AN EFFECTIVE & EFFICIENT APPROACH TO INCREASE FUEL EFFICIENCY IN SPARK IGNITION ENGINES

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AN EFFECTIVE & EFFICIENT APPROACH TO INCREASE FUEL EFFICIENCY IN SPARK IGNITION ENGINES

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ABSTRACT

This paper is about an extensive approach to redesign Hydroxy gas generator which is also known as Hydrogen-Hydrogen-Oxygen (HHO) gas generator, that produces Hydroxy gas. This Hydroxy gas can be used to increase the fuel efficiency in spark ignition engines, which are widely used in automobile industry. In a spark ignition engine, high pressure products of combustion expand through a piston in order to generate power. Here the fuel burning process seems to be very primitive. Hence, unburned fuel remains after the burning process. This causes the air pollution which is one of the biggest challenges that researches face in the automobile industry. HHO generator is an approach to increase the fuel efficiency in a combustion engine by reducing the amount of unburned fuel. The proposed approach is based on an ordinary HHO generator. Although people use HHO generators in practice a very little research has been carried out in implementing an efficient system. In this research we mainly focused on finding an efficient way to redesign the configuration of an ordinary HHO generator that is efficient than an ordinary system. Here the generator was tested under several conditions in order to determine a convenient design for an efficient HHO generator. An efficient/optimal system is supposed to produce a large volume of Hydroxy gas using a very little power. Therefore, such a system will be able to increase the power of a spark ignition system while reducing the air pollution.

Keywords: HHO, Hydroxy Generation, Spark Ignition System, Electrolysis

INTRODUCTION

The primary object of any engine is to convert the chemical energy stored in fuel into mechanical force and motion. The spark ignition engines which used in automobiles usually ignite the compressed air fuel mixture in order to generate work. A typical spark ignition engine has four strokes in one operating cycle. One operating cycle of a spark ignition engine is shown in Figure 1. Initially, fuel and air are mixed inside the carburetor and vaporize the mixture before feeding into the combustion engine. The energy produced by the ignition process is used to move the crank shaft in order to turn the wheels of a vehicle (JB, 1988).

$$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O \qquad (1)$$

$$2C_8H_{18} + 17O_2 \rightarrow 16CO + 18H_2O \qquad (2)$$

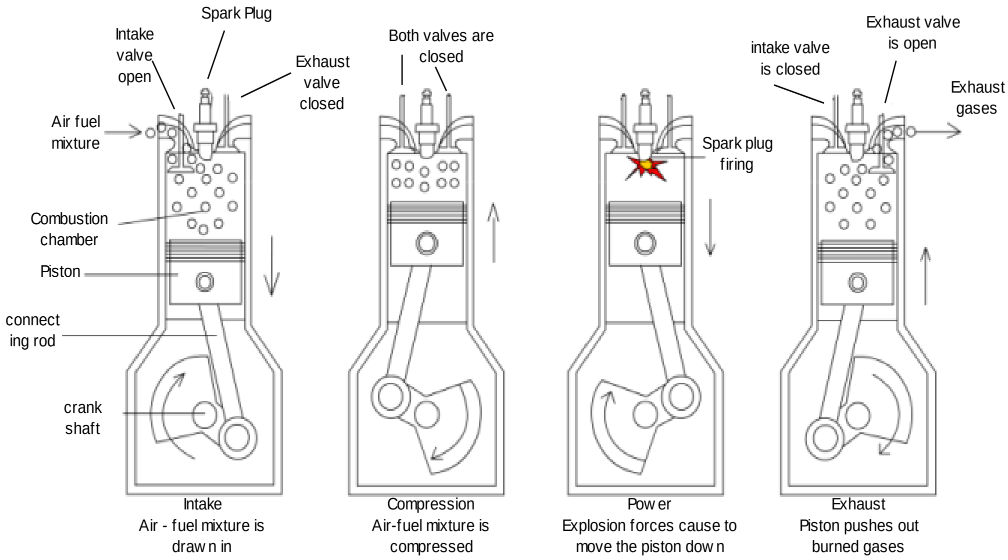

Figure 1 - One operating cycle of an automobile engine

Equation (1) shows the stoichiometric reaction for the combustion of Gasoline engine. In this process the total energy released per fuel mass is around 44.8 kJ/mole (Roper, 2006).The production and reaction of Carbon monoxide (CO) in the combustion process is shown in Equation (2). The amount of CO produced in the combustion process can be neglected, since it occurs rarely (John H., Seifield Richard C. Flagan, 1988).

The drawback in these types of engines is the excess of unburned fuel in the ignition chamber as shown in Figure 2. The impurities in the air mixture feed into the combustion engine cause to leave a percentage of fuel unburned. Due to this unburned process the energy production through a sample of fuel reduces. Hence, the efficiency of the engine decreases.

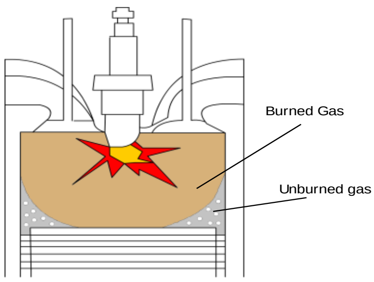

Figure 2 – Flame Propagation in the chamber

The efficiency of an engine can simply increase by,

reducing the amount of unburned fuel in the combustion engine.

producing a high energy using less amount of fuel.The solution introduced for this dilemma is HHO gas. HHO gas; Hydroxy gas or also known as Browns gas, Water gas or Green gas is a combination of two parts of Hydrogen and one part of Oxygen. HHO will combust when it brings to its auto ignition temperature. For a stoichiometric mixture in normal atmospheric pressure the auto ignition occurs at 570 ^{0}C. The energy required to ignite such a mixture is about 20 µJ. When the percentage of Hydrogen is between 4% - 95% by the volume of the HHO mixture, it can burn. During the ignition process of the HHO, the gas mixture releases energy and it converts into water vapor which causes to sustain the reaction. The energy produced by this ignition process is 241.8 kJ of energy for every mole of H_2 burned. The amount of heat generated in this combustion process varies according to the mode of combustion engine (Chaklader, 2002).

HHO can be produced by water electrolysis. In this scenario the molecules in the distilled water dissociate using two electrodes as shown in Figure 3. The separated molecules form a mixture of two particles of Hydrogen (H_2) and a particle of Oxygen (O_2) as given in Equation (3).

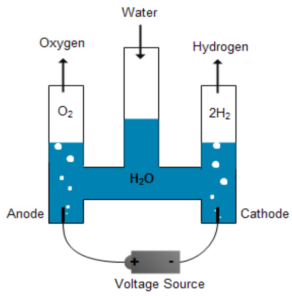

Figure 3 – Water Electrolysis

$$2H_2O \longrightarrow 2H_2 + O_2 \qquad (3)$$

The electrolysis system consists with two electrodes named, Anode and Cathode. Anode is positively charged and cathode is negatively charged and at each electrode H_2 and O_2 emits separately from the system. This electrolysis process causes oxidation which affect the materials to get corrode if the materials are corrosive materials. HHO gas can introduces as a highly ignite source of power which will provide much higher energy than in normal ignition process in a combustion engine (Sa'ed A. Musmar, Ammar A. Al-Rousan, 2011).

METHODOLOGY

The attempt of this research is to develop a HHO generator and to test under several conditions in order to determine a convenient design that produces a large amount of Hydroxy gas (Heyl, 1945). Up to the final combustion the whole system can be demonstrated by a simple block diagram shown in Figure 4. After the electrolysis process the generated HHO is mixed with the oxygen and fuel and carried them into the combustion chamber. A feedback system is been introduced to the system to get a better outcome as the temperature variation affects the HHO generating process.

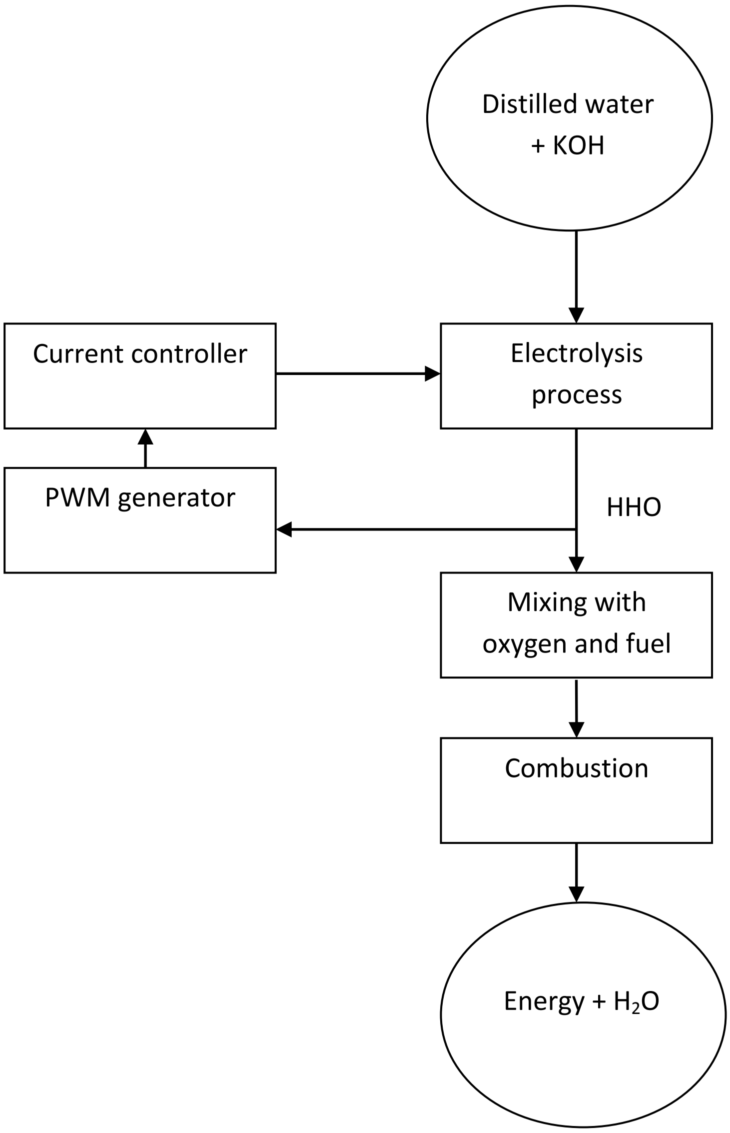

Figure 4 – Block diagram of the system

A typical HHO generator consists of several stages as shown in Figure 5. The HHO generator mainly consists of two electrodes, few neutral plates, gaskets and two end plates (Anon., n.d.).

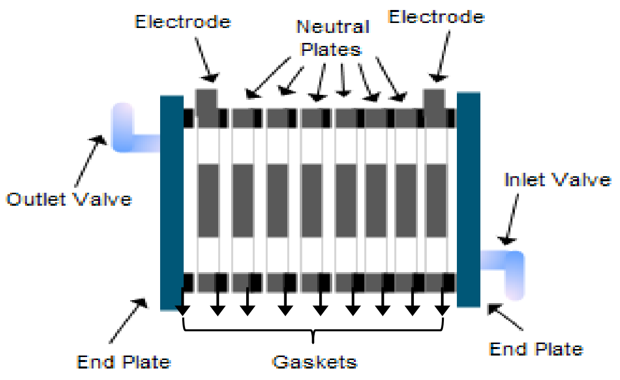

Figure 5 – Cross-sectional view of the HHO generator

The two end plates used are made of fibre to make them much solid. Fibre glass is much more resistant to oxidizing and will last for a very long period. The outlet and inlet valves are made of stainless steel in order to reduce corrosion. The two electrodes and the neutral plates are also made of using stainless steel. The gaskets used are selected considering the maximum value of temperature they can endure. As a matter of fact at least these gaskets should operate under 100 ^{0}C of temperature. The gaskets are used to separate each neutral plate from one another and also to separate the electrodes from the consecutive neutral plates and also to make a gap between the end plates and the electrodes. The distilled water from the reservoir feed into the HHO generator via the inlet valve as shown in Figure 6. The gaps inhibit due to the gaskets between each plate act as set of chambers which are get filled with distilled water supplied. Hence, the generator is filled with water which, acts as a conductive media and when the voltage is applied to the two electrodes, each neutral plate gets charged having different polarities for each consecutive plates. The produced gas and the water feed into the system circulate through the system via the inlet and outlet valves.The produced gas HHO feed into the bubbler which acts as a gas storage as shown in Figure 6. Initially the bubbler is filled with water and when it gets filled with HHO gas the excess of water feed into the reservoir. The water from the reservoir feeds into the generator which makes this process a circulate process.

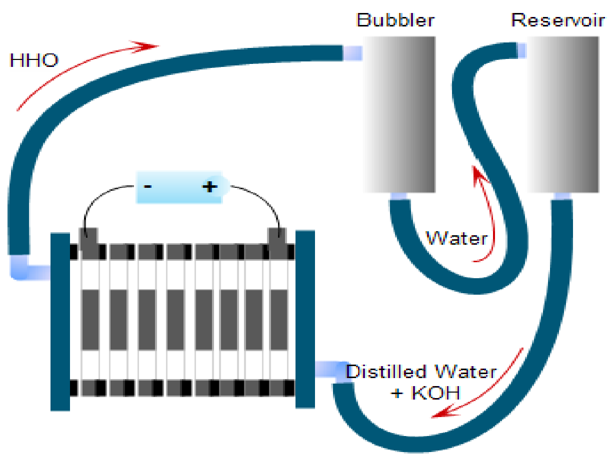

Figure 6 – HHO generator system with bubbler and the reservoir.

The process of electrolysis can be increase by adding a catalyst to the water before feeding into the generator which makes the water more conductive. This causes to increase the amount of current flows through the generator. To achieve this requirement Potassium Hydroxide (KOH) is selected as the catalyst in this approach (Ammar A. Al-Rousan, 2010).Also by introducing an extra electrode in the middle of the cell also cause to increase the production of HHO than using two electrodes. The modified design is shown by Figure 7.

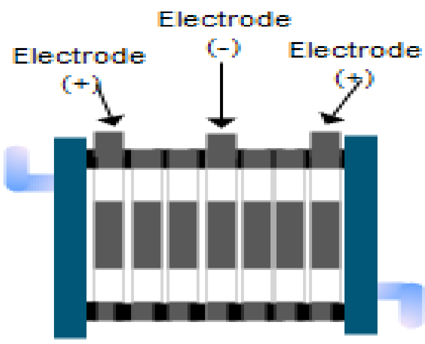

Figure 7 – HHO generator with three electrodes applied

In this approach we have used the 3 electrode method in the developed HHO generator which is shown in Figur 8.

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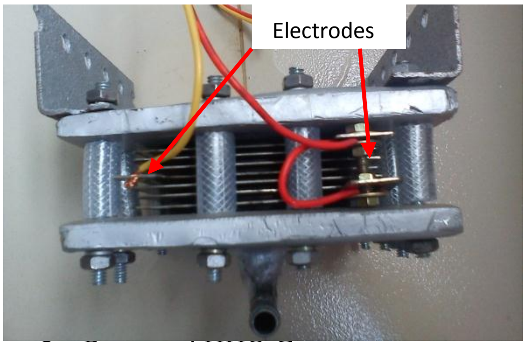


Figure 8 – Proposed HHO Generator

RESULTS AND OBSERVATIONS

In the first implementation of the HHO generator we have used Aluminum (Al) to make the neutral plates and the two electrodes. The used inlet and outlet valves also selected considering the same material. With the time the plates and the valves get corroded due to the reaction of KOH and Al. Hence for the further experiments all the metal parts were built using Stainless Steel as the metal. The corrosion rate of Al is 261.92 mpy (mile per year) for 1mole of KOH and for the Stainless Steel it is 1.882 mpy for the same concentration of KOH (L.F. D'iaz, L. Ballote, Maldonado Lopez, Daniel E. Rondero, 2009). Figure 9 shows a corroded Al plate.

Figure 9 – Corroded Al plate after a test run for 24 h with 30 g of KOH applied (500 ml water)

In the next step we have tested the generator using two electrodes and three electrodes separately for a same concentration of KOH mixed with a sample of water. For the experiment 15 g of KOH mixed with 500 ml of distilled water. For this experiment the neutral plates and the electrodes are made of using Stainless Steel. The distance between the plates for both scenarios is adjusted to be 2.5 mm.

Table 1 – Production of HHO and current consumption with number of electrodes

Number of electrodes	Production of HHO	Maximum current flow	Time taken
2	1 l	2 A	20 min
3	1 l	6 A	4 min

The second experiment is done separately for the two electrode method by changing the distance between the plates. The measured values are shown in Table 2.

Table 2 – Dependency of the distance between the plates using the two electrode method

Distance between plates	Production of HHO	Maximum current flow	Time taken
5 mm	1 l	1.8 A	20 min
2.5 mm	1 l	6 A	4 min

In each incident of the above experiment we have measured the temperature of the HHO generator, Table 3.

Table 3 – Dependency of the Temperature

Distance between plates	Production of HHO	Amount of Temperature increased
5 mm	1 l	15 ^{0}C
2.5 mm	1 l	5 ^{0}C

Initial temperature of the design is equal to the room temperature, 25 ^{0}C. So the deviation of the temperature with the variation of the distance between the plates can tabulated as shown in Table 4. The deviation of temperature is calculated with respect to the initial temperature value using the Equation (4).

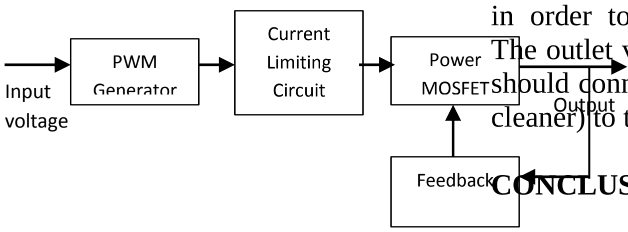
$$\text{Deviation of Temperature} = \frac{|\text{Practical Observation} - \text{Initial Condition}|}{\text{Initial Condition}} \quad (4)$$

Table 4 – Deviation of Temperature as a Percentage

Distance between plates	Deviation of Temperature as a %
5 mm	50%
2.5 mm	16.67%

For all of the above experiments the applied voltage is 12V which is equal to the battery voltage of a vehicle. Also those experiments done under the same room temperature and keeping the initial conditions as same for each and every experiment. The results shown in Table 2 and 3 correspond to the design which uses two electrodes. According to the results taken reveals that the small distance between the plates cause to draw large amount of current and cause to increase the production of HHO gas. The HHO generator for the three electrode method designed considering the results obtained in Table 3 and 4. So that the second is designed to overcome the failures examined and also the two electrode design also improved by reducing the distance between the plates before taking the results in Table 1. This process was done to make similar environments to both designs before the experiment. The results shown in Table 1, proves that the efficient design for the HHO generator is the three electrode method. In this scenario the designer must be aware of to keep the distance between the plates to the minimum value it can have.Also with the time a fact that observed is, for a particular design the increasing temperature cause to increase the amount of current flows through it. This result led us to design a current limiting circuit which is able to handle maximum current of 6A. The block diagram for the required electronic design is shown in Figure 10.

Figure 10 – Block diagram of the Electronic Circuit



The proven method using the results obtain can be applied to a vehicle in order to increase the fuel efficiency. The outlet valve of the designed generator should connect to the gas intake valve (air cleaner) to the combustion engine

CONCLUSION AND FUTURE WORK

In this research we have presented a convenient method to build up an efficient HHO generator. According to the results observed the amount of current flows through the generator increases that causes to increase the production of HHO as well as the increasing cell temperature which causes to increase the production of HHO. To build an efficient HHO generator the

distance between the plates, the Catalyst used, the material used to build up the plates and also the number of neutral plates and electrodes should consider with the amount of HHO need to be produced for a particular time. In the proposed approach the amount of current flows through the generator increased with the temperature of the generator which makes the battery to drain fast. So that the future research will mainly focus on limiting amount of current flows through the generator to 6A, which has found as ideal current to be used with the generator to get a continuous constant rate of HHO production from the cell. Next approach of this research is to connect the proposed HHO generator with an internal combustion engine, i.e. a spark ignition system and measure the efficiency of the fuel in vehicle and also to measure the reduction of emission of air pollutants such as CO_2, Co, etc.

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