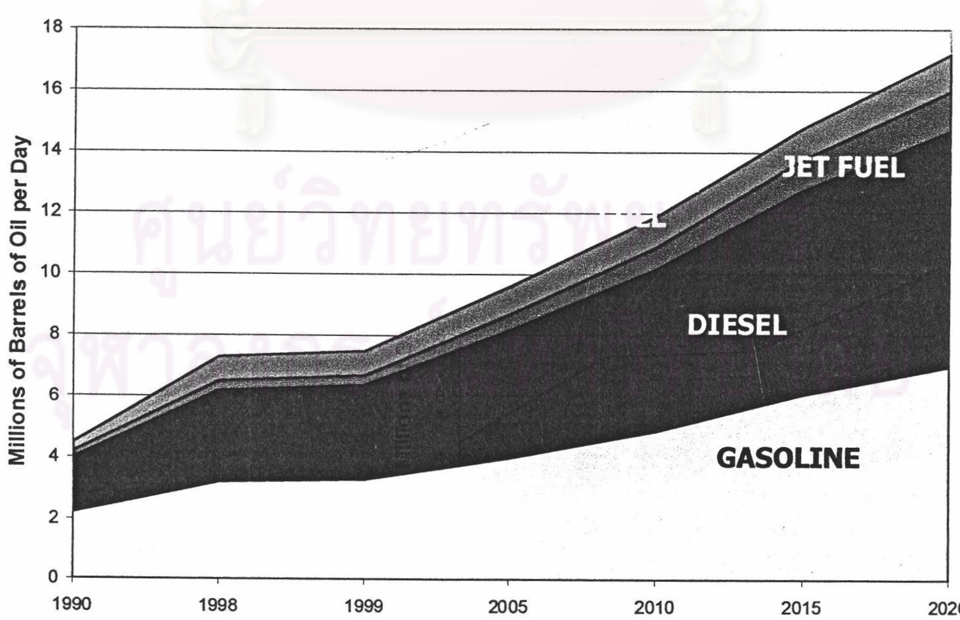
CHAPTER I

INTRODUCTION

1.1 Introduction

In the present, the diesel engines are the most important engines because they have extended over a much wider range of applications than any other engines currently in use. They are used for driving small and large electric power generating and pumping units such as the main propulsion of ships and their auxiliaries, in large and small road vehicles. The furthermore they are used for off road agricultural, civil engineering vehicles, machinery and also for mailway locomotives [1]. Therefore, the demaned for diesel fuel has been increased. The consumptions of diesel fuel are being continuously increased as shown in Figure 1.1.



Source: Derived from Energy Information Administration (EIA)

Figure 1.1 Transportation Fuels Consumption in the World [2].

Diesel fuel is obtained from crude oil, which is a mixture of hydrocarbons such as benzene, pentane, hexane, heptane, toluene, propane and butane. Diesel fuels are middle distillates, generally boiling within the range of 170-390^{o}C.

An important description of diesel quality is its "cetane number" which number has been developed on basis very similar to that adapted for measuring the ignition quality of gasoline in term of octane number. Cetane number is related to ignition delay after the fuel is injected into the combustion chamber. If ignition delays are too long, the amount of fuel in the chamber is increased and upon ignition results in rough running engine and increases smoke. In the other hand, a short ignition delay results to smooth engine operation and decreases smoke. Thus, high cetane number diesel fuel has good performance, low ignition delay period. Diesel fuel generally has cetane number about 40-55. Good ignition quality or high cetane number diesel fuel tends to result in easier starting, although in cold weather, smooth quiet running engine, faster warm-up, high combustion efficiency and save fuel oil.

Although, diesel fuel can be derived from petroleum products which obtained by distillation process, but it is not readily used as fuel for diesel engines. Being low cetane number, it has to be improved the quality as cetane improvement before application. For general increasing, cetane number can be performed into two methods.

1. Cracking of diesel fuel having low cetane number, such as by thermal cracking, catalytic cracking and hydrocracking.
2. Adding cetane improver which will decrease ignition delay period as that result of the diesel engines is more easily start. Many types of additives have been prepared to raise the cetane number of diesel fuel. Such additives usually contain nitrogen or sulfur, both of which are known

cetane improver under certain circumstance. Those include peroxides, nitrites, nitrates, nitrocarbamates, tetrazoles and the like.

Refer to the two methods as above, it was found that the cracking of diesel fuel process needed high cost and had not obtained the sufficient cetane number. Being the advantage cost over cracking of diesel fuel and higher cetane number needs, addition of cetane improver was substitutionally considered.

To the some extend, cetane improvers have been used for many years to improve the ignition quality of diesel fuels. Higher cetane value leads to faster engine start especially in cold weather, quieter engine operation, less smoke and possibly less injector coking. Recently, the use of cetane improvers has greatly increased due to increased demand for diesel fuel and the lower natural cetane number of diesel base stocks caused by more severe refining of crude oil to make unleaded gasoline of acceptable octane number.

Cetane improvers are special chemicals which improve cetane number of diesel fuel similar to ethanol and MTBE improve the octane rating of gasoline. At concentrations less than 0.15%, cetane improvers can reduce ignition delay times of diesel fuels. Fundamentally, the cetane improver concentration is another degree of freedom in designing a diesel fuel. In practice, this degree of freedom is often capable of simultaneously decreasing NO_x, hydrocarbon and particular emissions. Cetane improvers are considered a key technology to provide cleaner burning diesel fuel. They are key additives for making premium diesel, a fuel the National Research Council expects to power new generations of vehicles in the US. Cetane improvers are also capable of modifying the performance of alternative fuels such as ethanol so they can be used in diesel engines without significant engine modification [3].

Triglycerides found in vegetable oil, yellow grease and pork or beef fat are good feed stocks for a variety of specialty chemicals largely resulting form the reactivity of their ester bonds. Biodiesel has received considerable attention by researchers in the US because of the abundant indigenous triglycerides (vegetable oil, waste oils yellow grease, beef tallow and pork lard) which can be used as feed stocks to produced biodiesel. The principal benefit of these feed stocks is that their precursors are renewable resources. Much current activity focuses on blending biodiesel with diesel to reduce emissions. Potential advantages of biodiesel, such as reduced hydrocarbon emissions, parallel advantages of cetane number and blending cetane number of biodiesel were the subject of much recent investigation [3].

Nitrates have historically been the chemical functional groups that lead to good cetane improver performance. This thesis involved the synthesis of cetane improver by using vegetable oils (palm oil and soybean oil) as substrate. The reaction conversions, performances of products of nitrates compound and cetane number have been investigated.

1.2 Objectives and Scope of the Research

1.2.1 Objectives

1. To synthesize nitrate compounds from palm oil and soybean oil for using as cetane improvers in diesel fuel.
2. To study the properties of synthesized nitrate compounds blended with base diesel as cetane improvers.

1.2.2 Scope of the Research

1. Literature survey of the relevant research works.
2. Provide of chemicals and equipments.
3. Synthesis of nitrate compounds from palm oil and soybean oil by trans-esterification reaction, epoxidation reaction, hydrolysis and nitration reaction.
4. Characterization of the synthesized nitrate compounds by spectroscopic methods such as FT-IR and FT-NMR.
5. Determination of cetane number of diesel fuel base blended with synthesized nitrate compounds.
6. Summarize the results.