"Saya akui bahawa yang saya telah membaca karya inidan pada pandangan saya karya ini adalah memadai dari segi skop dan kualiti untuk tujuan penganugerahan Ijazah Sarjana Muda Kejuruteraan Mekanikal (Automotif)"

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ENGINE PERFORMANCE TEST ON NGV VEHICLE

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DECLARATION

"I admit this report is done all by my self except statement that I have already stated on each one of them"

Signature:…….

Author :…….....

Date :…….

To my beloved parent, sibling and friends.

ACKNOWLEDGEMENT

I would like to express my grateful to my supervisor Mr. Mohammad Zakaria bin Mohammad Nasir for his guidance and support in contributing for the success of this project. Not to be forgotten, Mr Syakir, technician in the automotive lab who help a lot in setting up the vehicle for testing. Lastly to my parent and friend and to all who contribute for the success of this project.

ABSTRACT

This project aim is to investigate the engine performance curve for the Proton Gen2 1.6L using gasoline and CNG as the burning fuel. The CNG is the main burning fuel for this test. The vehicle that was used in this study is the Proton Gen2 1.6L with the given engine specification power value 82 kW and the torque value is 148 Nm. The Dynojet dynamometer (WinPEP 7) is the software that is used to calibrate the data from the dyno to the computer.

Comparative result of gasoline and CNG through experiment is done and to determine which fuel is better and the performance different is indicated. Understanding the engine power and torque is crucial as it indicated the performance of a vehicle and their suitable fuel required for engine performance.

ABSTRAK

Matlamat projek ini adalah untuk mengkaji prestasi enjin bagi kenderaan Proton Gen2 1.6 L menggunakan minyak petrol dan gas asli bertekanan sebagai bahan bakar kenderaan. Gas asli bertekanan adalah bahan bakar utama yang digunakan untuk ujian ini. Kenderaan yang digunakan untuk tujuan ujian ini adalah Proton Gen2 1.6 L yang mempunyai enjin berspefikasi dengan kuasa 82 kW adan daya kilas 148 Nm. Dynojet dynamometer (WinPEP 7) adalah perisian yang dgunakan untuk menukarkan data dari mesin dyno kepada komputer.

Perbandingan keputusan antara bahan bakar petrol dan gas asli bertekanan dilakukan untuk menentukan bahan bakar yang mana lebih baik dan perbezaan prestasi ditunjukkan. Pemahaman mengenai kuasa dan daya kilas kenderaan adalah penting kerana ia dapat menunjukkan prestasi kenderaan itu seterusnya menentukan jenis bahan bakar untuk pembakaran dalam enjin pembakaran dalam.

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NOMENCLATURE

CH_4	=	methane
LNG	=	liquefy natural gas
Ppm	=	part per million
Atm	=	atmosphere
lb/ft3	=	pound per cubic feet
btu	=	BRITISH THERMAL UNIT
gal	=	gallon
°C	=	degree Celsius
P	=	power (watt)
W	=	work (joule)
t	=	time (s)
BP	=	brake power (W)
N	=	engine speed (rpm)
τ	=	torque (N. m)
F	=	force (f)
r	=	distance (m)
λ	=	Lambda
Mph	=	mile per hour

GLOSSARY OF TERM

BTU	=	British Thermal Unit
WOT	=	Wide Open Throttle
TDC	=	Top Dead Centre
BTDC	=	Bottom Top Dead Center
RPM	=	Rotation Per Minute
SI	=	International System Of Unit
RON	=	Research Octane Number
MON	=	Motor Octane Number
OSHA	=	Occupational Safety & Health Administration
CO_X	=	Carbon Monoxides
SO_2	=	Sulfur Dioxide
SO	=	Sulfate
NO_2	=	Natrium Dioxide
NOx	=	Nitrogen Oxide
HC	=	Hydrocarbons
CNG	=	Compressed Natural Gas
NGV	=	Natural Gas Vehicle
A.D	=	Anno Domini

CHAPTER I

INTRODUCTION

1.1 Introduction

Major concern of the world today is regarded to the concern of pollution that came out from the vehicle today. Most of the vehicle in this world run using gasoline thus eliminates the hazardous gases such as the nitrogen oxide (NOx), carbon monoxide (CO) and hydrocarbons (HC). One way to reduce this problem is by changing the transport pattern and by improving the engine technology and the third one is to change the used of fuel used in the vehicle. One of the main alternatives is by using the natural gas.

Natural gases form from the beneath of the earth when plant and animal matter are trapped under the solid rock under tons of pressure for millions of year. It is made of methane mostly, it is odorless and tasteless in its original form.

At this moment, the amount of natural gas is still largely in supply, and the usage of it can be expended longer with a wise conservation and proper managing of the gas. With the decreasing total value of the gasoline, natural gas is the main alternative fuel that can be consider, with its largely amount that are still available and with a cleaner burn of engine combustion. Hydrocarbon emissions from the natural gas engine consist almost only of methane and should be regarded as a greenhouse gas.

At this moment, the concern over when using the natural gas as the main fuel to moved a vehicle is the power that may be produced from the combustion of the natural gas. Lean burn operation of natural gas engine provides a means for combining high efficiency with relatively low NOx emission at full load. At reduced load, the air/ fuel ratio is normally reduced with increased NOx, emission and reduced efficiency as a result. This is major drawback for the lean burn engine, especially in urban application such as city busses and distribution track for urban use.

Therefore the purpose to write this report is to make a comparison on the engine performance test using the compressed natural gas (CNG) and gasoline. The data that available from this test can be used to make further investigation and research on CNG as the burning fuel for engine.

1.2 Project overview

The use of CNG in the automotive field has long been explored by the western country scientist. They have used it widely in the automotive industries as a transportation fuel since 60 years ago. With its clean burning properties, abundant supply and relatively low cost made it a popular choice among the country such as, Europe, Russia, South America and etc. there are over 1 million NGVs on the road worldwide with thousand of fast refueling station to accommodate them. In Malaysia, the used of NGV is still new, with its application mainly stick to the public transport such as the taxi. In Malaysia there are 42 filling stations for CNG user. (http://www.cng.com.sg/howdoesitwork.php) This small value shows that Malaysia has the potential to develop the usage of CNG in the automotive industry. Other applications that can benefit from the usage of this gas are such as transit buses, heavy duty truck, commuter light truck and etc. So by doing this research “Engine Performance Test on CNG Vehicle” it can improve the knowledge of Malaysian citizen about the opportunity that are available in CNG. In this research, an engine performance test will be done to get the engine performance properties reading. The data that can be obtained from the chassis dynamometer are such as torque, power,

and AFR. These data can be used to interpret it to a graph and can be used as a comparison to the gasoline and CNG and determine what characteristic that need to be improve.

1.3 Objective

Prediction the performance curve on passenger vehicle with different fuel

1.4 Scope

The scope for this research has been narrowed down to accommodate with the objective that has been set before. Among of the scope that has been determined are such:

- Literature study on NGV and gasoline vehicle
- Set up an experiment on chassis dynamometer
- Perform an experiment for engine characteristic
- Carry out brake performance curve with different fuel

1.5 Problem statement

Nowadays the petrol price is increasing day by day. This problem is uncontrollable because the supply of petroleum is decreasing and the demand is increase. Petrol as the burning fuel also contributes to the air pollution and effect the environment system as gaseous that came out form the exhaust cause acid rain and increase thermal heat. CNG in the other hand have more advantages than petrol such as, clean burning, cheaper price, and others. Therefore the study of using CNG should be done to maximize its advantage and usage.

1.6 Content overview

In the first chapter will be stated the title of the project, the objective and scope of this study. The second and third chapter will cover most of the literature review for this project. Meanwhile the fourth chapter will cover on the methodology that is the method to do this project and cover some specification on the material or devices that were used during the process. The fifth chapter will cover the result and discussion that were done on this project. Conclusion and recommendation is written on the last chapter that is the chapter sixth.

CHAPTER II

LITERATURE REVIEW

2.1 History of CNG

Natural gas was first used as fuel in China during the Shu Han dynasty in AD221-263. The gas was obtained from shallow wells near seepages and was distributed locally through piping made of hollowed-out bamboos. Since then, there are no records on the usage of natural gas until the early 17th century in Northern Italy, where it was used as a fuel to provide lighting and heating (Tiratsoo 1979, p.8). After that, as time goes by, the usage of natural gas was spread to North America, Canada, New Zealand and Europe, but the usage was limited to domestic and industrial heating.

Compressed Natural Gas is composed primarily of methane (CH4) and other heavier hydrocarbons such as ethane, propane and butane and also has significant quantities of carbon monoxide, nitrogen, helium and hydrogen. Natural gases form from the beneath of the earth when plant and animal matter are trapped under the solid rock under tons of pressure for millions of year. Due to its lower density characteristic, CNG will float above the other trapped substance such as crude oil and water.

In the 20^{th} century, the usage of natural gas expected to most part of the Western Europe and USA. The exploration of the usage of natural gas achieve its peak begin in 1950s in the USA where a large network of facilities and distribution

pipes were constructed for the purpose of promoting the use of natural gas. The use of natural gas in the transportation sector began as early as the 1920s and had little development since then (NaturalGas.org, 2004). Due to the lack of support from the public, the use of Natural Gas Vehicles (NGV) is limited mostly to the public transportation sector and as to generate electricity.

However, after the World War 2, there is growing interest on the usage of natural gas as vehicle fuel. This interest had led to establishment of approximately 1200 refuelling stations and 1500 sub stations for natural gas in Italy by the early 1950s (Shamsudin & Yusaf 1995, p.101).

The trend towards converting gasoline and diesel vehicles to use CNG is still quite unpopular in Malaysia, compared to more developed western countries. However, due to the limitation of the crude petroleum oil reserves, which should last for about 15 years, Malaysia has since resolved to do more researches and experiments to use alternative fuels such as natural gas. This is because the country natural gas reserves would last for about 80 – 90 years. Review showed that up until December 1994, there were about 900 vehicles converted to use CNG as fuel in Malaysia (Shamsudin & Yusaf 1995, p.103).

2.2 Composition of Compressed Natural Gas

Natural gas generally consists of a mixture of hydrocarbons with methane (CH4) as the prime component and other hydrocarbons such as ethane, propane, butane, nitrogen and carbon dioxide gases contribute to the remaining composition while traces of water vapour and hydrogen sulphide may be present in some natural gases. The properties of natural gas will vary depending on the location, processing and refining facilities. Usually, the maximum and minimum compositions are specified to enable comparisons to be made.

Table 2.1: Typical Composition of Natural Gas in Percentage (Questar Gas, undated)

Compound	Typical	Maximum	Minimum
Methane	87.3%	92.8%	79.0%
Ethane	7.1%	10.3%	3.5%
Propene	1.8%	3.3%	0.4%
Butane	0.7%	1.2%	0.1%
Nitrogen	2.2%	8.7%	0.5%
Carbon dioxide	0.9%	2.5%	0.2%

Current research on the natural gas vehicles found that the engine performance and emission are greatly affected by varying compositions of natural gas (Ly, 2002). It was also reported that the heating value, efficiency, and concentration of unburned hydrocarbon and other emission particles would highly depend on the source of supply of natural gas as the main fuel. It is also mentioned that this effect is especially dominant in heavy-duty engines with high compression ratio applications due to the increased amount of engine "knocking". Engine knocks are caused by the pre-mature ignition of the air-fuel mixture in the combustion cylinder, causing the engine to overheat and run inefficiently(Ly 2002). In other simple word, it will produce less power and torque, and also using more fuel for burning.

According to Natural Gas.org (2004), the raw natural gas is processed to remove impurities such as oil, condensate and water particles. The presence of these particles may obstruct the smooth flow of fuel into the engine when in use and may even bring the engine to a halt. 'Dry' natural gas, which consists of almost entirely methane, is then obtained by distilling the other hydrocarbons.

2.3 Natural Gas Vehicle

Natural gas vehicle (NGV) is referred to any vehicle that use compressed natural gas (CNG) or liquefy natural gas (LNG) as a transportation fuel. These fuels are considered alternative fuels under the Energy Policy Act of 1992 and qualify for alternative fuel vehicle tax credits. This means that the vehicle can have discount on the road tax and exempt for conversion kit. Dedicated natural gas vehicle (NGVs) are designed to run solely only on natural gas and bi-fuel NGVs have two separate fuelling systems that enable the vehicle to run either using natural gas or a conventional fuel (gasoline or diesel).

In general, dedicated NGVs demonstrate a better performance and have lower emissions than bi-fuel vehicles because their engines are optimized to run on natural gas. In addition, the vehicle does not have to carry two types of fuel, thus reducing weight for the vehicle. In Malaysia, NGV is normally run using bi-fuel that is using CNG and gasoline. Natural Gas is a hydrocarbon which is colourless, odourless, non-toxic and much lighter than air. It is also the cleanest burning fossil fuel available today. When compared to vehicle using gasoline or diesel as the burning fuel, NGVs can produce lower amount of harmful emission. In addition, some natural gas vehicle owner reported services lives increase to two to three years longer than gasoline and diesel vehicle and extended time between required maintenance.

2.4 Natural Gas Vehicle Operating System

Light-duty natural gas vehicles work much like gasoline-powered vehicles with spark-ignited engines. Figure 1 shown below is the basic of CNG fuel system components.

CNG enters the vehicle through the natural gas fill valve (A) and flows into high-pressure cylinders (B). When the engine requires natural gas, the gas leaves the cylinders and passes through the master manual shut-off valve (C) and travels through the high-pressure fuel line (D) and enters the engine compartment. Gas

enters the regulator (E), which reduces the gas pressure used for storage (up to 3,600 psi) to the required vehicle fuel injection system pressure. The natural gas solenoid valve (F) allows natural gas to pass from the regulator into the gas mixer or fuel injectors. The solenoid valve shuts off the natural gas when the engine is not running. Natural gas mixed with air flows down through the carburettor or fuel-injection system (G) and enters the engine combustion chambers where it is burned to produce power, just like gasoline.

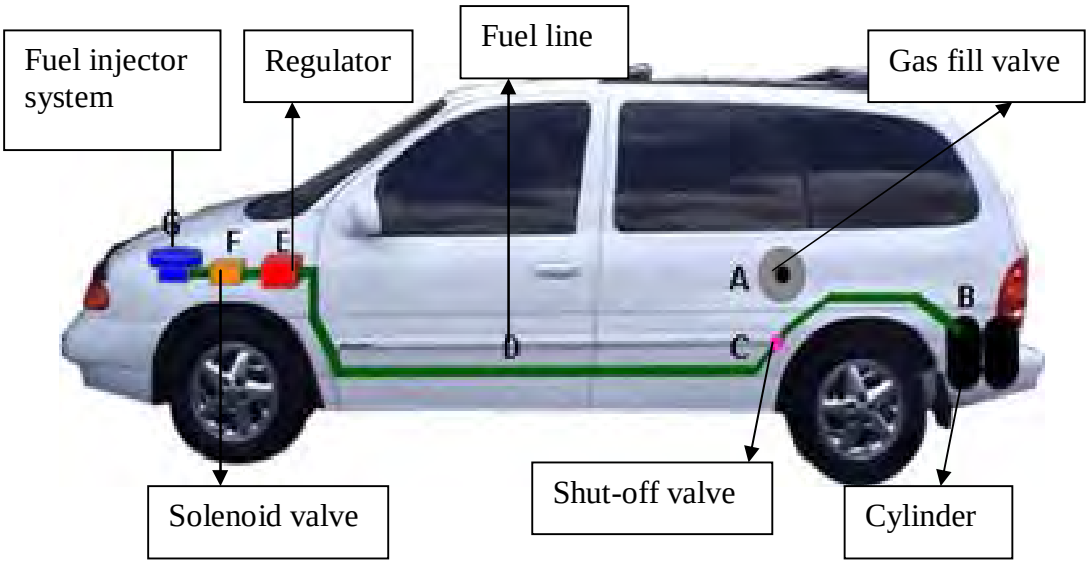

Figure 2.1: Schematic of a natural gas vehicle fuelling system. Adapted from Compressed Natural Gas: Courtesy of Thomason & Associates, Inc

The conversion of CNG-NGV EFI-Type Engine for petrol (gasoline) vehicles also known as Closed Loop System CNG-NGV conversion. It primarily involves a CNG-NGV kit, an Air-CNG venturi-mixer, CNG Cylinder, Injector Emulator, Anti-Contaminant Emission System (AES), Step Motor, Timing Advance Processor, fuel switch control unit, Lambda control unit, CNG pressure indicator, pressure regulator, Lambda sensor, actuator, CNG cylinder tank, and CNG injector.