CHARACTERIZATION OF FUEL ADDITIVE FOR FUEL SAVING AND INJECTOR OPTIMIZATION

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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CHARACTERIZATION OF FUEL ADDITIVE FOR FUEL SAVING AND INJECTOR OPTIMIZATION

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This report is submitted
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DECLARATION

I declare that this project report entitled "Characterization of Fuel Additive For Fuel Saving And Injector Optimization" is the result of my own work except as cited in the references.

Signature	:	....
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APPROVAL

I hereby declare that I have read this project report 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).

Signature : ....

Name of Supervisor : **PROF. MADYA DR. NOREFFENDY BIN TAMALDIN**

Date : ....

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DEDICATION

Especially for my beloved mother, father and family

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ABSTRACT

V1 Booster is a fuel additive product that developed for consumers to get high quality fuel at a lower cost. This product contains 55% of Palm Olein and 45% additive formulated from R&D with the combination of nanobiotechnology from Germany. Based on the information obtained from the supplier and website, V1 Booster is functioning as a fuel saver and can improve the engine performance with less emission produced. The objectives of this experiment are to study the properties of V1 Booster and the influence of this additives on engine performance and emission release. Then, to provide a complete analysis of fuel consumption by the engine before and after using V1 Booster. The V1 Booster is tested into RON 95 and RON 97. The method used in this project is Hydrometer to measure the density, Oxygen Bomb Calorimeter to obtain energy content, engine dynamometer to analyze power, torque and brake specific fuel consumption (bsfc) and Emission Gas Analyzer to measure emission level. The result shows the density is increase after added with V1 Booster. While the energy is increase after additives is added into RON 95 but decrease for RON 97. The engine test shows the V1 Booster increase the power and torque from 2000 rpm until 3000 rpm. However, after 3000 rpm, the difference after use the additives is slightly same from the baseline RON 95 and 97 and when engine travel at high speed it performance decrease compare to the baseline petrol. It same goes to brake specific fuel consumption (BSFC). The added of V1 Booster can reduce the fuel consumption maximum about 5% for RON 95 and 22% for RON 97. But, when travel at high engine speed the V1 Booster is not saving anymore. Therefore, the use of V1 Booster is effective for low engine speed or below 3000 rpm. After 3000 rpm until the maximum 6000 rpm of engine speed, the effectiveness of V1 Booster is starting to decrease and not fixed.

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ABSTRAK

V1 Booster adalah produk aditif bahan api yang dibangunkan untuk pengguna mendapatkan bahan api berkualiti tinggi pada kos yang lebih rendah. Produk ini mengandungi 55% daripada Minyak Sawit Olein dan 45% bahan aditif dirumuskan daripada R&D dengan kombinasi nanobioteknologi dari Jerman. Berdasarkan maklumat yang diperoleh daripada pembekal dan laman web, V1 Booster berfungsi sebagai penjimat bahan api dan boleh meningkatkan prestasi enjin dengan pelepasan asap dapat dikurangkan. Objektif eksperimen ini adalah untuk mengkaji sifat-sifat V1 Booster dan pengaruh aditif ini terhadap prestasi enjin dan pelepasan asap. Kemudian, menyediakan analisis lengkap penggunaan bahan api oleh enjin sebelum dan selepas menggunakan V1 Booster. V1 Booster ini diuji ke RON 95 dan RON 97. Kaedah yang digunakan dalam projek ini adalah alat Hidrometer untuk mengukur ketumpatan, Oksigen Bomb Kalorimeter untuk mendapatkan kandungan tenaga, enjin dinamometer untuk menganalisis kuasa, tork dan penggunaan bahan bakar khusus brek (bsfc) dan Pelepasan Gas Analyzer untuk mengukur tahap pelepasan asap. Hasilnya menunjukkan ketumpatan meningkat selepas ditambah dengan V1 Booster. Manakala tenaga juga meningkat selepas bahan aditif ini ditambah ke dalam RON 95 tetapi berkurangan bagi RON 97. Ujian enjin menunjukkan V1 Booster meningkatkan kuasa dan tork dari 2000 rpm sehingga 3000 rpm. Walau bagaimanapun, selepas 3000 rpm, perbezaan selepas penggunaan aditif cuma sedikit dari garis dasar RON 95 dan 97 dan apabila enjin berfungsi pada kelajuan tinggi prestasi ia menurun berbanding dengan garis dasar petrol. Begitu juga dengan bahan bakar khusus brek (BSFC). Apabila ditambah V1 Booster ia boleh mengurangkan penggunaan bahan bakar maksimum kira-kira 5% untuk RON 95 dan 22% untuk RON 97. Tetapi, apabila enjin berkelajuan tinggi Booster V1 itu tidak lagi menjimatkan. Oleh itu, penggunaan V1 Booster berkesan untuk enjin berkelajuan rendah atau di bawah 3000 rpm. Selepas 3000 rpm sehingga maksimum 6000 rpm, keberkesanan V1 Booster terhadap enjin mula berkurangan dan tidak tetap.

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LIST OF SYMBOL

W	=	Engine power
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
ρa	=	Air density evaluated at atmospheric conditions outside the engine
η_f	=	Fuel conversion efficiency
η_c	=	Combustion efficiency
A_p	=	Piston area
mep	=	Mean effective pressure
$bmep$	=	Brake mean effective pressure
$\bar{U}_p$	=	Piston speed
T	=	Torque (Nm)
P	=	Power (kW)

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

For many decades, fuel additives have played a major role in improving engine performance and quality of fuels for use in motor vehicles, transportation, aircraft and marine vessels. Fuel additives are chemical substance or preparation added to fuel, in concentrations typically less than 1%, to impart or enhance desirable properties or to suppress undesirable properties. Some examples include combustion improvers, detergents, cold flow additives and lubricity additives. The petrol fuel additives began to be commercially introduced in 1923 to provide the octane rating needed to enable vehicle designers to increase engine compression ratios to levels which gave acceptable efficiency and performance. During 1950 and 1960, the focus of additives use was changed to automotive fuel system, because the carburetor cleanliness and efficient operation became more important. In 1980s, the used of deposit control additives rapidly increase because of emissions problem cause by the deposits and to reduce deposit build-up within the engine inlet system. Since 1923 until today, different additives and additives package have been developed and produced because of the need for petrol fuel has grown, for economic as well as legislative reasons (ATC, 2013).

For economic reasons, in the refining process, usable fuel oil is extracted from the crude oil. Crude oil reserved is limited, but the oil consumption rate is increasing continuously at an alarming rate. Reducing fuel consumption can lower expensive fuel

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imports and give positive impact to domestic cost balance. Nowadays, modern gasoline or petrol fuels contain more olefins and aromatics. These olefins and aromatics may worsen engine cleanliness and also increase engine deposits that lead to less stable combustion. Additives are added as a means of stabilizing and improving these fuels, bringing them to the required regulated standards (B.Duboc, 2014).

Legislation has been a major influence on the additives market in the past few years. Because of climate change and air quality have become the serious issue, there are many countries focusing on reducing emission and improving air quality. The government released the requirements to limit the emissions of carbon monoxide (CO), nitrous oxides (NO_x) and encourage the use of additives in diesel and petrol fuel. The United States was the first country to mandate the use of deposit control in its gasoline. This directive was specifically introduced to reduce emissions in United States as the test carry out by EPA clearly shows the link between deposit control and emissions. The use of deposit control additives will improve the efficiency of the engine and produce environmentally friendly vehicles (AFTON, 2015).

1.2 PROBLEM STATEMENT

Nowadays, consumers are looking for simple and inexpensive ways to lower the cost of driving. The market has responded with a plenty of devices and fuel additive products which claim to improve fuel economy and reduce emissions. There are many advertisements about using the energy from the car's battery to split water molecules into hydrogen and oxygen gas which is then burned with the fuel. Besides that, there also devices that heat, magnetize, ionize or add metals to vehicle's fuel lines and capable to increase fuel economy and reduce exhaust emissions. Furthermore, several heavily marketed devices claim to increase the fuel efficiency by creating aerodynamic properties or turbulence that improves the air-fuel mix before to combustion. One of the fuel additives brand in Malaysia is V1 Fuel Booster as shown in Figure 1.1. This fuel additive was advertised to improve fuel economy, reduce exhaust emission and keep the cleanliness of the engine as shown in Figure 1.2. However, there are still not clear analysis and no technical report to support and prove the claims.

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Figure 1.1: V1 Fuel Booster

Figure 1.2: Advertisement of V1 Fuel Booster

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1.3 OBJECTIVES

The objectives of this project are as follows:

1. To study the properties of V1 Booster in term of density and energy content.
2. To investigate the influence of V1 Booster fuel additive on the engine performance and emission level of Spark Ignition gasoline engine.
3. To provide a complete analysis of fuel consumption before and after using V1 Booster fuel additive.

1.4 SCOPE OF PROJECT

The scopes of this project are:

1. This project use V1 Booster as fuel additive and tested on Petronas RON 95 and 97.
2. This project involved the analysis of engine performance in term of power, torque, and brake specific fuel consumption. The emission produce by the fuel additive will be analysed as well.
3. The engine test is carry out using step test on engine dynamometer from 2000 rpm until 6000 rpm.
4. For emission test, the data obtain at two engine conditions which when engine is idling and at 6000 rpm.

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CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Due to the competitive nature in the market, the information on the specific contents and compositions of the additives are kept confidential by the manufacturer. Only some general knowledge of additive compositions can be obtained from the patents of additive groups. The general methods of operation for the additives such as combustion improvers, fuel savers and clean emission are often known. However, the specific effects of the additives on the combustion process and efficiency of the engine are rarely available in the open literature.

2.2 FUEL ADDITIVES

In automotive field, the combustion of petroleum-based fuel in motor vehicle is a source to the emission that contains particulate and gaseous pollutants to the environment. The Clean Air Act that amended in 1970, Section 211, has recognized the potential health hazard in the combustion products from fuels and fuel additives.

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This act has empowered the Environmental Protection Agency (EPA) to require manufacturers of fuel and fuel additives to register their products (Jungers et al., 1975).

The additives in the fuel have multifunctional acting such as antioxidants, metal deactivators, corrosion inhibitors, and carburetor and valve deposit detergents. These additives also ordinarily act as third party, means used to supplement the additives already present in fuel and may not blended at the refinery (Jungers et al., 1975).

2.2.1 Types of Additives in Market

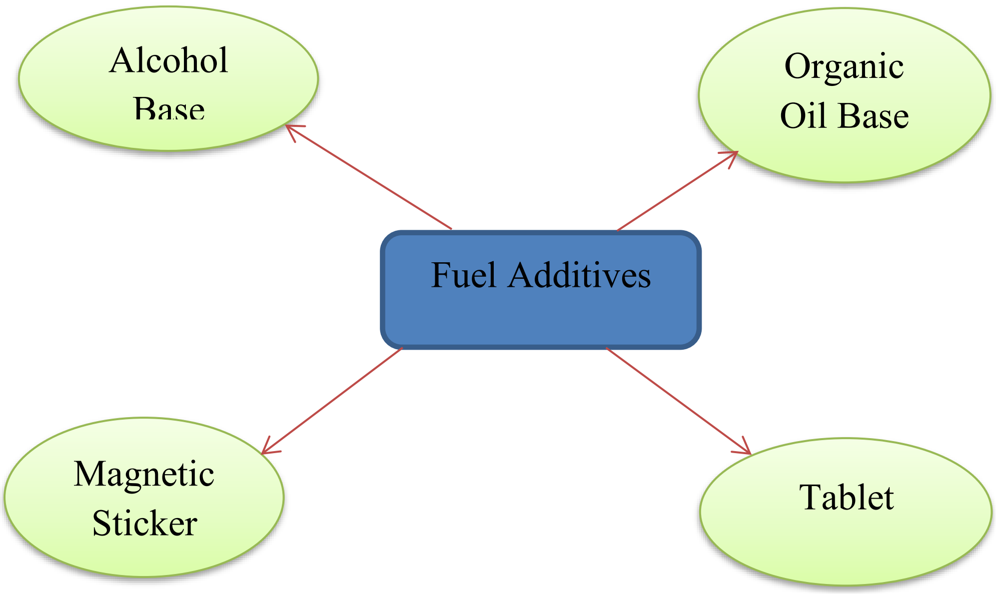

Figure 2.1: Types of Additives in Commercial Market

2.2.2 Elements in Fuel Additives

After the eighteen commercial fuel additives in the market have been analyzed by neutron activation analysis, there are several levels of elements have been found. These elements are Hg, As, V, Mn, Sb, Cr, Zn, Co, Se, Sn, Ag, Al, Fe and Sr as in table 2.1. Apparently, the predominant source of the Sn and Fe in the fuel additives may because of the solder connection in metal container. The intensive use of market

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additives can lead to environmental trace metal burden and increase the potential for poisoning exhaust catalytic (Jungers et al., 1975).

Table 2.1: Trace Elements in Fuel Additives (Jungers, 1975)

Element	Concentration range, μg/ml	Avg, μg/ml
Hg	<0.0002–0.002	
Cd	<0.02–0.20	
As	<0.001–0.23	
V	<0.001–0.031	
Mn	0.007–2.71	0.16
Ni	<0.013–<0.340	
Sb	<0.0005–0.0041	
Cr	<0.002–0.096	
Zn	0.032–38.0	8.8
Co	<0.0002–0.0360	
Se	<0.001–0.032	
Sn	<0.07–140	
Ag	<0.0003–0.0065	
Al	<0.01–2.30	
Fe	<0.03–560	
Sr	<0.033–37	
Br	<0.014–10	
Cl	0.5–18,200	1,334
Na	<0.01–99	
Ba	<0.02–4.2	
Ca	<17–1,900	
K	<0.7–63	

• 18 samples analyzed by neutron activation (*17*).

2.3 RESEARCH OCTANE NUMBER (RON)

The quality of the petrol is determined by the compositions and the hydrocarbons present in the mixture. Octane number is one of the characteristics in Spark Ignition (SI) engine that indicates the anti-knock of a fuel and depends on the hydrocarbon type. The octane number without additives is called as clear octane number and very dangerous to the environment. Because of this reason, the process such as alkylation have used in the refineries to improve the octane number. The common octane numbers that used in industry are Research Octane Number (RON) and Motor Octane Number (MON). The RON is tested and measured under low speed

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condition using ASTM D908 while MON is measured under high speed condition using ASTM D357. The lower number of RON used the easier for it to ignite in the engine. Therefore, the fuels with a higher number of RON will eliminate knocking, as it has high compression ratio and gain more power in the engine (Albahri et al., 2002).

2.3.1 Unleaded Petrol (ULP)

The petrol that has a RON number between 91 and 93 are categorized as Unleaded Petrol. Vehicles that use this type of RON need to install the catalytic converter because the gas emitted from the exhaust are high and hazardous to environment.

2.3.2 Premium Unleaded Petrol (PULP)

The Premium Unleaded Petrol is the petrol that has a RON number of 95. This PULP is a special blend of petrol created to bring high octane and knock free performance to unleaded cars. It gives more performance to the engine and run at maximum efficiency.

2.3.3 Ultimate Unleaded Petrol (UUP)

The Ultimate Unleaded Petrol (UUP) has a RON number of 98. This UUP is an advanced performance fuel designed to be better for any type or model of the vehicles. Formulated to clean the engine and reduce exhaust emissions, UUP keep the engine clean, give more performance and less harmful to the environment.

2.3.4 High Performance Petrol (HPP)

The first premium-plus petrol with 100 octane have produced by Petron and also meets the European fuel quality standard compatible with Euro 4 vehicle technology. The Petron Blaze 100 Euro 4 has extremely high octane in petrol and extraordinary engine cleaning capability to provide the powerful performance to the

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car. This HHP also contains organic combustion enhancer and friction modifier to provide the fuel operates efficiently. Therefore, the new Petron Blaze 100 Euro 4 is formulated to meet the European specification for cleaner, make it environment-friendly fuel.

2.4 SPRAY CHARACTERISTICS

The fuel spray and atomization play an important role to the performance and emission characteristic of the engine. The air-fuel mixture formation in the combustion chamber is affected by the characteristic of the fuel spray. The main parts of fuel spray characteristic are fuel injection pressure, cone angle, spray length and droplet size distribution. The higher fuel injection pressures encourage the engine for better fuel atomization and combustion characteristics. It also gives advantageous in terms of uniform distribution of droplets. However, the spray penetration should not hit the walls of cylinder as it may cause the problem of wall wetting and leads to uncountable loss (Prabhakara et al., 2015).

Spray cone angle is how wide the spray distribution as it comes out from the injector nozzle and penetrates the combustion chamber (Duboc, 2014). The spray has a very high velocity (typically 100 m/s) as it comes out from the injector and slowing down as the spray moves away from the nozzle. When the spray spreads out and mixing with the air gradually, the velocity reduces and the spray diverges more, as it penetrates into the combustion chamber. The spray has very high concentration of fuel in the middle and low concentration of fuel at the edges. The average range of the cone angle is 10-25˚ and if the cone angle is narrow, the spray will be denser and more localized. Therefore, narrow spray cone angle is better for the better combustion and performance.

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