CHAPTER I
INTRODUCTION

The number of factories in and around the Bangkok metropolitan area is increasing rapidly every year and each factory generates unique wastes. Some are toxic and harmful. Although the regulations about the environment have already been effective, they are expected to be more and more stringent in the next few years. Therefore, more economical and efficient methods have been studied and developed to deal with problems arising from various types of wastes. Among these wastes, wastes generated from textile mills are a major source of considerable pollution.

Water soluble dyes and heavy metals, which are extensively used in finishing processes, are the main components of wastewater from the textile effluent. Water soluble dyes can be categorized in four types according to their means of application, namely, acid dyes, reactive dyes, direct dyes and basic dyes. Nowadays, most commonly used dyes are the reactive and direct type for cotton dyeing. Even if the direct dyes are the simplest dyes to be applied and the cheapest in their initial and application costs, they have some limitations on the dye's shade range and wetfastness (Gohl, 1983). Heavy metals associated in the textile plant are copper, zinc, lead, antimony, chromium, cobalt, cadmium, barium, nickel, arsenic and mercury (Callely *et al.,* 1997). These pollutants result in a decrease in oxygen content in water, which causes an increase in BOD and COD. These pollutants also affect directly the living microorganisms, aquatic animals and humans. Moreover, their toxicity can cause serious diseases when their concentration is over a certain limit.

As a result, several processes such as flocculation, coagulation, oxidative and biological degradation have been studied and developed in order to control the quantity of textile wastes as limited by the government. However, several drawbacks and restrictions in operation are the main problems when these methods are applied in real situations i.e. high capital and operating cost and complicated operations. Liquid-phase adsorption is a promising technique for removal heavy metal compounds and dyestuffs from the textile waste streams by selectively adsorbing waste species onto solid adsorbents. In the application for heavy metal compounds and water soluble dyes adsorption, ion-exchange has been extensively used. The key component to the success of this technique is the appropriate adsorbent selection for particular type of waste. Therefore, a number of materials have been studied by several research groups, especially those obtained or derived from natural sources such as activated carbon, coal, fly ash, wood, silica gel, bentonite clay, bagasse pith, maize cob, coconut shell, chitin and chitosan (Guibal *et al.*, 1998, Ho *et al.*, 2001, Christopher *et al.*, 2002).

Recently, chitosan has increasingly been used as an adsorbent in many applications. The main reasons that make chitosan more attractive than others are its abundance, inexpensive, effectiveness and environmental inertness. Chitin, the precursor of chitosan, is a polysaccharide that contains acetamedo groups inside the molecules. It is mostly found in the crustaceans shell and mollusks i.e. crab, lobsters, shrimp and squids. Chitosan can be prepared by deacetylation of chitin, which results in increasing hydrophilicity, causing chitosan to be more selective ion-exchangeable with heavy metal ions and dyestuffs. In addition, chitosan also has some effective functions such as biocompatibility, biodegradability and anti-bacterial property. In contrast to chitin, the adsorption ability of chitosan for metals is superior due to its higher content of amino groups. Nevertheless, chitosan is soluble in acid conditions that occur in the textile streams. Cross-linked chitosan, by cross-linking agents such as glutaraldyhyde, can increase the acid tolerance and mechanical strength of chitosan (Shahid *et al.*, 1999).

The adsorption of heavy metal ions and dyestuffs by chitosan separately has been studied previously (Guibal *et al.*, 1998, Wu *et al.*, 2001). However, only few research works have been done on the simultaneous removal of both components by using chitosan in gel-bead form, which can suitably be applied to a column operation for a continuous treatment system. Thus, the objective of the present research is to study the kinetics and equilibrium of the adsorption of dye and heavy metal ions separately and simultaneously using cross-linked chitosan beads (CCB). The effectiveness of chitosan on dye and heavy metal removal was investigated in batch and continuous modes of operations. A kinetic model and an adsorption isotherm were used to describe the adsorption behavior of the systems.