CHAPTER I

INTRODUCTION

Background

With ever decreasing fuel resource and constantly increasing air pollution, the fundamental sustainability of present energy system has been a front line question for all nations worldwide. The present reserve of petroleum products is slowly decreasing day by day. This is actually expanding the gap between the global energy supply and energy consumption.

World transportation sector accounts for nearly 50% of the world consumption of petroleum from fossil. Diesel engines make up the largest part in the world transportation sector. These diesel engines consume high portion of diesel petroleum products as they are mostly used in the commercial sector and in many applications distributed widely in countless industries worldwide. There are urgently need to reduce high consumption of petroleum products for these engines as they produce harmful emission leading to all variant of pollutions.

Furthermore, there are very limited applications and technologies to minimize the fuel consumption of diesel engines. Only in the recent years, there has been many alternative ways of using renewable energy sources as a bridging technology to minimize the fuel consumption of the diesel engine and at the same time to lowering emission levels from the operation of these engines in all sort of application and transportation sector.

There are extensive research on alternative fuels such as LPG, CNG, Biodiesel and H_2, that may serve as future energy carriers. CNG is among the most dominant position as its population has grown worldwide in the automobile industry. Hydrogen is the desire source of future energy as it is the most abandon on earth. Currently, natural Gas is an energy source that is widely used in many fields such as residential, industrial, electricity production and transportation as well. The annual consumption of natural gas is steadily increasing in many countries worldwide. The natural gas consumption in transport is growing due to it lower level of pollutions

emissions and its very low particles emissions that make it attractive to the intensive use. Furthermore, the lower carbon content in natural gas meets the CO_2 emissions reduction requirements in order to decrease the greenhouse gases (GHG) emissions in the atmosphere.

However, using CNG in the internal combustion engine such as diesel engine; there are still many limitations of incorporating many modifications to the actual mechanical engine to maximize the benefits of using CNG. And moreover, one of the main purposes of improving the combustion process of traditional internal combustion engine is to find out useful way to reduce exhaust emissions without doing major alternation on their mechanical engine but merely installing additional devices to the system.

With the current technologies and in addition to a single alternative fuel operation, diesel dual fuel engines have been a subject of high interest due to their potential to reduce smoke emission and many other significant emissions with improved performance; while utilizing the benefits of using all kind of alternative energy such as hydrogen or CNG in an internal combustion engine. Most of the diesel dual fuel engines today are using gaseous fuel as secondary fuel while either petroleum diesel or biodiesel is only a pilot fuel to start the ignition process. HCNG is among the first choice of any secondary sources for diesel dual fuel engine. Hydrogen blended with natural gas has been viewed as feasible and viable secondary source of fuel to the pilot diesel fuel as it has high flame velocity, possible to store, feasible to set up supporting infrastructures and still contain high potential in many experiments to cut down pollutions.

Previous researches and on-going researches have been conducted with using hydrogen as another potential alternative fuel in the internal combustion engine whether in gasoline or diesel engine. Hydrogen properties are more superior to other alternative sources because of the flame propagation, bursting power and higher octane value and so many other great properties. However, by using hydrogen alone; there are still very limited infrastructure, storage and political economy factor that are preventing hydrogen usages in all kind of application, and especially in the transportation sector.

CNG and Hydrogen both have high ignition temperature but require an ignition source to be used in an internal combustion engine. The diesel fuel which has a much lower ignition temperature must be used as pilot fuel to ignite CNG and hydrogen in dual fuel operation in most of the researches around the world for the design of diesel dual fuel system.

A considerable amount of previous researches, experiments and testing have shown that neither CNG nor Hydrogen alone enhances all desired feature of a diesel dual fuel engine and therefore, it is rational to try blending a mixture of CNG and Hydrogen as a secondary source of fuel which is becoming a very popular research topic on fuel at this point in time. HCNG is by far much more superior source of fuel for internal combustion engine. Especially in the past few years, for the diesel dual fuel engine; HCNG has drawn many researchers from all around the world to discover its high potential and possible rational of replacing previous CNG version into new HCNG version in the near term.

In additional to the selection of secondary fuels, the majority of research works have further suggested a development of a suitable system to control supply of gaseous fuels and diesel in a manner so as to optimize the engine performance over the complete range of operation with least emission outputs.

In summary, there are still urgent prerequisites to develop a new technological change that can bridge yesterday's automotive technology with today's abandon resources of alternative energy such as HCNG to lower emission levels produced from diesel engine. Using diesel dual fuel technique is the only way to bridge these previous technologies from the past to today's technology.

This paper presents an investigation and experiment study of fuel saving with using a mixture of hydrogen and CNG in diesel dual fuel engine. In details, it will examine performance parameters and emission parameters of mixtures between hydrogen and CNG comparing to the original diesel operation. Performance parameters such as brake specific fuel consumption, brake thermal efficiency and brake energy consumption will be thoroughly examined and validated in this report. Emission parameters such as brake NO_x emissions, CO_2 emissions, CO emissions, Hydrocarbon emissions will also be measured and examined along with balancing improving performance and producing least emissions.

Purposes of the study

The purpose of this research project is to examine feasibility of using HCNG in diesel dual fuel engine while at the same time analyzing performance, emission levels and fuel economy of the final DDF system against normal diesel engine operation. Another major interest of this research is also focus on discovering a feasible and affordable diesel dual fuel system without having to modify the vehicle and its original engine at the most affordable investment. In summary, purposes of this research study can be summarized in below points.

1. To determine if HCNG is appropriate source of fuel for diesel dual fuel engine when comparing to only pure diesel operation

2. To investigate the performance characteristics of the engine by using the most affordable HCNG diesel dual fuel system available in Thailand

3. To investigate the emission characteristics of the engine by using the most affordable HCNG diesel dual fuel system available in Thailand

4. To evaluate the fuel economy of using the most affordable HCNG diesel dual fuel system in a EURO IV light duty diesel pick-up truck.

Scope of the study

1. The scope of this research is focusing on identifying an optimum lean burn fuel consumption with a closed loop dual fuel system on combination of HCNG blends with 4 cylinders common rail internal combustion engine; with the extend of measuring limited performance parameters such as Brake specific thermal efficiency, torque and horsepower and limited emission parameters such as NO_x, CO_2, CO, and HC.

2. The experiment will test only in diesel operation and HCNG operation where hydrogen will not be varied but CNG will be varied according to the computerized specially designed for this project

3. Engine load calculations data are measuring only from two sensors, TPS sensor and RPM sensor

4. Fuel saving will be measured from the amount of diesel consumed from running the selected vehicle in normal diesel mode on the real road and comparing the data against the amount of diesel consumed in HCNG DDF mode at constant speed during real road testing.

Limitation of the study

1. This proposed research only investigate, measure, and analyze the effect of mixing hydrogen with methane in the internal combustion engine with constant hydrogen content of 0.5 liters per minute

2. The research will be using a closed loop diesel dual fuel system to operate the diesel engine and measure for performance data and emission levels data of various combinations of different fuels in Toyota Hilux Vigo 4 cylinder D4D common rail engine.

3. In this research, the emission testing will be conducted to determine amount of emission levels in both normal diesel operation and HCNG DDF operation and the results will be compared to the EURO IV standard for diesel vehicle category M.

Key words

HCNG, Diesel Dual Fuel (DDF), Fuel Saving

Benefits of the study

There are certainly many great benefits of this research study. Summary of the benefits are listed below.

1. The benefits of this research include new findings for engine using HCNG dual fuel system

2. Provide suggestions and recommendations for future research in controlling the dual fuel system for internal combustion engine

3. Provide comparisons on performance parameters and emission parameters in each different combination of secondary fuel source.

4. Provide recommendations for balancing the performance and emission output with using different fuel sources under lean burned operations.

5. Provide fuel saving analysis for possibilities of using HCNG DDF system on all sorts of commercial vehicles in the near future.