EXPERIMENTAL STUDY ON THE EFFECT OF INTAKE AIR TEMPERATURE ON THE PERFORMANCE OF SPARK IGNITION ENGINE FUELED WITH HYDROGEN PEROXIDE BLENDED WITH GASOLINE

MUHAMMAD ASNAWI BIN OMAR

B041310368

BMCA

asnawi_omar@yahoo.com

PROJEK SARJANA MUDA

Supervisor: DR. ADNAN BIN ROSELI

2nd Examiner: PROF. MADYA DR. MUSTHAFAH BIN MOHD TAHIR

FACULTY OF MECHANICAL ENGINEERING

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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'I have read this thesis

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Bachelor of Mechanical Engineering (Automotive)'

Signatures : …….

Name of Supervisor : DR. ADNAN BIN ROSELI

Date : …….

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"I declare this report is on my own work except for summary and quotes that I have mention source"

Signatures : …….

Name of Author :MUHAMMAD ASNAWI BIN OMAR

Date : …….

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ABSTRACT

The aim of this experiment is to investigate the effect of intake air temperature. It will measure the performance of petrol engine running under alternative fuel. The alternative fuel that has been chosen is hydrogen peroxide and it will be blended with gasoline. Some of the characteristics of hydrogen peroxide are it portrays as a strong oxidizing agent however, it is a weak acid when immerse in water. The process of the mixture will be using a device called magnetic stirrer. The specimen used for the test is 5 vol% of hydrogen peroxide + 95 vol% gasoline and 10 vol% hydrogen peroxide + 90 vol% gasoline. Experiment was conducted by using generator engine Precision GX420 single cylinder with 4 strokes. The temperatures chosen for the whole test were 40°C and 60°C respectively. The temperatures were controlled by hot air gun where it will be attached at inlet of the engine. Pressure sensor and crank sensor have been installed on the engine to determine pressure, volume and crank angle. The data obtained was recorded and shown in DEWESOFT data acquisition system.

ABSTRAK

Tujuan eksperimen ini adalah untuk mengkaji kesan suhu udara pengambilan. Ia akan mengukur prestasi enjin petrol yang berjalan di bawah bahan bakar alternatif. Bahan bakar alternatif yang telah dipilih adalah hidrogen peroksida dan ia akan diadun dengan petrol. Sesetengah ciri hidrogen peroksida yang digambarkan sebagai agen pengoksidaan yang kuat, bagaimanapun, ia adalah asid lemah apabila terbenam dalam air. Proses campuran akan menggunakan peranti yang dikenali sebagai pengaduk magnet. Spesimen yang digunakan untuk ujian adalah 5 vol% daripada hidrogen peroksida + 95 vol% petrol dan 10 vol% hidrogen peroksida + petrol 90 vol%. Eksperimen dijalankan dengan menggunakan silinder tunggal Precision GX420 enjin penjana dengan 4 lejang. Suhu yang dipilih untuk keseluruhan ujian ialah 40 ° C dan 60 ° C. Suhu dikawal oleh pistol udara panas di mana ia akan dipasang di enjin enjin. Sensor tekanan dan sensor engkol telah dipasang pada enjin untuk menentukan tekanan, jumlah dan sudut engkol. Data yang diperolehi dicatatkan dan ditunjukkan dalam sistem pemerolehan data DEWESOFT.

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LIST OF ABBREVATIONS

RPM	=	Revolution per Minute
DAS	=	Data Acquisition System
H_2O_2	=	Hydrogen Peroxide
GA	=	Gasoline Alone
TDC	=	Top Dead Centre
BDC	=	Bottom Dead Centre
CO	=	Carbon Monoxide
CO_2	=	Carbon Dioxide
H_2O	=	Water
CH_4	=	Methane
CI	=	Compression Ignition
SI	=	Spark Ignition
NO_x	=	Nitrogen Oxide
ISFC	=	Indicated Specific Fuel Consumption
Q_{HV}	=	Data Heating Value
pH	=	Potential of hydrogen

LIST OF SYMBOLS

T	=	torque (Nm)
V_d	=	volume of cylinder (m^3)
v	=	volume (dm^3)
Π	=	2.134
S	=	Stroke
B	=	Bore
P_0	=	front of throttle pressure (Pa)
ISFC	=	gram per kilo Watt hour (g/kW.hr)
L	=	Liter
Km	=	kilometer
%	=	percentage
J	=	Joule
W	=	Watt
°C	=	Degree Celsius
N	=	number of revelation per minute (rev/min)
R	=	gas constant (0.287 kJ/kg K)
Cp	=	centipoise
OHV	=	Overhead valve

CHAPTER 1

INTRODUCTION

1.1 Overview

Petrol engines or gasoline are the type of engine that we has known. The calling for term is spark ignition engines that be refers to internal combustion engine. The petrol engines takes place during the combustion process where the process of the air fuel mixture is ignited by a spark plug. This process is has been take a flammable mixture of air and petrol when the charge is compressed. The four stroke spark-ignition (S.I.) engine was built by Nicolaus August Otto in 1876. He was a self-taught German engineer at the Gas-motoreufabrik Deutz factory near Cologne, and also experienced in many years in the largest manufacturer of internal-combustion engines in the world. It was one of Otto's associates - Gottlieb Daimler - who later developed an engine to run on petrol which was described in patent number 4315 of 1885.

Hydrogen peroxide appears colourless in a dilute solution. Despite it is a weak acid, hydrogen peroxide has strong oxidizing properties, and powerful bleaching agent. It commonly used as disinfectant, antiseptic, oxidizer and rocketry as a propellant. Characteristics of hydrogen peroxide are strong oxidizing agent and a weak acid in water. The formula is similar to water, only it is added with hydrogen peroxide.

1.2 Problem Statement

Nowadays, engine petrol has become the favourite choice by customer to be using. That people choice these petrol car as their favourite there are many a lot of benefits. It because the engine type of petrol is more efficiency to the vehicle. Besides that, these engine can also protect to our environment from damage or pollute.

However, the increase of gasoline fuel cost becomes the main talk in consumer. This comes into their thought where the price of the fuel is unreasonable to the consumer. Hence, from this issue, I want to introduce the alternative way to solve this problem. The alternative is to mix the hydrogen peroxide as the additive to the combustion engine. From this alternative way, it will save the usage of the petrol fuel as the main fuel. Besides that, the hydrogen peroxide (H_2O_2) is suitable for germicidal agent composed only of water and oxygen. From the fact, hydrogen peroxide is considered the world's safest all natural effective sanitizer.

1.3 Objective

i. To study the optimum air temperature for better performance of an engine.

ii. To study the ratio of petrol blended with hydrogen peroxide with respect to air temperature.

iii. To study the effect of air temperature on performance of petrol engine fuelled with hydrogen peroxide

1.4 Scope of Project

For the scope of project, we has using several tools during running the experiment. Firstly, it will stand by the material that using such as hydrogen peroxide as additive and gasoline. From these material it has several ratio that will be follow before starting the experiment. Secondly, the experiment will be running using engine generator. This engine generator has used single cylinder. The result that will get from this experiment is indicated power, indicated work, indicated specific fuel consumption, thermal efficiency and heat release rate. The experiment will be running in three time, where we has using the different specimen ratio for gasoline + hydrogen peroxide and different temperature for each experiment. In first experiment, the specimen that will be using during this experiment is 100% of gasoline and using temperature 40°C and 60°C. In second experiment, the specimen that will be using is 95 vol% gasoline + 5 vol% hydrogen peroxide and using temperature 40°C and 60°C. In final experiment, the specimen that will

be using is 10 vol% hydrogen peroxide + 90 vol% gasoline and using temperature 40°C and 60°C.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Nowadays, engine petrol is becoming the power source in automobile and transport system. People use this vehicle as daily usage. The gasoline type is a suitable type fuel that can use into the vehicle. Temperature in combustion engine is very important to ensure good performance of the engine. This is because, during the intake process, there is a lot of air from the outside enter combustion engine. The temperature of air is the main factor which can give the best result to engine performance. To test the performance of the petrol engine, hydrogen is blended into this petrol engine. The type of hydrogen that will be tested in this experiment is hydrogen peroxide. This hydrogen peroxide will be blended with the gasoline. From the experiment, we can observe the performance of the petrol engine during intake air temperature.

2.2 Characteristics of Hydrogen and Hydrogen Peroxide

2.2.1 Hydrogen

Characteristic of hydrogen such as wide temperature and pressure ranges. Besides that, it has high flame propagation rates within the engine cylinder in comparison to other fuels. Hydrogen can have a high effective octane number mainly because of its high burning rates and its slow pre-ignition reactivity. Hydrogen engine operation can be associated with less heat loss than with other fuels.

The reaction rates of hydrogen are sensitive to the presence of a wide range of catalysts. This feature helps to improve its combustion and the treatment of its exhaust

emissions. Hydrogen high burning rates make the hydrogen fuel engine performance less sensitive to changes to the shape of the combustion chamber, level of turbulence and the intake charge swirling effect. Internal combustion engines can burn hydrogen in a wider range of fuel-air mixtures than with gasoline. Hydrogen with wider flammability limits and higher flame speed make it more efficient in stop and start driving.

The concept of using hydrogen as an alternative fuel for CI engine has gained a lot of attraction recently. Hydrogen has many advantages over conventional fuels for internal combustion engine. It is a very clean energy source, its amount is practically unlimited, and it is considered as a high octane numbered fuel. Therefore it is very easy to implement hydrogen into the conventional spark ignition engine with a relatively higher compression ratio (White, Steeper, & Lutz, 2006).

2.2.2 Hydrogen Peroxide

Hydrogen peroxide is a liquid that can be mixed with the gasoline. One of its characteristics is it colourless appearance in dilute solution. It is a weak acid along with strong oxidizing properties, and powerful bleaching agent. Other than that, Hydrogen peroxide comes as a pale blue liquid, slightly more viscous than water, which appears colourless in dilute solution. It is a weak acid along with strong oxidizing properties, and powerful bleaching agent. It commonly used as disinfectant, antiseptic, oxidizer and rocketry as a propellant. species (Khan, Ahmed, Mutalib, & Bustum, 2013). Next, it also has strong oxidizing agent and a weak acid in water. The formula is similar to the water, with has added extra of hydrogen peroxide (Nagaprasad K. S., 2012).

Additionally, hydrogen peroxide is viable, alternative energy storage medium, competing with hydrogen gas, biogas, biodiesel and alcohol. Hydrogen peroxide can be used as energy dense fuel that burns the hydrogen, but requires no oxidizer as it is included inside the fuel. It will decompose with a release of tremendous energy, close to the energy per mole of hydrogen.

There are some advantages of hydrogen peroxide which as listed below:

i. Stable storage.

ii. Relatively easy to produce.

iii. High energy output.

iv. Only emits water vapour and oxygen.

Table 2.1: Properties of Hydrogen Peroxide

Appearance	Colourless liquid
Density	1110 kg/m^3
Boiling point	226℃
Freezing point	-27℃
Viscosity	1.81 cp
Specific gravity	1.11 kg/m^3

The viscosity of hydrogen peroxide is lower and after blended with the fuel, the density will be increased. It has been mentioned from study, the density of the fuel blended increase slightly with hydrogen peroxide composition due to the lower viscosity value of the hydrogen peroxide. Density is the main factor of the fuel property; it has given the effect to the engine performance characteristics. If the density of hydrogen peroxide is higher it will also increase the density of the fuel blends (Khan et al., 2013).

The pH value of hydrogen peroxide is much lower; subsequently the addition of hydrogen peroxide improved the acidic nature of the fuel blended. From study the pH of the diesel fuel blend demonstrates larger effect where it decrease linearly as the amount of hydrogen peroxide is increased in the fuel blend respectively(Khan et al., 2013).

2.3 The Performance of Hydrogen Peroxide in an Engine

From previous studies, experiments had been carried out and the results obtained shown that the performance of hydrogen peroxide gave impact to the engine. The impact of using a small amount of hydrogen peroxide mixture as an additive on the performance of a four cylinder diesel engine was evaluated. The required amount of the mixture was generated using electrolysis of water considering on board production of hydrogen peroxide mixture. Hydrogen has nine times higher flame speed than diesel has the ability to enhance overall combustion generating higher peak pressure closer to TDC resulting in more work (Bari & Mohammad Esmaeil, 2010).

The principle of hydrogen peroxide is similar to that of nitrous oxide system. Both promote power by increasing the oxygen content in per unit mass of gas. The hydrogen peroxide enhancement takes hydrogen peroxide as its working medium, the heat produced both in the decomposing process of hydrogen peroxide and combustion of fuel and oxygen which is emitted in the decomposing process will improve the energy of gas, and therefore the power of engine will boost in a minute. The hydrogen peroxide enhancement apparatus can increase oxygen content of unit air inflow by jetting hydrogen peroxide into the cylinder, so the output power of engine can be improved while the displacement and weight is still remain constant.

There is some effect to promote the auto ignition in the engine. Hydrogen peroxide has significant effect on promoting the auto ignition of hydrogen. The thermal decomposition reaction of hydrogen peroxide is the most important reaction for the production of hydroxide radicals which promotes hydrogen auto-ignition (Jeon & Bae, 2013).

2.4 Hydrogen Peroxide as Alternative Fuel

Hydrogen Peroxide can be an alternative fuel source. However high costs and the dangers surrounding its transport and production has discouraged any attempts of using it other than in rocket engines. New developments in the production of hydrogen peroxide that are safer and use less energy could change the equation. During hydrogen peroxide is used as a fuel, energy is released in the form of heat during the rapid decomposition of H_2O_2 to H_2O, creating steam and oxygen. In the case of high H_2O_2 concentration, much of the energy takes the form of enormous thrust propulsion as demonstrated by the jet car and rockets. Ho Teng et al. conducted experiments on using dimethyl ether as an alternative fuel for C.I. Engine and claimed that dimethyl ether spray pattern in the engine cylinder will affect the mixing and combustion process in engine cylinder, and also influence emission from combustion engine.(Nagaprasad K. S., 2012).

Hydrogen peroxide is generally considered to be an effective combustion promoter for different fuels. Hydrogen peroxide is used for two different conditions, first as the oxidizer substituent by partial replacement of air and second as an oxidizer supplier by using different concentration of H_2O_2. However, addition of hydrogen peroxide increases CH4 consumption rate and CO production rate, but it reduces production of CO_2.

Hydrogen peroxide under normal temperature is in liquid state making it easy to handle. After chemical dissociation, hydrogen peroxide produces only oxygen and its exothermicity is equal to 2884.6 kJ/kg without toxic products. To improve the combustion process, mixture of methane as auto ignition in air with 5% until 10% of hydrogen peroxide. Besides that, by replacing the air temperature with hydrogen peroxide, it is also an effective measure to burn the velocity. In combustion engine, flame with 20% of air which replaced by hydrogen peroxide has higher adiabatic flame temperature due to the reduction of nitrogen dilution and heat release from thermal decomposition of hydrogen peroxide(Chen, Li, Cheng, Hsu, & Chao, 2011).

Based on studies by scientist, a two-stroke engine can operate on ethanol water stabilized hydrogen peroxide blend, however with not more than 10 % water and 10 % hydrogen peroxide in ethanol. The presence of hydrogen peroxide significantly increases the temperature in combustion. Furthermore, this approach would require different materials resistant to hydrogen peroxide for carburettor membranes since the existing materials are dramatically weakened by the presence of hydrogen peroxide (Ć & Oros, 2012).

Hydrogen peroxide as an oxidant can substantially increase the theoretical voltage of fuel cells and improve the cell performance. The fuel cell that has using the hydrogen peroxide can operate with the absence of oxygen environment such as outer space and underwater conditions. During using electron transfer, hydrogen peroxide offers the low activation loss of the reduction reaction. Moreover, it can avoid the flooding problem during intrinsically liquid phase. As an alternative oxidizer, hydrogen peroxide has recently received ever-increasing attention, primarily because of its several unique characteristics as opposed to the gaseous oxygen.(Zhang, Ji, & Wang, 2014)

2.4.1 Revolution of Hydrogen Peroxide and Water

Hydrogen Peroxide will be an alternative fuel source in vehicle. However, due to high cost and potential dangers surrounding its transport and production has discouraged any attempts of using it other than in rocket engines. New developments in the production of hydrogen peroxide that are safer and use less energy could change the equation.

From the results of scientist, they changed the word of decomposition but they said the fuel is burned. This is mainly because when hydrogen peroxide is used as a fuel,

energy is released in the form of heat during the rapid decomposition of hydrogen peroxide to water. In that situation, hydrogen peroxide changed to water, which then creates steam and oxygen. In case of high concentration hydrogen peroxide, most of the energy takes in the form of enormous thrust propulsion as demonstrated by the jet car and rockets.

During the process of hydrogen peroxide decomposes into pure water, there is a change in molecule structure. The H_2O_2 molecule changes into H_2O+ 1 free O (water + 1 free oxygen atom) creating a lot of heat in the process. During World War II, hydrogen peroxide was used as fuel for underwater torpedoes. The reason is because of its ability to burn without presence of air. During the launching process, there was a trail of air bubble that can be seen behind hydrogen peroxide. It was evidence during the decomposition of hydrogen peroxide into water, free oxygen was released.

H_2O_2 decomposition releases pure oxygen as a product. Scientists found that the pure oxygen as a product could be used for burning carbon. In process of H_2O_2 decomposition, the heat causes the carbon and free oxygen making it to ignite and burn. In this way, the heat energy of the H_2O_2 fuel can be increased significantly.

2.5 Important of Air Temperature in SI Engine and CI Engine.

In internal combustion engine, there is normal combustion process occurs in three stages which are initiation of combustion, flame propagation, and termination of combustion. In addition, there are a few flows or steps of combustion; firstly, the initial of combustion normally starts across the spark plug gap when the spark is discharged. The fuel molecules in and around the spark discharge zone are ignited and a small amount of energy is released. The important criterion for the initial reaction to be self-sustaining is that the rate of heat release from the initial combustion be larger than the rate of heat transfer to the surroundings. The factors that play an important role in making the initial reaction self-sustaining, and thereby establishing a flame kernel, are the ignition energy level, the spark plug gap, the fuel air ratio, the initial turbulence, and the condition of the spark plug electrodes. After a flame kernel is established, a thin spherical flame front advances from the spark plug region progressively into the unburned mixture zone.

Secondly, flame propagation is supported and accelerated by two processes. The combined effect of the heat transfer from the high-temperature flame region and the bombardment by the active radicals from the flame front into the adjacent unburned zone

raises the temperature. Then, it accelerates the rate of reactivity of the unburned mixture region directly adjacent to the flame front. This helps to condition and prepare this zone for combustion. The increase in the temperature and pressure of the burned gases behind the flame front will cause it to expand and progressively create thermal compression of the remaining unburned mixture ahead of the flame front. It is expected that the flame speed will be low at the start of combustion, reach a maximum at about half the flame travel, and decrease near the end of combustion. Overall, the flame speed is strongly influenced by the degree of turbulence in the combustion chamber, the shape of the combustion chamber, the mixture strength, the type of fuel, and the engine speed.

Thirdly, when the flame front approaches the walls of the combustion chamber, the high rate of heat transfer to the walls slows down the flame propagation and finally the combustion process terminates close to the walls because of surface quenching. This leaves a thin layer of unburned fuel close to the combustion chamber walls which shows up in the exhaust as unburned hydrocarbons (Saraswat, Gadi, Gandhi, Arora, & Bansal, 2015). Air flow rate decreased and fuel flow rate increased with an increase of inlet air temperature, which reduced the air-fuel ratio of the engine. With the increase of the air temperature, the engine efficiency will be decreased and the exhaust gas temperature will be increased. Besides that, the fuel consumption of fuel also increase by the increase of air temperature (Alam, Song, & Boehman, 2005). The increase of inlet temperature led to the reductions of in-cylinder trap mass. Therefore, the capacity of oxygen and heat capacity of air charge was significantly reduced. This has resulted in an increase of brake specific fuel consumption at low load but slightly lowered the brake specific fuel consumption at part load when the charge air temperature is increased (Mamat, Abdullah, Xu, Wyszynski, & Tsolakis, 2010).

2.6 Improvement of Hydrogen Peroxide in Internal Combustion Engine

Every internal combustion engine has wanted to improve the performance of the engine. There is a piston that creates a mechanical energy and transfer to internal energy by expansion stroke in the cylinder. Some of the internal combustion engine is fixed on their displacement and thermal efficiency. So the alternative way to improve the power is by increasing the amount of air inlet and internal energy of the gas. Such examples are turbocharging and applying nitrous oxide system.