CHAPTER 1
INTRODUCTION

1.1 Motivations

1.1.1 Management of unwanted agricultural waste

Eucalyptus wood has replaced bagasse as the main raw material for pulp and paper industry, particularly with its current expanding market demand. In the pulp mill, eucalyptus bark has been generated in large quantity, e.g. more than 10 tons per day is produced alone from the commercial plantation area in Prachinburi province, Thailand. Currently, this bark has been utilized as an additional fuel but there is still a large quantity being disposed of every month. The management of eucalyptus bark has therefore become an industrial concern as environmental cost in the treatment of such waste has been on a sharp rise. It should be mentioned, however, that eucalyptus bark has very high carbon content at about 35–50% and a wide variety of products could then be derived from such material, and this includes "activated carbon" (Castro et al., 2000; Diao et al., 2002; Daifullah et al., 2004).

The preparation method of activated carbon involves thermal treatment, with the presence of chemical agents (chemical method) or activation of carbonized through controlled gasification (physical method). The disadvantage of the gas activation process lies in low yield and lack of homogeneity of the product (Kim et al., 2001). Chemical activation involves carbonizing the parent material after impregnation with the chemical with an ability to act as dehydrating agents, typically phosphoric acid, and then heating the mixture up to 400-800°C to simultaneously form and activate the carbon. Other possible advantages of chemical activation are simplicity as there is no need for the extra carbonization step, lower temperatures of activation and good development of the porous structure (Redriguez-Reinoso, 1997).

In this study, the possibility in the conversion of Eucalyptus bark to activated carbon was examined. Due to the advantages described above, chemical activation of Eucalyptus bark with phosphoric acid was selected as the method for the production of activated carbon. Phosphoric acid was employed as an activating agent. The carbon product was then tested for its adsorption capacity using several testing parameters as detailed later in this chapter.

1.1.2 Recovery of heavy metals

An increase in urbanization and industrialization as well as the world population has led to a variety of environmental and human health problems. Uncontrolled releases of heavy metals, particularly from anthropogenic sources are examples of serious concerns as the nature often has limiting capacity in taking up all these wastes, not to mention that several heavy metals could be vital to human health even at low concentrations, e.g. copper, nickel chromium and lead. Sorption process is one of the most effective techniques for the treatment of heavy metal containing wastewater, and the activated carbon is generally one of the most commonly used adsorbents. International growing demand of this adsorbent, mainly due to their usages in environmental mitigation applications, has led to a search for new, available low-cost feedstocks of renewable character.

Copper pollution arises from copper mining and smelting, brass manufacture, electroplating industries and excessive use of Cu-based agri-chemicals, whereas lead is introduced into water bodies from smelting, metal plating, lead batteries, mining, pigments, stabilizers, alloy industries and sewage sludge. With an increase in the need of Cu for different applications and a fast depletion of natural land based ores, Cu is all but depleted as an economically viable ore. Therefore, worldwide efforts are being made to look for alternate resources for the recovery of these metals.

In this research, chemical methods for the removal of Cu from the mixture of heavy metals (in this case, Cu-Pb is selected as a modeled binary mixture) from activated carbon were studied. The ultimate goal was to evaluate the possibility in employing adsorption technique using activated carbon obtained from eucalyptus bark as an adsorbent along with the solvent extraction in the recovery of a single metal from a binary mixture solution.

1.2 Objectives

There are two main objectives in this study. the characterization of activated carbon obtained from eucalyptus bark was investigated. Secondly, the application of activated carbon along with solvent extraction in the recovery of copper from binary mixture between copper and lead was examined.

Sub-objectives:

- To find optimal conditions in the production of activated carbon from eucalyptus bark by phosphoric acid activation

- To determine adsorption isotherms and adsorption kinetics of heavy metals on the activated carbon
- To determine appropriate conditions i.e. type of solvents, concentration of solvent, contact time, for the desorption of copper from binary mixture (copper-lead).

1.3 Scopes of study

1.3.1 Determination of optimum conditions for eucalyptus bark activation was performed by varying the following parameters:

- activation temperature
- weight by volume ratio of raw material and phosphoric acid (impregnation ratio)
- activation time

1.3.2 Properties of activated carbon were indicated by:

- %yield
- %ash content
- %weight loss
- bulk density
- iodine number
- methylene blue number
- BET surface area
- pore specific volume
- average pore diameter
- pore size distribution

1.3.3 Adsorption experiment for copper (Cu) and lead (Pb) (single component) was performed in batch experiments at the concentration of heavy metal of 0.1-10 mM. This is to determine:

- adsorption kinetics of single component
- adsorption isotherm of single component
- effect of pH for adsorption (pH range = 1-6)
- effect of temperature (25, 40 and 60 ^{0}C)

1.3.4 Adsorption experiment for copper (Cu) and lead (Pb) (single components) were performed in the column experiment at the concentration of heavy metal of 0.3 mM. This is to determine:

- flow rate: 2.5, 5.0 and 7.5 ml min^{-1}
- bed depth: 1.5, 3.0 and 4.5 cm

1.3.5 Adsorption experiments for copper (Cu) and lead (Pb) (binary components) were performed in the column experiment at the concentration of heavy metal of 0.3 mM. The controlled variables include:

- flow rate: 2.5 ml min^{-1}
- bed depth: 4.5 cm

1.3.6 Desorption experiments for copper (Cu) and lead (Pb) (single components) were performed in the batch experiment with at the concentration of heavy metal of 10 mM

- type of solvent for desorption: citric acid, sulfuric acid and phosphoric acid
- solvent concentration: 0.5-3 N
- contact time: 1-120 min
- the range temperature from 25-75°C

1.3.7 Desorption experiments for copper (Cu) and lead (Pb) (binary components) were performed in the mixture at the concentration of heavy metal of 0.3 mM

- type of solvent for desorption: citric acid, sulfuric acid and phosphoric acid
- solvent concentration: 0.5-3 N
- contact time: 1-120 min
- the range temperature from 25-75°C