ENGINE PERFORMANCE AND EMISSION LEVEL INVESTIGATION OF VEHICLE RUNNING WITH DIFFERENT TYPES OF RON FUEL GRADES AND FUEL BRANDS

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This report is presented in

Partial fulfilment of the requirements of the

Degree of Bachelor of Mechanical Engineering (Automotive)

Faculty of Mechanical Engineering

Universiti Teknikal Malaysia Melaka

May 2012

SUPERVISOR DECLARATION

"I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Automotive)"

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DECLARATION

"I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged"

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ACKNOWLEDGEMENT

I am sincerely appreciative to my lecturer, Dr Noreffendy Tamaldin for serving as my supervisor and for providing guidance while conducting the research and the writing of this 'Projek Sarjana Muda'(PSM).

I would like to thanks and convey special appreciation to the laboratory management especially Engine Performance Testing Laboratory, the lab technicians for their cooperation and support especially to Mr.Ridzuan Bin Ahmad who had been involves in providing technical data on the chassis dynamometer. I also want to thank my beloved family for their continous support and encouragement in everything I do. All these years of education have been made possible by their support and love.

Last but not least, I thank to everyone who involved directly and indirectly in this project. The sacrifice and commitment given towards me earning my bachelor's degree are desirable and without them, this PSM thesis would have been impossible.

ABSTRACT

The goal of this project is to analyse the performance of engine and emission level produced by vehicle by using different type of RON fuel grades and brands. This analysis involves chassis dynamometer for engine performance and using automobile exhaust gas analyzer for emission testing. For performance engine analysis, the engine first is tested by using chassis dynamometer with different type of RON fuel grades and brands. The result by running of chassis dynamometer will show the graph performance of engine include the power, torque and brake specific fuel consumption (bsfc). Next, the emission test is also performed to analysis and compares the data of emission level produced by vehicle. This emission test will be conducted with vehicle on idle and rapid acceleration by using chassis dynamometer with different type of RON fuel grades and brands. This project also targeted on developing the standard of procedure of fuel and emission testing using chassis dynamometer. At the end of the project, the result shows which type of RON fuel grades and brands produced greater engine performance and less emission level. Further experimental testing can be done for better output result such as using engine dynamometer which can obtain more accurate result for the fuel consumption.

ABSTRAK

Matlamat projek ini ialah untuk menganalisis, ujian eksprementasi prestasi enjin dan kadar gas pencemaran dari kenderaan yang menggunakan jenis-jenis gred minyak RON dan jenama minyak yang berbeza. Analisis ini melibatkan penggunaan casis dynamometer untuk ujikaji minyak dan menggunakan penganalisis exhaust gas kenderaan untuk ujikaji tahap gas pencemaran. Untuk ujikaji prestasi engine kenderaan, kenderaan diuji menggunakan casis dinamometer untuk mendapatkan data prestasi enjin. Hasil data tersebut dapat dilihat melalui graf prestasi iaitu termasuk kuasa, tork dan penggunaan minyak yang specific. Seterusnya, bagi ujikaji kadar gas pencemaran pula data yang diambil setelah ujikaji akan dianalisis dan dinilai. Ujikaji kadar pencemaran akan dijalankan pada situasi kenderaan pada tahap setara dan juga ketika kenderaan menjalani ujian pada casis dinamometer disamping menggunakan jenis gred minyak RON dan jenama minyak yang berbeza. Projek ini juga untuk membangunkan langkah-langkah ujikaji yang standard untuk ujikaji prestasi enjin dan kadar gas pencemaran menggunakan casis dinamometer. Setelah sempurna projek ini, hasil kajian akan dapat dilihat apakah jenis gred RON minyak dan jenama minyak yang menghasilkan kuasa atau prestasi enjin yang tinggi juga menghasilkan kadar gas pencemaran yang paling rendah. Eksperimentasi ujikaji lanjutan boleh dijalankan untuk mendapatkan data dan hasil kajian yang lebih baik dan tepat seperti menggunakan enjin dynamometer.

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$\dot{W}$ = Engine power

$\dot{W}b$ = Brake power

Vd = Displacement volume

n = Number of revolution per cycle

N = Number of revolution per minute(RPM)

Nc = Number of cylinder

B = Bore size

S = Stroke size

$\dot{m}_f$ = Mass flow rate of fuel

$\dot{m}_a$ = Mass flow rate of air

ρ_a = Air density evaluated at atmospheric conditions outside the engine

Q_{HV} = Heating value of fuel

η_f = Fuel conversion efficiency

η_c = Combustion efficiency

A_p = Piston area

mep = Mean effective pressure

bmep = Brake mean effective pressure

$\overline{U}_p$ = Piston speed

T = Torque (Nm)

P = Power (kW)

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CHAPTER I

INTRODUCTION

1.1 Project Background

Nowadays, in our market, there are two types of fuel RON available in Malaysia namely RON 95 and RON 97. A couple of years ago, government had introduced RON 95 fuel in our country because of the global fuel price increase sharply within short period of time. RON 97 fuel still remains in our market with a higher price than RON 95. People prefer the RON 95 fuels to be filled in their vehicles but questions arise about the performance of engine and fuel consumptions.

This final year project will discuss about the performance and emission study with different type of RON grades and fuel brands using a chassis dynamometer. The engine performance of vehicles will be analysed the graph of performance after fuel test using a chassis dynamometer. Emission test will conduct using portable combustion analyzer, and the data will be analysed to decide which type of fuel RON and brands gives higher performance and less emission level.

1.2 Objective

Below are the objectives for this project:

I. To compare the performance of engine with different types of RON fuel grades and brands.

II. To compare the emission level from vehicle by using different types of RON fuel grades and brands

III. To develop the standard of procedure of fuel testing by using chassis dynamometer, at FKM, UTeM.

1.3 Project Scope and Limitations

The scopes of this project are:

I. To analyze the performance of engine by using graph of performance (power, torque and brake specific fuel consumption (BSFC)).

II. To analyze the amount of emission gasses produced by different type of RON fuel grades and brands.

III. Using chassis dynamometer and portable combustion analyzer to make comparison of engine performance and emission level.

IV. Using two types of RON which RON 95 & RON 97 from three types of fuel producer (ESSO, PETRONAS, BHP).

1.4 Problem Statement

The general public nowadays still does not fully understand about to choice of fuel in their car between RON 95 and RON 97, which one will better deliver engine performance and also fuel consumption. There have been claims that RON 97 fuels performs than RON 95 fuels, and also helps clean engine components better. Some also said that the emission gasses output from a vehicle also affected by using different types of RON fuel grades. Therefore, the problem statements for this project are:

I. The effect of different of RON fuel grades and different brands to the vehicle remain unknown to the public.
II. Emission level produced from different RON grade and fuel brands also varies.
III. The vehicle performance (power, torque and brake specific fuel consumption) resulting from this RON grades and fuel brands also not fully understood.

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION

Fuel-related sources of engine performance problems include excessively high or low volatility, water absorption, improper storage and handling, enleanment, reduced motor octane, and materials compatibility. Performance problems can occur for a variety of reasons, and tracing performance problems to a specific cause is difficult, and often impossible. Potential engine performance problems resulting from fuel-related sources include rough engine operation, overheating, damaged pistons, vapour lock, starting difficulty, plugged fuel filters, fouled spark plugs, fuel leaks, hesitation during acceleration, flooding, stalling, and engine fires.

(D.J.Kortom, L.Haslett, L.Beard, K.Liechty, M.Coryell, C.Bruner-*Fuel Economy and Engine Performance Issues*)

2.1 RESEARCH OCTANE NUMBER (RON)

The Research Octane Number (RON) is a number that is awarded to different grades of fuel with present to its capability to resist auto-ignition or known as knocking. RON is determined by running the fuel in a test engine with a variable compression ratio under controlled condition, and the result is compared with mixtures of iso-octane and n-heptane. The other words, is a rating used to measure a fuels knocking resistance in spark-ignition internal combustion engines. The lower of RON the easier it becomes for fuels to ignite in the engine. Therefore, the fuels with a higher octane number will eliminate knocking, which have high compression ratio and gain more power in the engine. Below are the basic about available fuel:

a) Unleaded Petrol (ULP)

Unleaded Petrol or ULP has a Research Octane Number (RON) of between 91 and 93. Vehicles that use ULP operates with a catalytic converter because of the emitted gasses from exhaust are too high.

b) Premium Unleaded Petrol (PULP)

This premium petrol is a special blend of petrol with a higher octane rating which can produce higher engine power. So it gives more performance to the vehicle as well as knock-free performance and assisting the vehicle to run at its optimum. PULP has a Research Octane Number (RON) of 95 or 96.

c) Ultra Premium Unleaded Petrol (UPLUP)

Ultra means ultimate or it is a fuel have high octane unleaded fuel that maximises engine power and performance. The fuel burns cleanly as well as producing less pollution. UPULP which has a RON of 98 commonly recommended for imported high performance vehicles.

In practice, it is believed that the higher octane rating makes engines better in performance. This attracts people to use higher-octane gasoline in their engines. Although, it has been explained that using correct gasoline is the best for the engines, people still prefer to use higher-octane gasoline.(Toyotasa, 2000). Another study clearly reported that octane number plays an important role on exhaust emission. The results demonstrated that as the octane number was increased from 91 to 93, CO emission boosted nearly 5 %.(C.Sayin,& I.Kilicaslan, 2006).

2.2 INTERNAL COMBUSTION ENGINE (ICE)

This section will cover the working principle and engine parameter of the 4 stroke ICE.

2.2.1 Working Principle

Internal combustion engine (ICE) is a heat engine that converts chemical energy in a fuel into mechanical energy, commonly made available on rotating output shaft. Chemical energy of fuel is first converted to thermal energy by means of combustion or oxidation with air inside the engine. This thermal energy raises the temperature and pressure of the gasses within the engine, and the high pressure gas then expands against the mechanical mechanism of the engine. This expansion is converted by the mechanical linkages of the engine to the rotating crankshaft, which is the output of the engine. The crankshaft, in turn, is connected to a transmission or power train to transmit the rotating mechanical energy to the desire final use. Most of the ICE is reciprocating engines having pistons that reciprocate back and forth in cylinders internally within the engine.

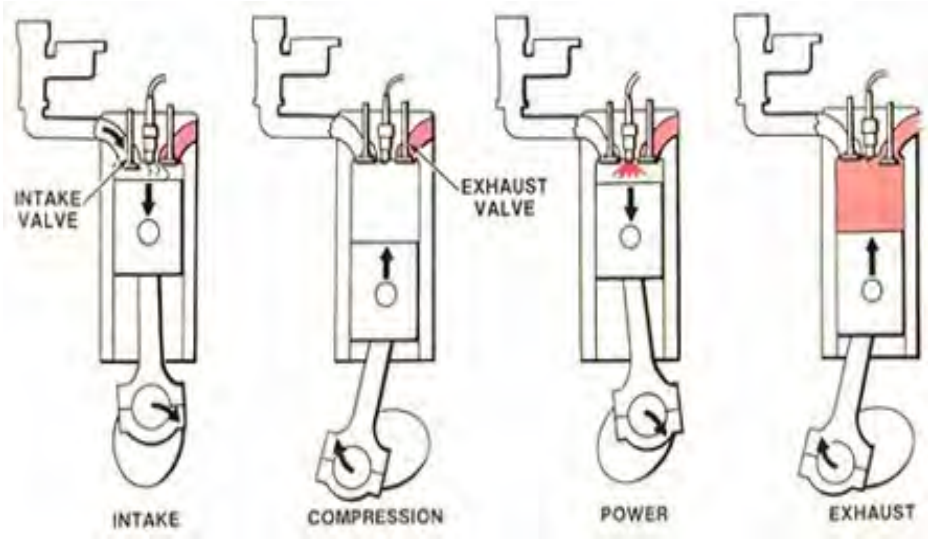

Figure 2.1: Four Stroke ICE Cycle (Pulkrabek , 2004)

Below are the four-stroke SI engine cycle detail descriptions of internal combustion engine as shown in Figure 2.1:

a) First Stroke: Intake Stroke or Induction

The piston moves downward that draws a combustible mixture of fuel and air past the throttle and intake valve into the cylinder. At this stroke, the intake valve open and the exhaust valve closed.

b) Second Stroke: Compression Stroke

During the Compression stroke, the piston moves upward, compressing the fuel/air mixture. The entire valve closed, and it will raise the temperature of the mixture. A spark ignites the mixture toward the end of the compression stroke.

c) Third Stroke: Expansion or Power Stroke

At power stoke, the spark plug fires, ignites the compressed fuel. As the fuel burns it expands, driving the piston downward. The expansion or power stroke resulting from combustion of the fuel-air-mixture. At this stroke, both intake and exhaust valve closed.

d) Fourth Stroke: Exhaust Stroke

At the bottom of the power stroke, the exhaust valve is opened by the cam/lifter mechanism. The upward stroke of the piston drives the exhausted fuel out of the cylinder. At this stroke, the intake valve closed and the exhaust valve open.

2.2.2 Engine Parameter

Engine parameters are used to determine a performance evaluation of the engine after run the engine testing.

Torque

The engine torque τ is a measure of the work done per unit rotations (radians) of the crank. It also a good indicator of an engine's ability to do work. Unit of torque are Nm or lbf-ft.

$$\tau = \text{bmep}.\text{V}_{\text{d}/}2\pi\text{n} \quad \text{.....(1)}$$

Power

Power is defined as the rate of work of the engine. Unit for the power is kW. (1 kW = 1.341 hp)

$$\dot{W} = \frac{WN}{n} \quad \text{.....(2)}$$

$$\dot{W} = 2\pi N\tau \quad \text{.....(3)}$$

$$\dot{W} = \left(\frac{1}{2n}\right)(mep)\left(A_p\right)\left(\bar{U}_p\right) \quad \text{.....(4)}$$

Air Fuel Ratio and Fuel Air Ratio

Define as the mass ratio of fuel present during combustion

$$\text{AF} = \frac{m_a}{m_f} = \frac{\dot{m}_a}{\dot{m}_f} \quad \text{..... (5)}$$

$$\text{FA} = \frac{m_f}{m_a} = \frac{\dot{m}_f}{\dot{m}_a} = \frac{1}{AF} \quad \text{..... (6)}$$