FEASIBILITY STUDY OF HHO CELL FOR 150CC MOTORCYCLE SI ENGINE

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A report submitted
in fulfillment of the requirements for the degree of
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DECLARATION

I declare that this project report entitled "Feasibility Study of HHO Cell for 150cc Motorcycle SI Engine" is the result of my own research except as cited in the references.

Signature: ....

Name: MOHD SHAHMIRZZY BIN KELVIN SEMBAI

Date: ....

SUPERVISOR DECLARATION

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 in Bachelor of Mechanical Engineering with Honours

Signature: …………………………….................................

Supervisor: PROF. TS. DR. NOREFFENDY BIN TAMALDIN

Date: ………………………………………………………

DEDICATION

In the name of Allah, the Most Gracious and the Most Merciful

I dedicate this work to:

My parents,

Kelvin Sembai Abdullah and Shafiah Binti Mohd Hatim

My siblings,

Supervisor who always give support and encouragement,

Professor Ts. Dr. Noreffendy Bin Tamaldin

ABSTRACT

Internal combustion engine (ICE) is an old technology and has a long history of evolution. The need for another power source in order to maintain its sustainability for the future is being much highlighted in today’s scientific community. Amongst the different alternative fuels, HHO gas is found to be the most viable solution in regards of its generation and storage as it is considered renewable, recyclable, and non-polluting fuel. The use of HHO gas in gasoline engines is relatively new. Any improper addition or modification to the engine may cause performance deterioration instead of enhancement. In this study, various HHO plates with different surface roughness are fabricated for HHO gas production analysis to match the specified engine. Further test will be done by tuning the input voltage supply and weight of catalyst used. The optimum flowrate of HHO gas will then be commissioned into the air intake manifold of the engine for the analysis of performance and emission. The various surface roughness of the plates are obtained by grinding and polishing the surface to mirror-like surface and categorised to non-polished, one-sided polished, and fully polished. The surface roughness of the plates are inspected with metallographic microscope and measured with a roughness tester. The analysis of HHO gas production with the three types of plates are done with a flow meter while the specified engine is set up with a dynamometer for analysis of performance and emission. The manipulated variables are the voltage input and weight of catalyst used to find the optimum setting for the specified engine. By commissioning the HHO gas into the air intake manifold, the analysis of performance and emission are done to evaluate its effectiveness. In the findings, the rougher surface of the plates produced the most HHO gas under the same condition. The performance of the engine only improved by a small margin but the emission improved vastly with the addition of HHO gas.

ABSTRAK

Enjin pembakaran dalaman (ICE) adalah teknologi lama dan mempunyai sejarah evolusi yang panjang. Topik untuk sumber kuasa yang lain untuk mengekalkan kelestariannya demi masa depan semakin hangat dalam komuniti saintifik hari ini. Di antara pelbagai bahan bakar alternatif, gas HHO didapati penyelesaian yang paling berdaya maju dalam hal penjanaan dan simpanannya kerana ia dianggap sebagai bahan bakar yang boleh diperbaharui, kitar semula, dan tidak mencemarkan. Penggunaan gas HHO dalam enjin petrol agak baru. Sebarang penambahan atau pengubahsuaian yang tidak betul kepada enjin boleh menyebabkan kemerosotan prestasi dan bukan peningkatan. Dalam kajian ini, pelbagai plat HHO dengan kekasaran permukaan yang berbeza direka untuk analisis pengeluaran gas HHO untuk menyesuaikan dengan enjin yang ditentukan. Ujian selanjutnya akan dilakukan dengan mempelbagai bekalan voltan dan berat katalis yang digunakan. Kadar aliran gas HHO yang optimum kemudiannya akan dimasukkan ke manifold pengambilan udara enjin untuk analisis prestasi dan pelepasan. Pelbagai kekasaran permukaan plat diperolehi dengan mengisar dan menggilap permukaan sehingga merupai permukaan seperti cermin dan dikategorikan kepada tidak digilap, satu sisi yang digilap, dan digilap sepenuhnya. Kekasaran permukaan plat diperiksa dengan mikroskop metalografi dan diuji dengan penguji kekasaran. Analisis pengeluaran gas HHO dengan tiga jenis plat dilakukan dengan meter aliran manakala enjin yang ditetapkan didirikan dengan dinamometer untuk analisis prestasi dan pelepasan. Pembolehubah dimanipulasi adalah input voltan dan berat pemangkin yang digunakan untuk mencari tetapan optimum untuk enjin yang ditentukan. Dengan memasukkkan gas HHO ke dalam manifold masuk udara, analisis prestasi dan pelepasan dilakukan untuk menilai keberkesanannya. Dalam penemuan, permukaan yang lebih keras plat menghasilkan gas HHO yang paling dalam keadaan yang sama. Prestasi enjin hanya meningkat dengan margin yang kecil tetapi pelepasan bertambah dengan penambahan gas HHO.

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All praises and thanks to Allah (S.W.T), who has guided us to this, never could we have found guidance, were it not that Allah had guided us. (Q7:43).

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LIST OF ABBREVIATIONS

KOH	Potassium Hydroxide
H_2O	Water
TCI	Transistor Controlled Ignition
SOHC	Single Overhead Camshaft
IC	Internal Combustion
H_2	Hydrogen gas
CO_2	Carbon Dioxide
HC	Hydrocarbon
CO	Carbon Monoxide
HHO	Oxyhydrogen
DC	Direct Current
SI	Spark ignition
PVC	Polyvinyl Chloride
HDPE	High Density Polyethylene
NaOH	Sodium Hydroxide
NaCl	Sodium Chloride
TDC	Top Dead Centre

LIST OF SYMBOLS

V	=	Voltage
I	=	Ampere
R	=	Ohm
cc	=	Cubic centimeter
Nm	=	Newton meter
Ah	=	Ampere hour
kW	=	Kilowatt
hp	=	Horsepower
A	=	Ampere
ppm	=	Parts per million

CHAPTER 1

INTRODUCTION

1.1 Background

One of the major problems the scientific community facing today is global warming. With many theories suggested that the increase of exhaust gases concentration in the atmosphere as one of the major contributors of the global warming (Ishida et. al., 2003). Besides, the ever increasing use of the conventional fossil fuels in the transportation sector and the associated environmental impacts have become the major concern worldwide. The world energy consumption in the transportation sector, in particular, increases by an average of 1.1 percent per year (EIA, 2013). The exhaust pollutants from the internal combustion (IC) engines also contributes greatly to the total environmental pollution worldwide. Combining all the issues of the fluctuation of fossil fuels' price, an increase in the concerns environmental issues and energy security, plus the stricter rules and regulations on engine or vehicle emissions, this have led researchers to put more efforts and interest towards alternative fuels and advanced vehicle technologies.

Among the different alternative fuels, researchers have used biogas, syngas, producer gas either solely or with H_2 blends successfully in gasoline engines. H_2 gas is a carbonless fuel whose combustion does not generate emissions such as HC, CO and CO_2, but from the commercial point of views there are concerns in regards to the viable solutions for both the generation and storage of H_2. The use of hydroxy gas (HHO gas) in gasoline engines is relatively new. It can be considered as a renewable, recyclable and non-polluting fuel as it does not contain carbon in its molecule. Hydroxy gas is also known as HHO, Brown's gas, Water gas and Green gas. HHO gas stands for Hydrogen-Hydrogen-Oxygen gas with the mixture of H_2 and O_2 in a ratio 2:1 by volume. The HHO gas is the product of water electrolysis, which is invented since March, 1978 by Yull Brown (Yull, 1978). Hence, electrolytic gas often called as "Brown's gas" or Hydrogen Rich Gas (HRG).

Water electrolysis is a technique that utilizes a direct current (DC) to split water into protons, electrons, and gaseous oxygen at the anode (positive electrode) and hydrogen at the cathode (negative electrode) in the electrolyzer. The basic idea of electrolysis in HHO production process is to separate the hydrogen and oxygen atoms in a water molecule. The product of the process, which is the HHO gas will be mixed with air before being fed into the combustion chamber. With the addition of HHO gas, (Ammar, 2010) indicated that the effect on the reduction of fuel consumption is as the same as if hydrogen had been used.

1.2 Problem Statement

The spark ignition (SI) engine is one of the three types of combustion engines in practice; Spark ignition engine, Diesel engine and Turbine engine. In these engines, the unburned fuel remains after the burning process. The unburned fuel leads to performance losses and air pollution which is one of the biggest challenges that researchers face in the automobile industry. The HHO cell is an efficient approach to increase engine performance as well as to reduce exhaust pollutants released to the air.

In this study, the focus is to find an efficient surface roughness of HHO plate for Yamaha 150cc SI engine. As the production of HHO gas will be mixed with air before entering the combustion chamber, the flowrate of HHO gas produced entering the engine air intake has to be analysed. Moreover, the mismatch of air-fuel ratio (AFR) will result in performance deterioration. This may also lead to potential problems that includes engine knocking, increase in fuel consumption and emission. Hence, not only the engine performance will be affected, but the engine life will also be reduced. Therefore, a proper study on the analysis, evaluation, design and fabrication of an efficient HHO plate's surface roughness will be able to increase the engine performance while reducing air pollution.

1.3 Objective

The objectives of this project are as follows:

1. To fabricate various HHO plate surface roughness for HHO gas production analysis to match the specified engine.
2. To analyse the flowrate of HHO gas produced with various voltage input and weight of catalyst.
3. To evaluate the engine performance and emission from the commissioning of HHO cell with the motorcycle SI engine.

1.4 Scope of Project

The scopes of this project are:

1. Fabrication of HHO plates with various surface roughness suitable for the specified engine.
2. Testing of Yamaha 150cc motorcycle SI engine for baseline analysis.
3. Tuning of input voltage supply from DC source and weight of catalyst for efficient HHO gas flowrate and improved combustion.

1.5 General Methodology

The actions that need to be carried out to achieve the objectives in this project are listed below.

1. Literature review

   Journals, articles, or any materials regarding the project will be reviewed.

2. Analysis

   Baseline testing and analysis will be performed with the Yamaha 150cc SI engine with dyno to understand the engine requirement for HHO cell integration.

3. Fabrication

   The design rule of the HHO cell plate will be fabricated to cater for Yamaha 150cc SI engine.

4. Evaluation

   Evaluation will be made on the comparison of engine performance and emission for Yamaha 150cc SI engine and optimization of HHO cell flowrate to match engine intake requirement for perfect combustion with and without HHO cell.

5. Report writing

   A report on this study will be written at the end of the project.

CHAPTER 2

LITERATURE REVIEW

This chapter will discuss about the literature review by referring to journals, books, articles and any material related to the feasibility study of HHO cell for 150cc Motorcycle Engine to obtain the data. HHO generators had been studied by many researchers before. The topics that will be discussed in this chapter are the working principles of HHO generator, types of HHO cell, catalysts used in HHO generator, cell design include electricity supply on HHO cell, cell plate and a summary of the cells being discussed.

2.1 HHO Generator

A HHO or Brown gas generator is a device that can convert water molecules into HHO molecules. The concept of HHO generator is a relatively new technology. It is often referred to as HHO gas or Brown gas generator due to its working principle of using the concept of electrolysis to split water (H_2O) into its base molecules of 2 hydrogen and 1 oxygen molecules with suitable electrodes and catalyst-added solution to enhance the process.

It is generally made up of three essential components – electrodes, solution, and electric current (Affan, 2016). It uses the electrodes connected to an electric current to pass through a solution to decompose the solution or a molten compound (Bhardwaj et. al., 2014). Through this process, an enriched mixture of hydrogen and oxygen or Oxy-Hydrogen bonded together molecularly and magnetically will be produced in the form of HHO or Brown gas (Akash, 2014).

A HHO or Brown gas generator works when electrode plates are dipped in water mixed with electrolyte or catalyst in it (Arvind et. al., 2014). A loop of electric current is generated when the electrode plates are connected to a DC power supply that provides the electric current. This continuous loop of electric current between the power supply, electrodes and the solution will decompose or dissociate the catalyst-added solution to produce HHO or Brown gas. The electrolyte or catalyst used to mix with the solution is potassium hydroxide (KOH). It is mostly mixed with 20 - 30 wt. % of the solution because of the optimal conductivity and require to use corrosion resistant stainless steel to withstand the chemical attack (Aaditya et. al., 2015). The increase in the amount or amplitude of electric current supplied can also increase the rate of HHO gas generation (Vino, 2012).

There are getting more studies that are being conducted to research on the design of an on-board hydrogen generation system. This can be done either from the regeneration of hydrogen from the vehicle’s fuel supply or generating hydrogen from electrolysis of water (Nikhil and Deepak, 2015). The rate of HHO gas generation and the liberated volume of the gas directly depends on the concentration of electrolyte, amplitude of electric current and the area of contact between the electrodes and the solution (Kumar and Rao, 2013)

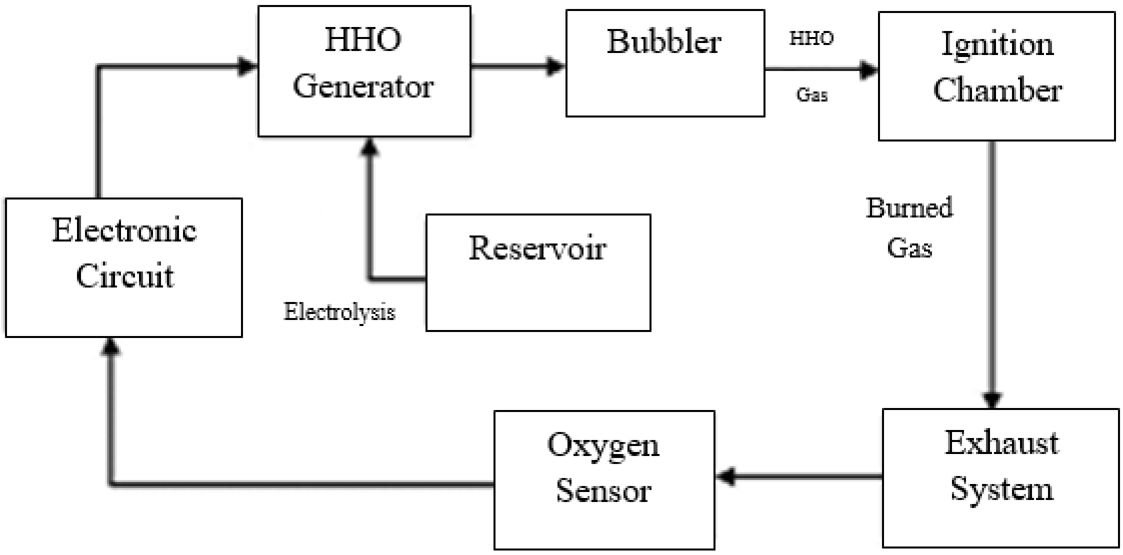


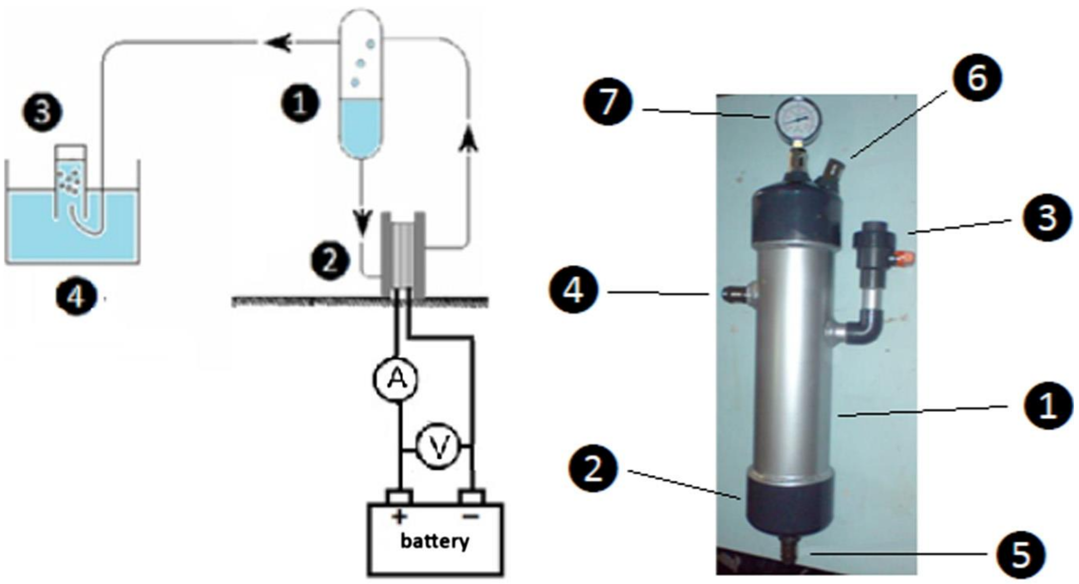
Figure 2.1: Block Schematic Diagram of HHO Generator Integration With IC Engine

2.1.1 HHO Separation Tank

After the HHO gas is produced in the HHO generator, the gas flows to the HHO separation tank. A HHO separation tank or Hydrogen Bubbler is a device that acts as a one-way valve to prevent explosive flashback or flow back of the generated HHO gas from moving back to the HHO generator. It performs this function by bubbling the HHO gas through a non-flammable liquid so that flashback from any source is arrested. From safety point of view, this device works as a vital component to prevent any unwanted events. From the separation tank, the HHO gas flows through the pipe to the air intake of the engine (Prithivirajan et. al., 2015).

The HHO separation tank is generally constructed from a PVC pipe that has a capacity of 3 litres depending on the size of the HHO generator. The HHO separation tank and its components are shown in Figure 2.1 used in the study (EL-Kassaby et.

al, 2015). It was made of 8.9 cm of PVC pipe (1) with a capacity of 2.2 L. The PVC end caps (2) were used to seal the top and bottom. To refill the tank with distilled water with dissolved catalyst, a 1.27 cm PVC ball valve (3) was used. Hoses would be connected to the water inlet (4) and HHO gas outlet from the cell. The distilled water with dissolved catalyst would be carried to the cell through outlet (5) before entering the HHO gas outlet (6) to the engine. It is also constructed with a Pressure gauge (7) with vacuum range of 0 – 1 bar and a spring loaded vacuum breaker.



(a) (b)

Figure 2.2 (a): Schematic diagram of the HHO gas generation system.

Figure 2.2 (b): HHO separation tank components.