CHAPTER 1

INTRODUCTION

1.1 Introduction

The policy of Thailand to permit international companies to invest in the country has been increasing over the last 20 years because of economic reason. The examples of that policy include tax-free status for export goods, low cost of labor and quality technician labor. Therefore, international companies from Japan, Taiwan, Korea and European Union have transferred technology, manufacturing and distributing parts into the industrial sector particularly machinery processing such as turning and drilling.

After carrying the above policy, the industrial sector is grown up. From the data of Ministry of Commercial, they reveal that instruments, accessories of automobiles, parts and mechanical components export have had a positive upward trend from B.E.2543 to B.E.2547. In addition, the government has planned to promote Thailand to become a center of producing accessories of automobiles and mechanical components in Asia. Therefore manufacturing processes such as cutting, forming and casting are the main activities which have to be carried out. Such processes normally generate large amount of heat between tools and piece of works. Therefore it is necessary to use cutting fluids to carry heat away and maintain the quality of the products.

Cutting fluids are fluids that optimize metalworking operations. Cutting fluids are called by names such as coolant, cutting oil, lubricant and machining fluid. These fluids are used for lubricating and cooling of metal cutting operations by reducing friction between tool and piece-work [1]. The cutting fluids also prevent fine chips of metal catching on the tools and piece-work. In addition, cutting fluids are also employed to produce a desired finish on an accurate piece-part. Cutting fluids are required to perform at the highest rate of speed with maximum tool life, minimum downtime and the fewest rejected piece-work, maintaining accuracy and finish requirements.

There are four major classes of cutting fluids which are widely used in mechanical process [2]. The first called "straight oil, neat oil or insoluble oil" consists primarily of 100 percent refined mineral oil, animal and vegetable oils. It does not dilute with water when using in the process. The straight oils are mineral oil without additives. The mineral oil is always used in mechanical processes due to its low cost and mastery. The second called "soluble oil or oil water emulsion" consists of 60-90 percent mineral oil when using in mechanical process, it has to be mixed with water in a ratio range of 1 to 20 % v/v to form oil-in-water emulsion. The additive agents are added to the cutting fluids in an attempt to minimize the impact of the processes and prolong useful cutting fluids life. The third called "synthetic cutting fluids" is a mixture of synthetic organics without mineral oil. The chemical synthetic organic compound includes polyalphaolefins, polyethylene glycol, polypropylene glycol or ester oil. The fourth called "semisynthetic" is a hybrid of soluble oil and synthetic. The components of this class are 5–30 percent mineral oil. The chemical compounds are similar to synthetic cutting fluid. The main components of cutting fluids are organic compounds [3]. It is a form of lubricant, additive, corrosion inhibitor or emulsifier.

The heat generated from the friction of tool and piece-work reduces the chemical properties of cutting fluids such as lubricating between tools and piece works. These also result in a losing strength of tool and generating corrosion at new surface of piece-works. In addition, color of the fluids change from white to grey. Finally, it has a bad odor which requires the new replacement.

There are many methods to treat cutting fluids e.g. chemical process, flotation process, ultra-filtration, and combination between chemical and separation processes. The chemical processes employ some chemical to break the oil-water emulsion. The flotation processes is used to separate oil emulsion. The oil is skimmed and sent to incineration. The ultrafiltration is a physical process that removes oil emulsion by passing cutting fluids through semipermeable membrane [4-7]. The emulsion always clogs up the pores of membrane.

Adsorption is one of the interesting methods to treat spent cutting fluids. Chitin is a natural biopolymer and second only to cellulose which is the first in abundance of biopolymers. The sources of chitin are shells of shrimp, crab and squid pen. The other sources of chitin are shells of insects and cell walls of fungus and algae. Chitosan is a derivative of chitin. Chitosan was prepared by boiling chitin in concentrated base. Chitin and chitosan are used in many products due to the fact that chitin and chitosan are biopolymers, biocompatibility and biodegradable. Chitin and chitosan thus do not present problems for humans and the environment. Chitin and chitosan can be created in the form of a gel, beads, fiber, membrane and colloids. Materials for medical supplies are the main products from chitin and chitosan. The medical use of chitin and chitosan are for augmenting, floss, scar silk, release drug and spurious skin. Food and beverage process uses chitin and chitosan to filler, control weight, food preservation and packaging. Agricultural process uses chitin and chitosan for coating seeds, fillers in animal feed, insecticide and drugs for antibacterial and fungus. In the cosmetic processes, chitin and chitosan is used for fillers in shampoo and lotions. In wastewater treatment, chitosan is used for coagulation and removal of heavy metals from wastewater.

In this research, the purpose was to study a treatment of cutting fluids by adsorption on shrimp chitosan and modified chitosan. Adsorption isotherm and kinetic adsorption of cutting fluids on chitosan and modified chitosan were also considered. Heat of combustion of adsorbents before and after adsorption was investigated.

1.2. Objectives of Research Work

From the viewpoint of its importance and the simplicity of adsorption, the author has attempted to use adsorption to treat cutting fluids. This is an area worthy of study since such application is uncommon in wastewater treatment. Therefore the objectives of this research work are:

1.2.1. To study kinetic and adsorption isotherm of adsorption cutting fluids on chitosan and modified chitosan.

1.2.2. To study removal cutting fluids by continuous adsorption on chitosan and modified chitosan.

1.3. Scope of Research Work

This research investigates the adsorption efficiency of cutting fluids using chitosan and modified chitosan. The physical properties of adsorbents include the size of adsorbents, solubility, swelling and humidity of adsorbents are also considered. The surface area and pore diameter of adsorbents are determined by a BET instrument. The surface charges of adsorbate and adsorbents are studied using by a Zetasizer 3000 HS (Malvern Instruments, UK). The models adsorption isotherm of Langmuir, Fueundlich and Brunauer-Emmett-Teller (BET) are studied. The pseudo-first and -second orders rate adsorption are mentioned. Mechanism of adsorption is studied using intraparticle diffusion. Heat of combustion of adsorbents before and after adsorption is determined by bomb calorimeter. Fourier Transform Infrared Spectroscopy (FT-IR), Scanning Electron Microscopy (SEM) and CHN instrument are employed in this work. The thermodynamic parameter and activation energy of adsorption are evaluated as well. Additionally the continuous adsorption is studied by glass cylinder and plastic rectangle columns.

1.4. Organization

The remainder of this thesis is arranged in the following format. Chapter 2 is general review of fundamentals of the principle of adsorption, cutting fluids and chitosan. The review of relevant literature for treatment of cutting fluids is also presented. Chapter 3 described the properties of materials that are used in all experiments and experimental procedures. Results are presented and discussed in Chapter 4. Chapter 5 described the kinetic and adsorption isotherm. The effect of temperature on adsorption is also mentioned. Mechanism of adsorption of cutting fluids on adsorbents is emphasized. The limiting step of adsorption is also considered. Chapter 6 deals with results and discussion of continuous adsorption on chitosan and modified chitosan. Chapter 7 is concerned with a brief overview of the work and the conclusions thereof. Recommendations for future work are made.