CHAPTER I

INTRODUCTION

1.1 Introduction

Biodiesel or biofuel has been developed over the past few decades in several countries as an alternative to fossil fuel (Crabbe et al., 2001). It is becoming more attractive worldwide because of increasing crude oil prices as well as environmental concerns. Besides being a renewable resource, it is expected that biodiesel can reduce greenhouse gas emissions and other exhaust pollutants (Petroleum Authority of Thailand Public Company Limited, 2007). The more the demand for fuel increases, the more the research on biodiesel is needed. In Thailand, a demand for petroleum fuel is increasing, especially the demand for diesel fuel, which is up to more than 43 million liters per day (46.6%) (Ministry of Energy, 2007). Therefore, alternative fuels like gasohol and biodiesel are figuring into crucial National Plan policies by the Thai government to promote their use. Alternative fuel is not only for reducing fossil fuel import and use, but also for a better environment in term of producing less pollution emissions. Using biodiesel as opposed to diesel fuel can reduce carbon monoxide hydrocarbon emissions by 20-40% and reduce particles by 60% (Petroleum Authority of Thailand Public Company Limited, 2007). Subsequently, the Thai government announced a policy that is aimed at increasing the use of biodiesel to be 2.4 million liter per day by 2011 and 8.5 million liter per day by 2012 (Ministry of Energy, 2007).

In general, biodiesel is produced from vegetable that contains oil in their seeds such as soybean, rapeseed, sunflower, and palm. Oil inside seeds is extracted from vegetable seeds and be processed into diesel like fuels by several techniques such as transesterification, microemulsion, and pyrolysis.

Palm oil is one of the world's most important vegetable oils. It is used mainly for edible purposes and has become an important raw material in chemical and biotechnological applications in recent years (Lim et al, 2005). Palm is widely grown in Southeast Asia and 90% of the palm oil produced is used for food, while 10% is used for nonfood consumption (Demirbas, 2003).

Furthermore, there have been several studies conducted on palm oil as a biodiesel fuel. Thailand's first study on palm oil as a biodiesel fuel was in 1985, in accordance with His Majesty the King of Thailand's initiative because of the oversupply of palm oil and impact of rising oil prices. Blending of purified palm and diesel sold in the Thai market was found to have no negative impact on diesel engines, and it was found to promote the lubricity and antiwear in the fuel injection pump as well as reduce pollutants in exhaust emission (Petroleum Authority of Thailand Public Company Limited, 2007). In addition to palm oil, other vegetable oils such as soybean oil, corn oil, peanut oil, sunflower oil, and coconut oil, and animal fat and waste cooking oil are being considered as alternatives fuel sources.

The advantages of vegetable oils as diesel fuel are their (1) liquid nature-portability, (2) heat content (88% of diesel fuel), (3) ready availability, (4) renewability, (5) lower sulphur content, (6) lower aromatic content, and (7) biodegradability. While their disadvantages are (1) higher viscosity, (2) lower volatility, and (3) the reactivity of the unsaturated hydrocarbon chain (Ma et al., 1999 and Demirbas, 2003). The major problem associated with the use of vegetable oils as diesel replacement fuel is its high fuel viscosity that affects fuel injection characterization of engine; however, there are four techniques for solving this problem. The four techniques are dilution, pyrolysis, microemulsion, and transesterification.

In Thailand, transesterification is a method mostly used for biofuel production. In transesterification process vegetable oil was reacted with methanol by the support of catalyst to yield biodiesel in form of methyl ester and glycerol as a by product. Meher et al. (2006) reported that the optimum reaction conditions for the transesterification process produced a yield of methyl ester more than 85% in 15 minutes. In the microemulsion technique, instead of a chemical reaction process to obtain a new product (i.e. fatty acid from vegetable oil reacting with alcohol to get ester), the microemulsion technique only rearranges the fatty acid in vegetable oil to cooperate with the surfactant, alcohol, and a very small amount of water to create a homogeneous phase called microemulsion biofuel.

This microemulsion product may be considered to be a biofuel since some properties of the product have been changed. Advantages of this technique are that it is simple and a very low energy consumption in the process, and no by-products are produced. And most importantly, the amount of soot from exhaust gases

is low when compared to those of fossil diesel. Lif et al. (2006) reported that surfactants can be burnt readily without soot formation and should not contain sulphur and nitrogen.

However, since a chemical reaction may not occur in microemulsion formation, the structure of the fatty acid is not altered into an ester as it did in the transesterification process. As a result, some properties such as viscosity may not be as low as biodiesel produced from the transesterification technique. Thus, this microemulsion biofuel may be applied in low speed engines (single or two-cylinder engines).

Water, even a very small amount in diesel oil significantly affects the oil's quality. The standard level of water allowed to exist in diesel is not higher than 0.05% since water causes incomplete combustion and generates soot in exhaust emission. In the microemulsion form, water is trapped in very small-size micelles (of 100 Angstroms scale) and it is expected that would generate less soot as compared to petroleum diesel. Therefore, this study aims to propose microemulsion technique of biofuel preparation as another alternative for biofuel production.

1.2 Objectives

The main objective of this research was to study the application of the microemulsion technique for producing biofuel and examine its properties for biofuel application. The specific objectives corresponding to the main objective were

1. To investigate the systems of combining palm oil, a surfactant, alcohol, and water to form transparent microemulsion biofuel.
2. To study the phase behavior of microemulsion systems and develop pseudo-ternary phase diagrams at different ratios of compositions
3. To determine the composition of a diesel fuel blend with our prepared microemulsion biofuel.
4. To examine properties and performance of the microemulsion biofuel product as well as its blends with petroleum diesel.

1.3 Hypotheses

Microemulsion technique can be used for biofuel preparation by homogenizing oil, surfactant, alcohol, and allowing a small amount of water solubilized in micelles. In addition, the microemulsion-based biofuel can reduce some exhaust pollutants.

1.4 Scope of the Study

Corresponding to the objectives, the scope of the study can be divided into three parts:

Part 1: Microemulison Phase Diagram

The microemulsion system had four components: palm oil, nonionic surfactant, absolute ethanol alcohol as the cosurfactant, and water. The desired phase as microemulsion biofuel is the stable homogeneous and transparent phase. The phase behavior of microemulsion in different ratios of composition was explained by the pseudo-ternary diagram.

Part 2: The Microemulsion Biofuel Properties

The selected microemulsion biofuel from Part I was examined for its properties as biofuel according to American Standard Test Method (ASTM). The product at 100% as well as a blending of our product with fossil diesel was also examined in comparison. Parameters for their properties were kinematic viscosity, flash point, acid number, and carbon residue. In addition, the stability of the microemulsion biofuel and the effect of temperature on their stability were investigated.

Part 3: The Performance of Microemulsion Biofuel

A microemulsion biofuel and its blends were determined in order to exhibit the efficiency of their performance as a fuel. The performance of our microemulsion biofuel and its blends were tested with single-cylinder engine at the National Metal and Material Technology Center (MTEC). The emissions such as hydrocarbon and nitrogen oxides (NO_x) were measured.