CHAPTER I

INTRODUCTION

Lubricating oil is one of the highest valued products derived from petroleum. It is used in industrial machines, automobiles and is applied to lubricate and prevent wear of moving surfaces. After the lubricating oil is used, it is contaminated by dust, oxidation products, and unburned fuel from combustion reaction. In addition, the oil absorbs many metal traces from the engine block, and the used oil gradually loses its lubricant properties. The used or contaminated oil is usually considered a waste [1].

In Thailand, Lubricating oil contributed a great deal to the used oil total of about 230 million liters a year [2]. Removing used oil in the wrong way will cause serious problems to animals, plants, and the environment. For example, throwing the used lubricating oil into the water will destroy the ecology system. The oil will float up to the water surface and block the solar collector and oxygen. Invisible toxics from waste lubricating oil also harm humans. For example, often touching the used lubricating oil will damage physical conditions such as dry skin, irritations, and rashes. Also eating the food contaminated with the lubricating oil will cause diarrhea. For these reasons, the treatment of wastes has become one of the most important concerns of modern society. The disposal of wastes oil can be accomplished by combustion as engine fuel (pretreatment is required), incineration, and disposal in supervised landfills. However, combustion and incineration of wastes is often difficult and cleaning of flue gases is complex and expensive because they contain important quantities of contaminant. Gulyurtlu et al. [3] pointed out that waste oils are not appropriate for combustion in burners with respect to inorganic emissions (Pb, Cu, halogens).

A number of studies to remove various pollutants existing in the waste lubricating oil and simultaneously to reuse these resources as valuable products have been attemped. Some of the technologies successfully applied the operation of the newly developed regenerating plants which produced the re-refined lubricating oil, with an equivalent quality to new lubricating oil [4]. This method of disposal is no longer practical, because these treatment processes have several problems such as low yields, environmental pollution, and sludge disposal. Therefore, it is necessary to seek a suitable method to solve the disposal problems.

A possible alternative for hydrocarbon natural waste is pyrolysis. Many pyrolysis studies have been applied to organic materials such as coal, waste plastics, waste wood, and oil shales [5-7]. Pyrolysis products such as gases, liquid oils and char can be used as fuel. Moliner et al. [8] reported a higher yield in volatile gases when the temperature was increased (35-60% from 600 to 700 ^{o}C). Methane, light olefins, and benzene, toluene, and xylene (BTX) were the most abundant by products. On the other hand, methane and BTX were favored when the temperature was increased. Nerin et al. [9] indicated similar behaviors of machine and automotive origin waste oils (rich in long paraffins) with respect to cutting origin waste oil (high attractive yield in light olefins and very low in BTX). Kim and Kim [10] studied batch low temperature pyrolysis of waste oils (420-440 ^{o}C) with a high holding time of the residue (5-50 min), in order to elucidate the cracking reaction kinetics of the paraffins at low temperature to obtain gasoline.

The disadvantages of pyrolysis are usually a low selective process, leading to a wide distribution of products and the qualities of products are not suitable for using in other applications. For this reason, the present work would use the cracking method with some selective catalyst. Waste lubricating oil is converted to liquid fuels using many types of catalysts such as the shape-selective zeolite catalyst and metal-supported catalyst. This research expected that the catalytic cracking reaction could have higher efficiency than pyrolysis or thermal cracking.

Objectives and scope of this study

The main purpose of this study is to investigate the effects of temperature, initial pressure of hydrogen gas, reaction time, and amount of catalysts on percent yield of products and product distributions and obtain the optimum condition for catalytic cracking of waste lubricating oil over Fe/activated carbon (Fe/AC), $CoMo/Al_2O_3$ and HZSM-5 catalysts. The determination of significant parameters was achieved by using 2^3 experimental design. Various reaction parameters and ranges were as follows,

- Temperature	range of	375-425 °C
- Initial pressure of hydrogen	range of	5-10 bar
- Amount of Fe/AC and $CoMo/Al_2O_3$	range of	1-5wt%

- Amount of HZSM-5 range of 0.1-0.5 wt%

- Reaction time range of 10-90 minutes

This work was also aimed at a study of the detailed kinetic of catalytic cracking reaction which leads to the postulation of a reaction mechanism.