STUDY ON TYPICAL EMISSION FROM PETROL ENGINE FUELED WITH LIQUEFIED PETROLEUM GAS (LPG)

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"I admit that have read this work and in my opinion this work was adequate from scope aspect and quality to award in purpose Bachelor of Mechanical Engineering (Automotive)"

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"I hereby, declare this thesis entitled
Study on Emission from Petrol Engine Fueled with LPG
is the result of my own research except as cited in the reference"

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To **My Beloved Mother,**

Mdm. Kartina Binti Arshad

and **My Beloved Father,**

Mr. Helmi Bin Abdullah

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ABSTRACT

Liquefied Petroleum Gas (LPG) is one of the current alternative fuels that can take over conventional petrol for better environment and better for human living. This is currently being talked about all over the world, the effect of greenhouse and global warming. Conventional petrol releases emissions that consist of gases such as carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NO_x). So, alternative fuel is needed to reduce those harmful emissions. In this report, the emission from LPG combustion in petrol engine including typical and aftertreatment emission from both fuel LPG and petrol is studied. The experiment is conducted using petrol engine and fuelled with both petrol and LPG. The petrol and LPG emissions are identified using gas analyzer and are compared. LPG combustion produces carbon monoxide (CO), hydrocarbon (HC) and nitrogen oxide (NO_x) gas. Further study in this area should be done in terms of having environmental friendly surroundings all the time and having renewable resource of fuel at most time.

ABSTRAK

Gas Petroleum Cair (LPG) ialah salah satu bahan bakar alternatif yang boleh menggantikan petrol yang sedia ada untuk persekitaran dan kehidupan yang lebih baik. Ia selalunya dibincangkan di seluruh dunia, kesan rumah hijau dan pemanasan global. Hasil pembakaran daripada petrol menghasilkan gas-gas seperti karbon monoksida (CO), hidrokarbon (HC) dan nitrogen oksida (NO_x). Justeru, bahan bakar alternatif diperlukan untuk mengurangkan penghasilan gas-gas yang merbahaya ini. Dalam laporan ini, gas-gas yang terhasil daripada pembakaran LPG dalam enjin petrol termasuk gas asal dan setelah dirawat dikaji. Eksperimen dijalankan dengan menggunakan enjin petrol dan petrol dan LPG digunakan sebagai bahan bakar. Hasil pembakaran daripada petrol dan LPG dikenalpasti dengan menggunakan mesin pengenalpasti gas dan gas-gas tersebut dibandingkan. Pembakaran LPG menghasilkan gas-gas seperti karbon monoksida (CO), hidrokarbon (HC) dan nitrogen oksida (NO_x). Kajian lanjut perlu dijalankan dari segi mesra persekitaran sepanjang masa dan pembaharuan sumber bahan bakar.

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CHAPTER 1

INTRODUCTION

1.1 Background

A petrol engine or gasoline engine is an internal combustion engine with spark-ignition designed to run on petrol (gasoline) and similar volatile fuels. It differs from a diesel engine in the method of mixing the fuel and air, and in the fact that it uses spark plugs. In a diesel engine, merely the air is compressed, and the fuel is injected at the end of the compression stroke. In a petrol engine, the fuel and air are pre-mixed before compression injection. Pre-mixing of fuel and air allows a petrol engine to run at a much higher speed than a diesel, but severely limits their compression, and thus efficiency.

Emissions are generated in the combustion process of automobile and other internal combustion engines. Emissions from automobile engines tend to be concentrated in specific areas especially in town, causes local levels of pollutants may be high. The emissions of concern are hydrocarbons (HC), carbon monoxide (CO), nitrogen oxide (NO_x), sulphur and solid carbon particles (part).

The major causes of these emissions are nonstoichiometric combustion, dissociation of nitrogen, and impurities in the fuel and air. These emissions pollute the environment and contribute the global warming, acid rain, smog, odours, respiratory and other health problems.

According to the current scenario, the petrol price is increasing to reach record high prices. The price increases of this period due to some factors, including statements from the Official Energy Statistics from the US Government showing a decline in petroleum reserves (www.eia.doe.gov). According to (Michael Cohen 2006), demand growth continues over non-Organization of Petroleum Exporting Countries (OPEC) supply growth, non-OPEC supply has failed to meet expectations, low OPEC spare capacity levels increase the demand for inventories, geopolitical issues in major OPEC producing countries have lowered production and increased the risk of future production disruptions, worldwide refining sector bottlenecks have raised refiner margins, weather has disrupted supplies, available evidence suggests that increased speculative activity in oil markets.

Rising petrol prices will affect the industries operation and especially to the transportation. Before the run up in petrol prices, many motorists choose for larger engine capacity and less fuel consumption vehicles where petrol prices still low. This trend began reversing in 2008 due to rising prices of petrol.

This scenario will spur demand for alternate fossil fuels, such as liquefied natural gas and for renewable energies, such as solar power, wind power, and advanced biofuel and biodiesel. For example, China and India are currently heavily investing in natural gas facilities in Myanmar (burma.suite101.com). Oil companies such as ExxonMobil, Shell, BP, ChevronTexaco, and ConocoPhillips have begun to fund research into alternative fuel. They have invested $1.2 billion on renewable and alternative sources of energy between 2000 and 2005 (democrats.senate.gov).

1.2 Problem statement

Internal combustion engines are one of the main contributors to air pollution, which give a damaging impact on our health and the environment and are suspected to cause global climate changes. Nowadays, as the petrol price is become more expensive, people in Malaysia are looking for alternative fuel to replace the current petrol. One of the alternative fuels is Liquefied Petroleum Gas (LPG). According to research (Yousufuddin and Mehdi 2007), LPG is chosen as the alternative fuel because of economical and responsibility to save the environment. In some countries such as Australia, it has been used since the 1960s as an alternative fuel for spark ignition engines (Beer, T. 2004). Recently, it has also been used in diesel engines.

1.3 Objective

In a petrol engine, combustion process would produce emissions of a few gases and particulate matter. So, the aim of the study is to measure and identify gas emission from LPG combustion.

1.4 Scope

The scopes of the project are:

1. Measure gas emission from petrol and LPG combustion.
2. Studies on comparison of typical and aftertreatment gas emission between petrol and LPG.
3. Preliminary study of catalytic converter used in LPG fuel.

1.5 Project Summary

As a summary of this project, the gas emission from LPG combustion is measured and identified such as carbon monoxide (CO), hydrocarbons (HC), and nitrogen oxides (NO_x). The LPG's typical and aftertreatment gas emissions are compared to gas emission produced by petrol combustion. Preliminary study of catalytic converter used in LPG fuel is done.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to Internal Combustion Engine

The internal combustion engine is a heat engine in which the burning of air and fuel mixture occurs in a space called a combustion chamber. This exothermic reaction of a fuel with an oxidizer creates gases of high temperature and pressure, which are permitted to expand. The defining feature of an internal combustion engine is that useful work is performed by the expanding hot gases acting directly to cause movement, for example by acting on pistons, rotors, or even by pressing on and moving the entire engine itself (www.speedace.info).

This contrasts with external combustion engines such as steam engines which use the combustion process to heat a separate working fluid, typically water or steam, which then in turn does work, for example by pressing on a steam actuated piston.

2.2 Engine Pollution

Generally internal combustion engines particularly produce moderately high pollution levels, due to incomplete combustion of carbonaceous fuel, leading to carbon monoxide and some soot along with oxides of nitrogen & sulfur and some unburnt hydrocarbons depending on the operating conditions and the air/fuel ratio.

Diesel engines produce a wide range of pollutants including aerosols of many small particles that are believed to penetrate deeply into human lungs (www.speedace.info).

2.3 Introduction to Liquefied Petroleum Gas (LPG)

Liquefied Petroleum Gas (LPG) is often identified as propane. Actually, according to research (Brasil T. and Vincent R. 1998), LPG is referring to a mixture of hydrocarbons with propane as dominant substance that is pressurized into a liquid for use as a fuel. Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy (2003) stated, LPG is a mixture of several gases that is generally called propane in reference to the mixture's chief ingredient. It is change to the liquid state at the moderately high pressures found in an LPG vehicle's fuel tank.

LPG is described as a group of hydrocarbon-based gases derived from crude oil and or natural gas. The purification of natural gas produces about 55 percent of all LPG, while crude oil refining produces about 45 percent. LPG is mostly propane, butane or a mix of the two. It also includes ethane, ethylene, propylene, butylenes, isobutene and isobutylene; these are used primarily as chemical feedstock rather than fuel (The Energy Report 2008).

LPG includes saturated hydrocarbons, which are propane (C_3H_8) and butane (C_4H_{10}). It can be stored separately or as a mixture. They exist as gases at normal room temperature and atmospheric pressure (www.e-lpg.com).

The common interchanging of the two terms is explained by the fact that in the U.S. and Canada, LPG consists primarily of propane (see Table 2.3(a)) (www.nett.ca/faq/lpg-1). In many European countries, however, the propane content in LPG can be as low as 50% or less.

Table 2.3(a): Composition of LPG (www.nett.ca/faq/lpg-1)

Propane	85% min. by liquid volume
Propylene	5% max. by liquid volume
Butane & heavier HC	2.5% max. by liquid volume
Sulfur	120 ppm max. by weight

The major sources of LPG are natural gas processing and petroleum refining. Raw natural gas often contains excess propane and butanes which must be removed to prevent their condensation in high-pressure pipelines. In petroleum refining, LPG is collected during distillation, from lighter compounds dissolved in the crude oil. Therefore, LPG can be considered as a by-product and its composition and properties will be differing to the source. The characteristic properties of LPG are compared with gasoline in Table 2.3(b) (Yousufuddin and Mehdi 2007).

Table 2.3(b): A Comparison of LPG and Gasoline Properties (Yousufuddin and Mehdi 2007)

Characteristic	Propane	Gasoline
Chemical Formula	C_3H_8	C_8H_{18}
Boiling Point (°C)	-44	30-225
Molecular Weight (kg/Kmol)	44.1	114.2
Density at 15 °C kg/l	0.507	0.705
Research Octane Number	100	96-98
Stoichiometric air fuel ratio (kg/kg)	15.6	14.7
Flame speed (m/s)	48	52-58
Upper Flammability limits in air (% vol)	74.5	7.6
Lower Flammability limits in air (% vol)	4.1	1.3
Lower calorific value (kJ/kg)	46.365	42.1

2.4 LPG Emissions

The major harmful emissions from LPG engines are similar to those from other internal combustion engines (www.nett.ca/faq/lpg-2):

- Carbon monoxide (CO)
- Hydrocarbons (HC)
- Nitrogen oxides (NO_x)

Carbon monoxide (CO) is generated in the exhaust as the result of incomplete combustion of petrol and basically it is a very toxic, colourless and odourless gas. LPG emissions may contain considerable amounts of CO. When engines operate in enclosed spaces, such as warehouses, buildings under construction, or tunnels, carbon monoxide can accumulate quickly and reach concentrations which are dangerous for humans. It causes headaches, dizziness, lethargy, and death.

Hydrocarbons (HC) are a product of incomplete combustion of petrol. LPG emissions contain only short chain hydrocarbons. The environmental impact of LPG hydrocarbon emissions causes ozone reactivity, contributing to smog. But the impact to environment is less than gasoline impact. However, hydrocarbon derivatives are responsible for the characteristic smell which is often a nuisance when LPG engines operate indoors.

Nitrogen oxides (NO_x) are a mixture of gases that are composed of nitrogen and oxygen. Two of the most toxicologically significant nitrogen oxides are nitric oxide (NO) and nitrogen dioxide (NO_2). Both are non-flammable and colourless to brown at room temperature. NO_x are released to the air from the exhaust of motor vehicles, the burning of coal, oil, or natural gas, and during processes such as arc welding, electroplating, engraving, and dynamite blasting (www.atsdr.cdc.gov). NO_x emissions are also a serious environmental concern because of their ozone reactivity and important role in smog formation.

Unlike diesel engines, there are practically zero particulate emissions from LPG engines. Concentration ranges of particular emissions CO, HC and NO_x are listed in Table 2.4(a).

Table 2.4(a): Emissions from LPG Engine (www.nett.ca/faq/lpg-2)

CO (%)	HC (ppm)	NOx (ppm)
0.2 - 2	50 - 750	250 - 2000

Malaysia's Department of Environment has stated the emission standard for petrol and diesel vehicles limit. The emissions included are carbon monoxide and hydrocarbon at idle speed. There are listed in Table 2.4(b) below.

Table 2.4(b): Malaysia Emissions Standard (www.adb.org)

Type	Pollutant	Permissible limit
Diesel vehicles	black smoke	50 HSU or % opacity
Petrol vehicles		
New models (after 1-1-97)	CO	3.5%
	HC	600ppm
Existing models (after 1-1-97)	CO	4.5%
	HC	800ppm

According to Table 2.4(a) and Table 2.4(b), the concentration of carbon monoxide and hydrocarbon emissions from LPG combustion are lower than the emission standard level stated by Malaysia's Department of Environment. So, it can be said that LPG is very suitable to be used by any vehicles in Malaysia.