Effect Of HHO On Emissions And Efficiency In Two Stroke Engine 150 Cc

[1]J. W. Paletekan, [1*]Suwandi, [1]Tri Ayodha Ajiwiguna, Eddy Ariffin

[1] *School of Electrical Engineering, Telkom University, Bandung, 40287, Indonesia*
[2]Department of Engineering Physics, Faculty of Engineering and Science, National University, Indonesia
[*]*suwandi.sains@gmail.com*

Abstract

Emission generated by motor vehicles is one of the environmental pollution and it can interfere with the health, especially on the 2-stroke engine in which the emissions are greater than the 4-stroke engine. In this study, HHO, generated by electrolysis process in a reactor, was injected into 2-stroke engine. A test method called "idle" was performed using SNI 19-7118.3-2005 standard so that the emissions generated on the 2-stroke engine was reduced. HHO was added by forwarding the gas through the hose on bubbler and entering the air hose filter in the carburator. The reactors were conditioned to produce 400 ml electrolysis and a catalyst such as KOH with different concentrations. It affected the rate of HHO flow. Prior to the addition of HHO, levels of HC was 6453 ppm at 6000 rpm and it decreased by 31.66% when the HHO was added. This decrease also occurred in CO, where the levels of CO fell from 2. 56% to 1.75 %. On the other hand CO_2 levels increased from 2.23 % to 4.22 % with the HHO addition. In this study, it was found that the best HHO rate was147 mLpm. Besides, at 6000 rpm, the engine efficiency increases 5.1 % when 147 mLpm HHO was added.

Keywords: *emissions of vehicles; electrolysis; HHO; efficiency*

1. Introduction

Today many people use motor vehicles in support of daily activities. This cause the high rate of population growth, which increased the amount of activity in the transport as a means of subsistence. Use of motor vehicles classified as effective and cheap. . However, motor vehicle can createnegative impact on health and the environments because of the emitted pollutants (contaminants), such as carbon monoxide (CO), nitrogen oxides (NO_x), hydrocarbons (HC), sulfur dioxide (SO_2), lead (Pb) and carbon dioxide (CO_2). One of the most pollutants released by motor vehicles is carbon monoxide (CO) [4].

This study was done to investigate the role of HHO in reducing the emissions produced by a 2-step engine 150 cc. The HHO produced via water electrolysis process. The addition of HHO in the engine 125 cc four strokes can reduce 40 % of CO levels and 38 % of HC levels. Later, HHO produced from the electrolysis process will be connected by a hose leading to the intake manifold so that fuel will be mixed before entering the combustion chamber. After that the resulting emission levels will be tested by the change between 1500 rpm (idle) until 9000, and the

results obtained will be compared with emission levels without the addition of HHO.

2. Theory

2.1 Two Stroke Engine

The inner workings of the 2-stroke engine is when the piston moves from the bottom dead center (BDC) to top dead center (TDC), the movement of the piston is running the steps of suction and compression stroke, in which when the piston rises suction valve opens so that the incoming air mixing, fuels and lubricants. After mixing it comes in, the piston will compress the gas trapped in the combustion chamber. Before reaching the TDC, the spark plug lits to burn the gas into the combustion chamber. When the piston moves from TDC to BDC, the piston will run the pace of expansion and exhaust step, in which the piston will press the space so that the pressure increases. As it passes through the drain hole, the gas from the combustion chamber is out. The piston continues to press until the bottom dead center (BDC).

Fuel combustion within the engine can take place in a complete or incomplete. Combustion is said to be perfect if it produces carbon monoxide and water vapor. All elements of C contained within the fuel react with oxygen, and gases are not completely into CO_2. While the complete combustion occurs when hydrocarbons produce CO_2 and H_2O as well as the mixture of fuel and oxygen (from the air) has an appropriate comparison. It could theoretically calculate the amount of oxygen needed in order to achieve complete combustion. However, in practice, combustion is never ideal. Excess air must be supplied in order to complete combustion can be achieved. If air is supplied too much, then this can reduce the heat of combustion. With change the level of air, the mixing ratio between fuel and O_2 certainly will change. Change of excess air is known through measurement using O_2 analyzer.

2.1 Hydrogen Gas Reactor

Our reactor design is presented in Fig. 1. Reactor was built from materials such as acrylic, nuts and bolts, HDPE and rubber, stainless steel plate, ring and glue. Besides, it also consists of an electrolyte, electrode, and hose connected to HHO electrolysis process camber. In addition, air passes through air filter and is mixed with the HHO before getting into the carburetor. The reactor was made to test whether HHO was flowing through the hose to set fire to HHO output.

The hydrogen gas is produced from the electrolysis process. Positive ions are contained in the cathode will absorb electrons, and ions produce H_2 molecules and negative ions will move toward the anode to release electrons and ions to produce a molecule O_2. Brown conducted the research with pure water electrolysis to generate gas called HHO and patented under the name of Brown's Gas [2].

steel selected for rustproof and has a stable oxide layer. The element chromium contained within the type of steel is at least 10.5%, which is protective of the effects of environmental conditions [3]. Source voltage is required in this study comes from motorcycle batteries, which amounted to 12.43 volts.

2.2 Efficiency

Thermal efficiency is obtained by first knowing the value of torque generated by the engine and the mass flow rate of fuel. The torque value is known with dynotest test on the machine, while the mass flow rate determined by testing using a stopwatch. The equations used to calculate the efficiency are as expressed in Eq. (1-3):

$$P_e = \frac{\tau \times n \times 2\pi}{60} \tag{1}$$

$$v_f = \frac{sg_f \times V_f}{t_f} \times 3600 \tag{2}$$

$$\eta_{th} = \frac{P_e}{v_f \, Q_c} \tag{3}$$

where P_e, τ, n, v_f, sg_f, V_f, t_f, η_{th}, and Q_c are torque (Nm), spin machine (rpm), mass flow rate of fuel (kg/h), shaft power (W), specific gravity of fuel (0,739 gr/ml), the volume of fuel (ml), time spent of fuel (s), thermal efficiency, and calorific value of fuel (9766,4 kcal/kg), respectively.
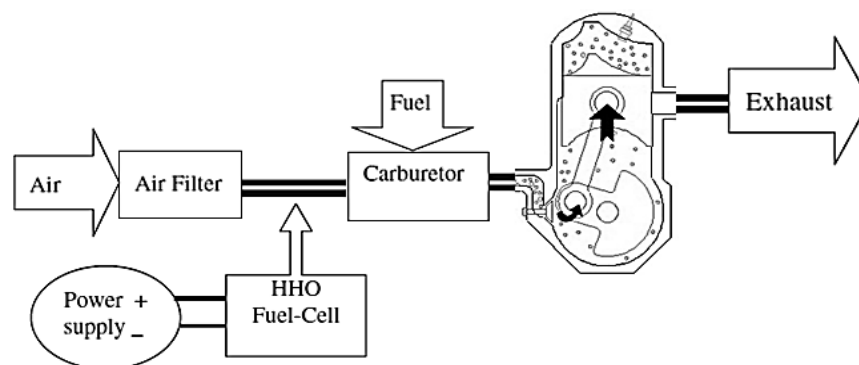
Preparation of this reactor using acrylic and HDPE as the container dimension's 14x6x14 cm and electrode used stainless steel by type 316L. Stainless

Fig. 1. Schematic design of the reactor

3. Methodology

The experimental flowchart is shown in Fig. 2. Initially, the HHO reactor was built followed by the HHO presence testing. The electrolysis cells were installed to produce hydrogen. Finally, emission testing was conducted to determine the effect of HHO to the machine efficiency.
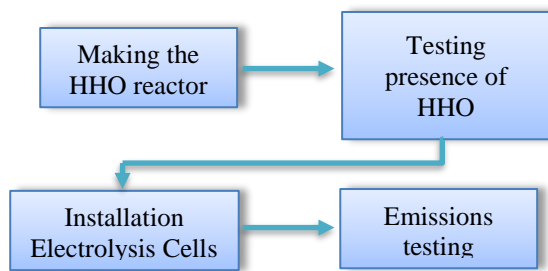
Fig 2. Research Flowchart

4. Results and Analysis

4.1 Reactor Testing

The reactor was tested by providing different concentrations of electrolytes and catalysts to determine the number of produced HHO. Fig. 3 describes the production of HHO as a function of KOH mass. KOH was chosen as the catalyst due to its solubility in water and its highly hygroscopic property which absorbs water easily. It is also thermally very stable. KOH concentration is varied from 2 grams to 22 grams per 400 ml of distilled water. A 12.43 volt is applied to the reactor.

Fig. 3 shows that the production rate of HHO per minute increases with the addition of KOH concentration. A saturation of HHO production occurs at 20-gram KOH. It can be influenced by the surface area of the electrode which limits the production of HHO.
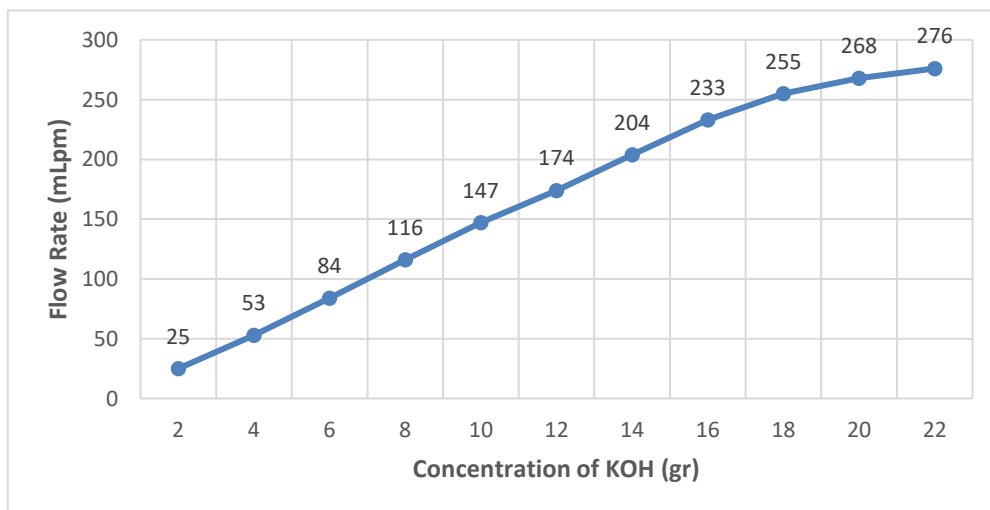
4.2 Emission Testing

Emission's testing was conducted to measure the concentration of HC, CO, CO_2. The test method was called the "idle" by using SNI 19-7118.3-2005 standard. In this test , the HHO flow rate was 53, 116, 147, 174, 204, and 233 mLpm. Data were collected on a machine with KR150KEP39931 numbers at the Motor Vehicle Testing Center Bandung.

Figure 4 shows that HHO flow rate affects the levels of emitted HC. At idle, the engine without the granting of HC HHO showed levels of 5556 ppm, while a rate of 233 mLpm HHO showed levels of 4638 ppm HC, which showed a decrease of 16.523%. The higher the rpm is given, the greater the level of emitted HC.

Figure 5 shows that the decreasing levels of CO was produced by the addition of HHO in the combustion chamber. However, the carbon monoxide levels also increased when the machine rotation was increased. This is due to the addition of fuel and air mixture which increased rev the engine to increase the power, so that complete combustion is not achieved [1]. The biggest change occurred when the HHO flow rate was 147 mLpm. Compared to the machine without the HHO addition, Co decreases from 2.05% to 0.05% at idle.

Figure 6 shows that the average percentage of CO_2 is only 3.88% without the addition of HHO. This value increased when HHO was added. The highest percentage of 4.5 % occurred in the idle condition with 174 mLpm HHO flow rate. This slightly increase of CO_2 level at idle might due to the wet mixture of air and fuel so that combustion occurs was not perfect. A perfect combustion is marked by numerous levels of CO_2 and at least the levels of CO released. Thus, on the condition of 7000 rpm can be said arson was almost perfect.

Fig 3. Production Rate of HHO

Paletekan   et al. / Journal of Measurement, Electronics and Communication Systems
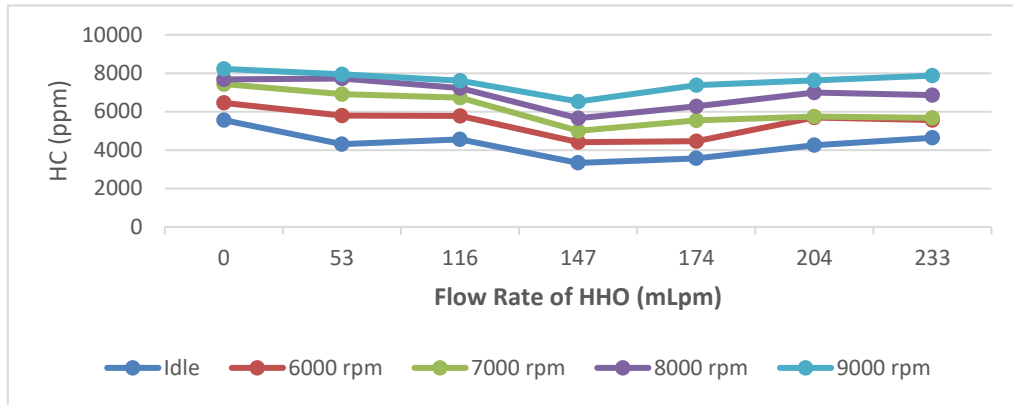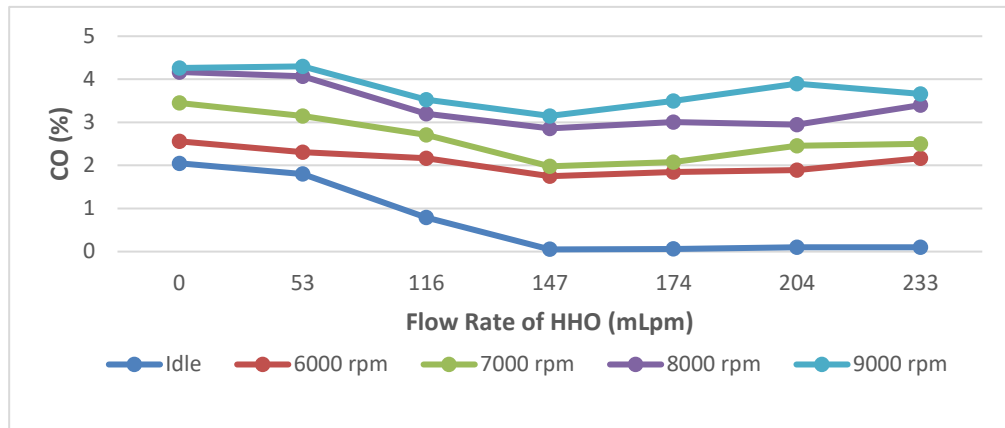

Fig 4. Hydrocarbons Generation
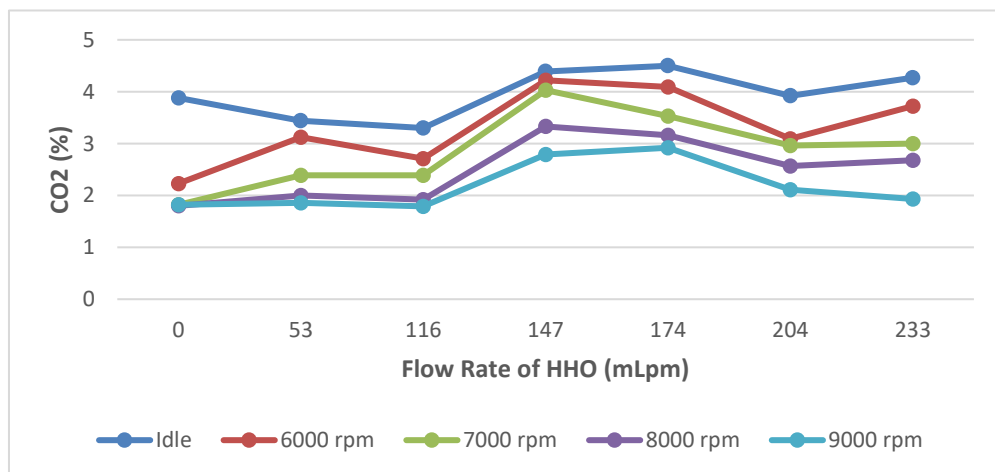

Fig 5. Carbon Monoxide Generated
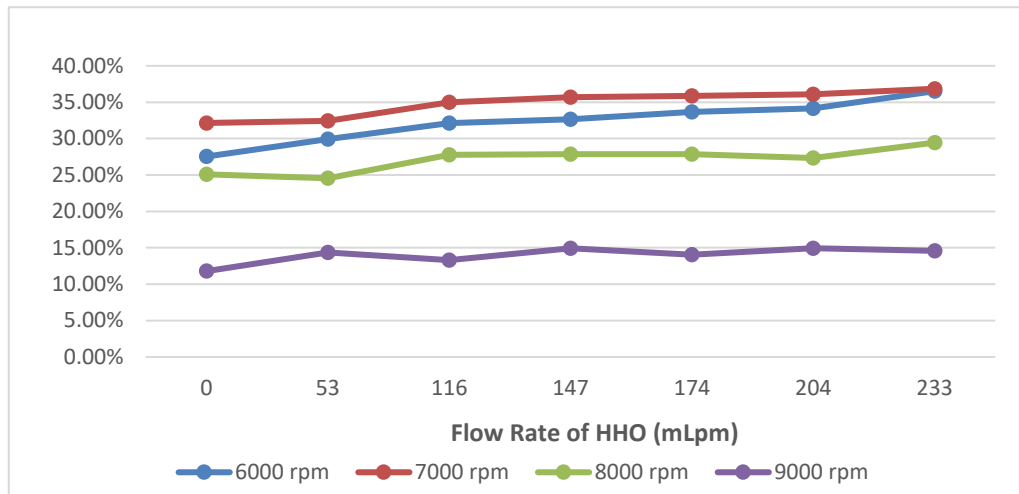

Fig 6. Carbon Dioxide Generated
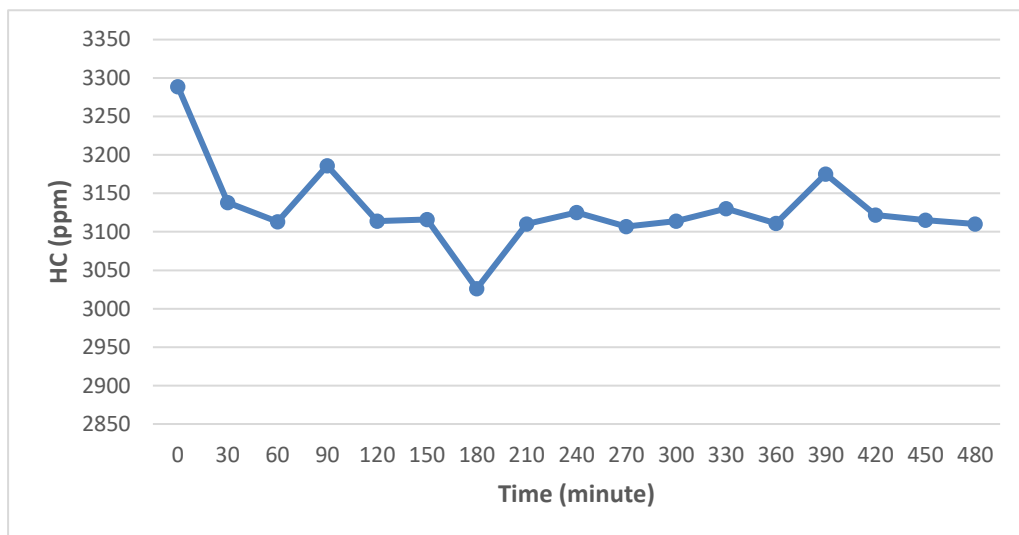
Fig 7. The efficiency with addition of HHO

Fig 8. Reactor Ability to Change the Levels of HC

Efficiency is obtained by first dynotest of a machine [Ref]. It aims to get the value of torque at a specific rpm were then calculated to gain efficiency. With the torque value, the value for the efficiency can be calculated, and the results can be seen on Fig. 7

The graph in Figure 7 shows that the greatest efficiency occurs at 7000 rpm condition. When HHO was added the efficiency was increased. Efficiency is obtained by the torque value which indicates that the maximum torque occurs between 6000 rpm to 7000 rpm. After that rpm conditions, the efficiency was decreased. In addition, fuel consumption also affects the efficiency due to torque influence. Faster fuel consumption diminished the efficiency of the engine.

4.3 Reactor Ability

Reactors made with additional catalyst must have the ability in which a current rate of granting catalyst HHO will decline or may be said not remain in optimal conditions. Here is a graph of the ability of the reactor to determine the levels of HC generated.

Figure 8 shows that the amount of HC during eight hours measurement when the motor was at idle condition. The motor used 10 grams of KOH which is equal to 147 mLpm HHO production rate. In the initial state, hydrocarbons generated at 3289 ppm. However, after 30 minutes, the resulting hydrocarbon content decreased to 3138 ppm. After eight hours elapsed, HC levels was remained stable. However, the HC production tended to decrease after 390 minutes indicating the ability of the reactor to produce 147 mLpm HHO only sustained up to 390 minutes.

5 Conclusion

We conclude that the addition of HHO reduce levels of HC down to 3331 ppm at idle condition. This value increases with the increasing of engine rotation. , Besides, the level of CO also decreases down to 0.05% at idle condition. This CO level also increases with the

increasing of engine rotation. On the other hand, the CO_2 level increases up to 4.5 % at idle and decreases with the increasing of engine rotation.

The engine efficiency increases up to 8.98% with the increasing of HHO rate. This increase was influenced by the torque generated at a specific rpm in accordance with the HHO flow rate and time needed to consume fuel. The reactor is built to maintain an optimal HHO production rate up to 390 minutes (6.5 hours). In this study, the most optimal HHO rate was 147 mLpm.

6 Bibliography

[1] Bosch, G. R. 1999. *Emission Control for Gasoline Engines Edisi 3*. Stuttgart.

[2] Chang, R. 2005. *Kimia Dasar Jilid 2*. Jakarta: Erlangga.

[3] Outokumpu. 2013. *Handbook of Stainless Steel*. Espoo: Outokumpu Oyj.

[4] Sengkey, L. S., Jansen, F., dan Wallah, S. 2011. Tingkat Pencemaran Udara CO Akibat Lalu Lintas dengan Model Prediksi Polusi Udara Skala Mikro. *Jurnal Ilmiah Media Engineering*. **1:2** 119-126.

7 Author Information

a. Junior Wanto Peletekan

Junior was born in Jember, Indonesia on June 24th, 1994. Junior studied at Engineering Physics, University of Telkom and graduated in 2017.

b. Suwandi

Suwandi is a senior lecturer in Engineering Physics, Telkom University. The field involved is renewable energy

c. Tri Ayodha Ajiwiguna

Lecturer at Telkom University. Tri Ayodha Ajiwiguna is one of the lecturers who has expertise in the field of energy systems.

d. Eddy Ariffin

Eddy Arifin is a senior lecturer in the department of Engineering Physics, Faculty of Engineering and Science, National University, Indonesia. Eddy Arifin is one of the lecturers who has expertise in the field of renewable energy.