


NATURAL GAS VEHICLE (NGV) ENGINE PERFORMANCE TESTING

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**A thesis submitted in fulfillment of the
requirements for the award of the degree of
Bachelor of Mechanical Engineering (Automotive)**

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MAY 2008

I declare that this thesis entitled “*Natural Gas Vehicle (NGV) Engine Performance Testing*” is the result of my own research except as cited in the references.

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This work is dedicated to my beloved family

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ABSTRACT

Natural Gas Vehicle (NGV) looks like the other vehicle. The difference in NGV is the power source that the vehicles use. NGV use natural gas like Liquid Petroleum Gas (LPG) and Compressed Natural Gas (CNG) as the power source. Natural gas is acknowledged as being the mainstream alternative fuel. In Malaysia, pollution is not the only reason to introduce natural gas-power vehicles but economic is another factor. Besides, the country has massive, under exploited natural gas reserve. Natural gas reserve is four times larger than oil reserve. As such, a study has been conducted on vehicle that power by natural gas. This research aims to study the engine performance of vehicle using natural gas system and gasoline system. Compressed Natural Gas (CNG) is common gas use for NGV. It has been accepted widely as an alternative to gasoline. The engine performance parameters that can be determined are power, torque, and air-fuel ratio (AFR). Torque is a good indicator of an engine ability to do work. Power is defined as the rate of work of the engine. The fuel consumption for both systems also can be calculated from the AFR value. The engine performance testing is conducted to show the performance for both systems. The chassis dynamometer can be used to handle the testing. The expected result from this testing is the engine performance using NGV system is less than using gasoline system. The suggestion to improve the engine performance using NGV system will be make. The comparison result for both engine systems is important. The good engine performance with less emission and economical for users is main target for manufacturer while producing the vehicle.

ABSTRAK

Kenderaan Gas Asli (NGV) adalah sama seperti kenderaan lain. Perbezaannya adalah NGV sumber bahan api yang digunakan untuk menggerakkan kenderaan. NGV menggunakan gas asli seperti Gas Petroleum Cecair (LPG) dan Gas Asli Mampat (CNG) sebagai punca kuasa. Gas asli sudah diketahui sebagai sumber bahan api alternatif utama. Di Malaysia, pencemaran bukan sahaja sebab bagi memperkenalkan kenderaan yang menggunakan gas, tetapi faktor ekonomi juga memainkan peranan. Selain itu, negara mempunyai simpanan gas asli yang besar. Simpanan gas asli adalah empat kali ganda dari simpanan minyak. Oleh itu, satu kajian telah dijalankan ke atas kenderaan yang menggunakan gas asli sebagai sumber kuasa. Kajian ini adalah untuk mengkaji prestasi enjin kenderaan menggunakan sistem petrol dan gas asli. Gas Asli Mampat (CNG) adalah gas asli yang biasa digunakan. Ia telah diterima sebagai satu alternatif yang terbaik untuk petrol. Parameter prestasi enjin yang akan dikaji adalah dari segi kuasa, daya kilas dan nisbah udara dan bahan api (AFR). Daya kilas adalah untuk menunjukkan keupayaan enjin. Kuasa pula didefinisikan sebagai kadar kerja enjin. Jangkaan bahan api yang digunakan untuk kedua-dua sistem boleh dicari menggunakan AFR. Ujian prestasi enjin dilakukan untuk menunjukkan prestasi enjin bagi kedua-dua sistem. Ujian dibuat menggunakan casis dinamometer. Keputusan yang dijangka dari ujian ini adalah prestasi enjin menggunakan sistem NGV adalah kurang daripada menggunakan sistem petrol. Cadangan untuk meningkatkan prestasi enjin bagi sistem NGV akan dikemukakan. Perbandingan prestasi enjin bagi kedua-dua sistem adalah penting. Ini kerana pengeluar kenderaan sekarang adalah menitikberatkan prestasi enjin yang bagus disamping dapat mengurangkan pencemaran dan lebih ekonomi.

CONTENTS

CHAPTER	TITLE	PAGE
	TITLE	i
	DECLARATION	ii
	DEDICATION	iii
	ACKNOWLEDGEMENT	iv
	ABSTRACT	v
	ABSTRAK	vi
	CONTENTS	vii
	LIST OF TABLES	xi
	LIST OF FIGURES	xiii
	LIST OF SYMBOLS	xvi
	LIST OF ABBREVIATIONS	xvii
	LIST OF APPENDICES	xviii
CHAPTER 1	INTRODUCTION	1
	1.1 Research Overview	3
	1.2 Problems Statement	4
	1.3 Objectives	5
	1.4 Scopes	5
	1.5 Research Flowchart	6
	1.6 Research Milestone	7

CHAPTER	TITLE	PAGE
CHAPTER 2	LITERATURE REVIEW	8
	2.1 Natural Gas Vehicle (NGV)	8
	2.1.1 CNG as an Alternative Fuel	8
	2.1.2 Types of Natural Gas	11
	2.1.3 Compressed Natural Gas (CNG)	
	Overview	12
	2.1.4 Combustion Characteristics of CNG	15
	2.2 How NGV System Works	17
	2.2.1 CNG Fuel System Overview	17
	2.2.2 NGV Fuel System Parts and	
	Components	21
	2.2.3 NGV Operations	24
	2.3 Types of NGV Vehicle	25
	2.3.1 The CNG Engine	25
	2.4 NGV Engine Performance	26
	2.4.1 Previous Research	26

CHAPTER	TITLE	PAGE
CHAPTER 3	NGV ENGINE PERFORMANCE TESTING METHADODOLOGY	28
	3.1 Apparatus - Chassis Dynamometer	29
	3.1.1 Principal Operations of Dynamometer	29
	3.1.2 Principal of Chassis Dynamometer	30
	3.2 Engine Classification	32
	3.2.1 Engine Specifications	32
	3.3 Engine Performance Testing	33
	3.3.1 Research Methods	33
	3.3.2 Testing Problems	37
	3.3.3 Expected Results	37
	3.4 Identify and Analyzing Process	39
	3.5 Improvement of Engine Performance Using NGV System	39

CHAPTER	TITLE	PAGE
CHAPTER 4	RESULTS AND DISCUSSION	
	4.1 Results and data	40
	4.1.1 Engine Performance Results for Gasoline	41
	4.1.2 Engine Performance Results for CNG	44
	4.2 Analysis Engine Performance Testing	47
	4.2.1 Analysis Power and Torque to Engine Performance	48
	4.2.1.1 Power Differential	52
	4.2.1.2 Torque Differential	53
	4.2.1.3 Discussion	54
	4.2.2 Analysis Air Fuel Ratio (AFR) to Engine Performance	56
	4.2.2.1 AFR Table	58
	4.2.2.2 Stoichiometry Mixture	59
	4.2.2.3 Discussion	60
	4.3 Recommendations	62
	4.3.1 Improving data and results accuracy	62
	4.3.2 Improving NGV engine performance	62
CHAPTER 5	CONCLUSION	63
	REFERENCES	64
	APPENDICES	66

LIST OF TABLES

TABLE NO.	TITLE	PAGE
2.1	Energy content of alternative fuels relative to petrol and diesel (Maxwell, 1995)	10
2.2	Natural Gas Characteristic	11
2.3	Methane and Gasoline Characteristics (Source: Guibet, J.C.et al.1999)	12
2.4	Fuel Price (Petronas Pump Price, 2005)	14
2.5	CNG and LNG Fuel System Component (Stephens, D. et al. 2002)	22
2.6	Power and Torque Loss with Mechanical CNG Conversion Relative to Gasoline Performance	27
3.1	Engine specification	32
4.1	Engine Performance Results for Gasoline at Speed	41
4.2	Engine Performance Results for Gasoline at Engine Speed	43

TABLE NO.	TITLE	PAGE
4.3	Engine Performance Results for CNG at Speed	44
4.4	Engine Performance Results for CNG at Engine Speed	46
4.5	Table of Maximum Power	52
4.6	Table of Maximum Torque	53
4.7	Table of Maximum AFR	58
4.8	Table of Minimum AFR	58

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
1.1	Research flowchart	6
2.1	Methane chemical diagram	15
2.2	CNG Fuel System Layouts (3D) (Stephens et al. 2002)	19
2.3	CNG Fuel System (schematic diagram) (Stephens et al. 2002)	20
2.4	NGV system parts in vehicle (http://www.autoworld.com.my)	21
2.5	NGV operations flow (http://www.ngvontario.com)	24
2.6	Graph Power vs Engine Speed	26
3.1	Research methodology	28
3.2	Sample graph No.1; Power and Torque vs Speed	30

FIGURE NO.	TITLE	PAGE
3.3	Sample graph No.2 ; Power and Torque vs Speed	31
3.4	Tire position on the drum	33
3.5	Tire alignment	34
3.6	Body straps tie at lower arm	34
3.7	Engine performance testing	35
3.8	NGV switcher	36
3.9	WinPEP 7 software	36
4.1	Graph Power vs Speed	48
4.2	Graph Power vs Engine Speed	48
4.3	Graph Torque vs Speed	49
4.4	Graph Torque vs Engine Speed	49
4.5	Graph Power Torque (CNG) vs Speed	50
4.6	Graph Power Torque (CNG) vs Engine Speed	50
4.7	Graph Power Torque (Gasoline) vs Speed	51

FIGURE NO.	TITLE	PAGE
4.8	Graph Power Torque (Gasoline) vs Engine Speed	51
4.9	Graph Air Fuel Ratio (AFR)(Gasoline) vs Speed	56
4.10	Graph Air Fuel Ratio (AFR)(Gasoline) vs Engine Speed	56
4.11	Graph Air Fuel Ratio (AFR)(CNG) vs Speed	57
4.12	Graph Air Fuel Ratio (AFR)(CNG) vs Engine Speed	57

LIST OF SYMBOLS

P	=	Power kW, hp
τ	=	Torque Nm, lbf-ft
N	=	Speed RPM
AFR	=	Air Fuel Ratio
m_a	=	Mass of air kg
m_f	=	Mass of fuel kg
λ	=	Lambda

LIST OF ABBREVIATIONS

ICE	=	Internal Combustion Engine
NGV	=	Natural Gas Vehicle
CNG	=	Compress Natural Gas
LNG	=	Liquefied Natural Gas
LPG	=	Liquefied Petroleum Gas
RPM	=	Revolution per Minute
WOT	=	Wide Open Throttle

LIST OF APPENDICES

APPENDIX	TITLE
A. EXPERIMENTS APPARATUS	
A1	Blower
A2	Exhaust Sucker
A3	Lock
A4	Magneto
A5	Straps
A6	Chassis Dynamometer
A7	Experiment Set Up with Proton Gen 2 1.6 L
B. CNG EQUIPMENTS	
B1	NGV ECU
B2	CNG Tank
B3	NGV switcher
B4	Gas Distributor
B5	Pressure Gauge
B6	Proton Gen 2 1.6 L

C. EXPERIMENTAL GRAPHS

- C1 Graph Torque vs Speed
- C2 Graph Torque vs Engine Speed
- C3 Graph Power vs Engine Speed
- C4 Graph Power vs Speed
- C5 Graph AFR vs Engine Speed
- C6 Graph AFR vs Speed

CHAPTER 1

INTRODUCTION

Current trends in the automotive industry are ever changing especially regarding the usage of alternative fuels. The search for the best alternative fuel that produces the least amount of emission has sparked concerns to many researchers. Maxwell (1995) stated that many studies on alternative fuel have been carried out and researchers are looking at natural gas, liquefied petroleum gas (LPG), methanol, ethanol, and hydrogen. All of these fuels have their advantages and disadvantages which are cost, availability, environmental impact, usage in vehicle, safety and the acceptance by consumers.

Current fuel price inflation and also current oil crisis, drastic moves were taken by many countries to reduce petroleum usage and finding other alternatives to its usage. In developing countries, the concern of finding alternative fuels has started and already had become an issue. With gas reserves three times more than petroleum oil, Malaysia is increasingly turning its attention towards natural gas. The national petroleum company of Malaysia, PETRONAS has embarked on the Natural Gas for Vehicles (NGV) program where NGV dispensing facilities are available at some selected PETRONAS service stations, located in high traffic density areas of Kuala Lumpur and Johor Bahru. The government support for the NGV program was seen in 25% reduction on car road tax for using NGV as well as requiring new taxis in the Klang Valley to use CNG by engine conversion systems.

In automotive applications, natural gas can be used in three forms based on how the natural gas is stored. One of the most popular forms of natural gas is the compressed natural gas (CNG), which is natural gas in pressurized form. The other least popular methods of obtaining natural gas are liquefied natural gas and the absorption natural gas.

CNG is a good alternative to petrol and diesel. Consumers would easily accept this form of alternative as it has low operational cost due to subsidized price and its usage could provide cleaner engine emissions. The main reason behind CNG fuel being cleaner is that natural gas is principally comprise of 90% methane, which is the simplest form of hydrocarbon. Even so, the CNG fuel available today still lack in some qualities compared to petroleum fuel. For example, CNG fuelled engines normally possess lower engine performance compared to petrol.

The main reason is that CNG fuel system creates a lot of losses in terms of volumetric efficiency due to mixing process. This happens as CNG must be supplied to the engine through a mixing device before the mixture of CNG and air is drawn into the engine. This causes less fuel in the combustion chamber and reduces volumetric efficiency. Currently petrol fuelled engine are converted into a CNG fuelled engine by means of a fuel mixing device.

Another alternative fuel used is liquefied petroleum gas (LPG). Liquefied gas is a mixture of propane and butane and is the most commonly used as engine fuel. When LPG is used to fuel internal combustion engine, it is often referred to as autogas. Natural gas used as engine fuel does not need to be processed and no changes in engine design are required if the engine is to be fed with gas. Because of that, users prefer to use natural gas than liquid gas.

1.1 RESEARCH OVERVIEW

Research on alternative fuel for motor engines which is NGV engine performance testing has been carried out aggressively due to higher demand on environmentally friendly engines. Besides, the increasing of fuel price is also being the most important factors for this research. Natural gas vehicle (NGV) is one of the commonly use alternative fuel vehicle today. One type of fuel being considered is the compressed natural gas (CNG). Work has been done which includes the automotive and industrial engines which is common petrol engine system and NGV engine system. The main area of research is to study the performance of NGV system in the internal combustion engine (ICE). Furthermore, another objective of this research is to make the improvement engine performance using the current system of NGV. Hence this project, which will investigate engine performance in two types of engine; with NGV system and without NGV system (gasoline). To archive the objectives, the engine performance testing will be done using chassis dynamometer. The results of the engine performance testing from two types of engine will be analyzed. Besides, the improvements of engine performance using NGV system can be suggest and further research will be making.