complex surfaces or large surface areas. Moreover, this technique is suitable for deposition on many substrates such as stainless steel, alumina, silica/glass, etc (Sonawane et al., 2002).

Titanium dioxide (TiO_2) has been widely used as a photocatalyst due to its activity, conservative nature, low cost, commercial availability, non-toxicity and high stability of light illumination (Oppenlander, 2003).

In this research, a prototype of fixed bed photocatalytic reactor (FBPR) was developed. The reactor configuration was rectangular aluminum box with hyperbolic roofs for light concentration with UV within the reactor. The catalyst (TiO_2) was immobilized on stainless steel plates. The effects of pH of wastewaters, flow rate, height level, TiO_2 coating surface area and initial concentration that influenced the photocatalytic-reduction efficiency of chromium (VI) were studied in order to find the optimum operational parameters.

1.2 Research Objectives

The main objective of this research was to find the optimum operational parameter of FBPR for chromium (VI) removal. The specific objectives were:

1. To innovate the prototype of FBPR
2. To investigate effect of operational parameters, pH of wastewaters, flow rate, water level, TiO_2 coating surface area and initial concentration of chromium (VI), on the photocatalytic-reduction efficiency of chromium (VI)

1.3 Hypothesis

1. FBPR can efficiently remove chromium (VI).
2. The studied parameter consisted of pH of wastewater, feed flow rate, water level of wastewater, TiO_2 coating surface area and initial concentration of chromium (VI) were influence the photo-reduction efficiency of chromium (VI) using FBPR.

1.4 Scopes of the study

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

1. TiO_2 thin films were prepared by sol-gel technique.
2. Media used only stainless steel.
3. Pollutants used synthetic chromium wastewaters.
4. Wavelength of UV lamp used at 380 nm.
5. The thin films characteristics were measured for photocatalysis purposes only. This characteristic study was not involved optical or electrochemical aspects.
6. The studied parameter consisted of pH of wastewaters, flow rate, water level of wastewater, TiO_2 coating surface area and initial concentration of chromium.

1.5 Expected result

1. Obtained the prototype of FBPR.
2. Obtained the efficiency of chromium (VI) removal by FBPR.
3. Obtained the optimum operational parameter for chromium (VI) removal by FBPR.

1.6 Advantage of research

Results from this research can be further used to prepare TiO_2 thin film on stainless steel plate by sol-gel technique. Moreover, they can be applied to design a full-scale photoreactor that is practically used in industrial wastewater treatment containing chromium (VI) by photocatalytic process.