# CHAPTER I

# INTRODUCTION

## 1.1 Introduction [1,2]

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°C. They are normally produced by blending two or more refinery streams such as light gas oil (LGO), heavy gas oil (HGO) and kerosene. In a complex refinery with several downstream cracking capabilities, more middle-distillate streams may be available for blending. The proportions of the different components in the finished blend will be determined by their individual characteristics and the requirements of the diesel fuel specification such as distillation, viscosity, cetane, cold properties, etc.

An important description of diesel quality is its " cetane number " which is related to ignition delay after the fuel is injected into the combustion chamber. If ignition delay is too long, the fuel will accumulate in the cylinder until it reached ignition condition and then will burn rapidly, causing a sudden pressure increase which may result in engine knocking. Too long an ignition delay may result in a smoked exhaust, a decrease in engine efficiency, and possibly dilution of the crank case oil.

A reduction in ignition delay can be obtained by varying the chemical nature of the injected fuel. Straight-chain paraffinic hydrocarbons give the least ignition delay, while branched-chain paraffins and cyclic (including aromatic) hydrocarbons tend to have poorer ignition characteristic.

For this reason, n-hexadecane (cetane) has long been used as a standard reference material for determining the ignition quality of commercial diesel fuels. A scale called "cetane number" has been devised for ranking the relative ignition delay characteristics of given diesel fuel. The cetane number of unknown fuel can be determined by comparing its ignition delay in a standard test engine with reference fuels which are prepared by blending cetane and 2,2,4,4,6,8,8-heptamethylnonane until a reference fuel is found to have the same ignition delay characteristics as the unknown fuel.

The cetane number is obtained by the equation.

Cetane number = (vol.% cetane) + [ 0.15 (vol. % heptamethylnonane) ] (1)

Cetane rating, which is measured by a standard cetane test engine according to a procedure carefully detailed in American Society for Testing and Materials Standard D-613, is critical. A high cetane rating means the fuel autoignites relatively easily and exhibits a shorter ignition delay than a fuel with a low cetane rating. The reverse of the octane rating of gasoline where octane measures a fuel's resistance to autoignition.

At the present, diesel fuel consumptions are being continuously increased as shown in Figure 1.1.

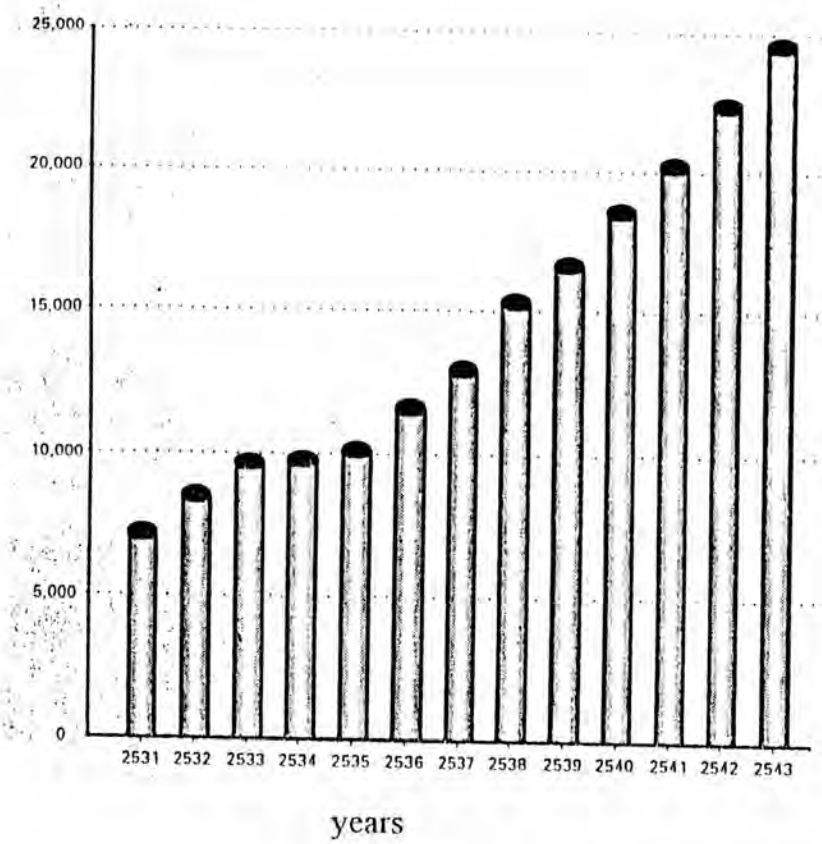


**Figure 1.1** The quantity of high speed diesel consumption in Thailand.

Although, diesel fuel can be derived from petroleum products which obtained by distillation process, but it isn't readily used as fuel for diesel engines. Being low cetane number, it have 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 so that result of the diesel engines is more easily start. Many type 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, nitrosocarbamates, 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 extent, cetane improvers have been used for many years to increase the cetane number 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, 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.

From several studies by Thomas G Samuel, Jr. **[3]**,. Filbey H. Allen **[4]** and Seemuth D. Paul **[5]**, they have revealed that cetane number of diesel fuel was increased by addition of a small amount of a cyclododecyl nitrate, tetrahydrofuranol nitrate and dioxane nitrate such as dioxan-5-ol nitrate, in comparison with the addition of the commercial cetane improver, isooctyl nitrate.

Furthermore, Mortella J. David **[6]** and Nontaganok Soomboon **[7]** have indicated that tetrazole derivatives such as 5-propyltetrazole, 5-pentyltetrazole increased cetane number as good as 2-ethylhexylnitrate, a

commercial cetane improver. Rattanatawonkiti Wichit [8] has pointed out that tetrazole derivatives such as 5-(4'-nitrophenyl) tetrazole improved less cetane number than isooctyl nitrate. Because this compound contains benzene ring in molecular structure, therefore, cetane number decreased consequently.

From these previous works, it is obvious that there are need for further investigation of the cetane improver containing nitrogen and/or oxygen in straight chain molecular structure. Because these compounds tend to have the high cetane number. Accordingly, in this study, it is anticipated that the cetane number can be effectively increased by these compounds.

## 1.2 Objective and Scope of the Research

### 1.2.1 Objective

The principle objective of this study was to synthesize dinitrate compounds and study their properties as cetane improvers.

### 1.2.2 Scope of the Research

1.To synthesize dinitrate compounds .

2.To characterize dinitrate compounds using chromatographic and spectroscopic methods.

3.To determine cetane number of diesel fuel blended with dinitrate compounds .