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[Barcey* 5(5): May, 2018] ISSN 2349-4506
Impact Factor: 3.799

Global Journal of Engineering Science and Research Management

HHO GAS AS A COMBUSTION ENHANCER IN A S.I ENGINE

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DOI: 10.5281/zenodo.1245226

KEYWORDS: oxy-hydrogen, electrolyser, S.I Engine (Spark Ignition), calorific value.

ABSTRACT

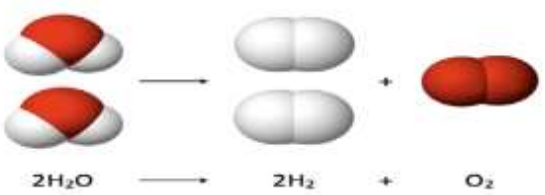
In today's world, there's a lot of need for energy, so considering the crisis of current scenario, we decided to produce energy from water in form of HHO gas (hydrogen hydrogen oxygen gas), this gas is also known as oxy-hydrogen and brown gas, which is obtained by the process of electrolysis. It is actually an electrolysis unit having high grade stainless steel/graphite/semiconductors as electrodes and mixture of water & suitable ionic solution (KOH or NAOH) as electrolyte. We are going to use this gas as a part fuel along with petrol which will improve the combustion efficiency of the IC engine. HHO gas burns clean and has lot more power due to high calorific value, thus increasing the power produced by the engine. And as this gas is produced form water, the emission of hydrocarbons and carbon dioxide is reduced. The outcome of this project is that the mileage of the vehicle is increased and the fuel consumption decreases due to the HHO gas supplied to the engine, which in fact increases the fuel efficiency. In this research we mainly focused on finding an efficient configuration of an ordinary HHO electrolyser that is efficient than an ordinary system. Therefore, such a system will be able to increase the power of a spark ignition (S.I) engine while reducing the air pollution.

INTRODUCTION

THE global market is in the need for lot of energy in terms of fuel and also the scientist as well as researchers are searching for alternatives fuels, which is indeed going to change the engine design to a certain extent. So among such solution is hydrogen as an alternative fuel. This gas will reduce the pollution up to an extent. Combustion of fossil fuels has caused serious problems to the environment and the geopolitical climate of the world. The main negative effects on the environment by Fossil fuel combustion are emissions of NOx, CO, CO2, and unburned hydrocarbons. Hydrogen burns clean and has high calorific value, which leads to clean burning of fuel (petrol and hho gas), which leads to produce a significant amount of energy.

The use of hydrogen leads to save our fossil fuel which is not a renewable resource. One way to get hydrogen is by electrolysis of water, a method for separating hydrogen and oxygen in water using an electric current. The equipment used is called HHO gas electroyser, which consists of dry and wet type. Electrolysis process at the HHO gas generator will separate the atoms bond. The hho gas is formed in the electrolyser which contains steel plates of grade 316L and it is sandwiched with gaskets in between each plate maintaining a gap of 1.73 millimeters. We wanted efficient gas production therefore we kept modifying the design by reducing/adding the number of plates, until we found the optimal design which gave us max production of gas. The produced gas is then let into the system i.e. after the carburetor, and therefore the mixture of petrol and HHO gas is let into the intake manifold which is then combusted via spark.

The stoichiometric equation of this process can be expressed as in:
Electrolysis: $2H2O \rightarrow 2H2 + O2$
Combustion: $2H2 + O2 \rightarrow 2H2O$



Type of cells:
1) Wet cell
2) Dry cell

This project uses a dry cell because it needs less amount of electrolyte also the heat generation is comparatively less.

Sample of DRY CELL

Sample of WET CELL

Why dry cell?
The name could be misleading as this electrolyzing cell uses water just like any other electrolyzing unit. There are, though, some attributes of this cell that makes it easier to design and handle. With wet HHO cells, the whole unit is underwater, while in the case of dry cells, the plates are separated with rubber seals. These sealing stops the water from leaking from the cell, the electrical connections and the edges of the plates are not touching the electrolyte. These parts of the unit are staying dry, thus the name dry cell. To make sure the gas made from the electrolyte gets out of the cell and the solution to flow between the plates, there are holes on the top (for the gas + the electrolyte) on the metal stainless steel plates.

With the dry cell generator, considering the surface of the plates in the unit, we can use much less electrolytes compared to wet cells. Therefore, the volume and weight of the cell is smaller.

As the electronic connections are underwater in the wet cell model, their surface will slowly be corroded by the electrolyte. In the HHO cells, the connections are situated on the outside, thus not corroding.

WORKING PRINCIPLE OF ELECTROLYSER

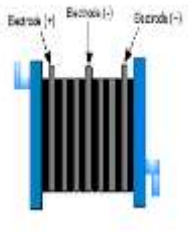
This works on the principal of electrolysis process. Electrolysis is the process that converts water to gas. The electrical supply for the process is used from the Vehicles battery and alternator. An electrical power source i.e. 12v battery is connected to the three electrodes. Two electrodes are shorted together, it can either be positive or it can either be negative that doesn't matter. The gas and electrolyte will together come out from the cell which is then passed to the bubbler, as the gas is light it will get accumulated on the top. And from there it will pass through the outlet of the bubbler which will be an inlet to the engine after the carburetor.

CONSTRUSCTION OF THE PROJECT
The project consists of the following components:

1. Electrolyser
2. Tank with 12v 3LPM pump
3. Bubbler (safety device)
4. Flash back arrester
5. S.I engine (generator)

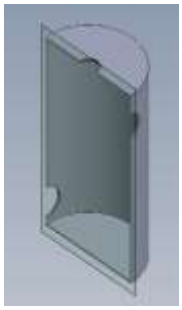
Electrolyser/cell: It consists of 11 stainless steel plates of grade 316L out of which 3 are electrodes sandwiched between two Teflon end plates with gaskets between each plate.
Dimension of the plate- (151x74x1.5) mm,Gaskets thickness-1.73mm.

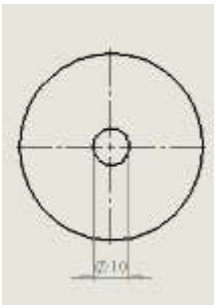


Model of Electrolyser ***Fabricated model of Electrolyser***

Tank- It is made of stainless steel 316L grade, 2 liters, 100mm inner diameter, 255mm height. 12v pump 3lpm is attached to the bottom of the tank, which keeps the electrolyte circulating through the cell. The tank is ¾ filled.



SOLIDWORKS MODEL OF TANK ***ORTHOGRAPHIC VIEWS OF TANK***

Bubbler- It is a safety device, which is half filled with water and it has a flash port at the top which consist of seat and poppet, this is for when the excess pressure is built up in the bubbler that pressure is let out from the flash port. The gas is bubbled into the water and then it gets accumulated to the top as it is light and this helps the system when there is an unfortunate back fire, which results in the damage of the bubbler but saving the whole cell and the tank.

Bubbler

Flash/flame arrester- This device is small in size and it is installed in the pipe, which is before the bubbler. It consists of steel wool which avoids the flame to propagate to the bubbler; if the flame arrester fails then the bubbler does its work.

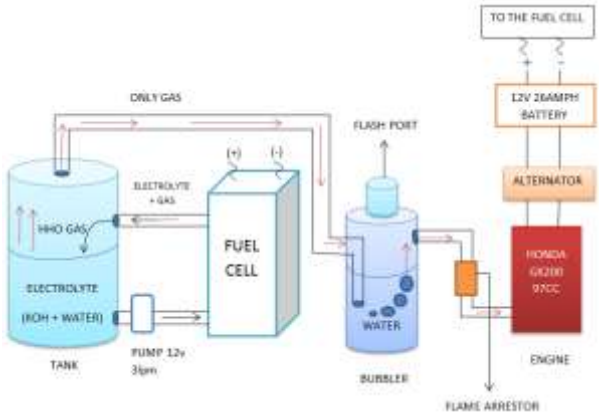
Flash back arrester

S.I engine (generator) - we used Honda GK200 97cc petrol engine for experimentation. We put the gas after the carburetor by modifying the suction line by adding a copper pipe of 6mm ID.

Generator

BLOCK DIAGRAM OF THE SYSTEM

The setup

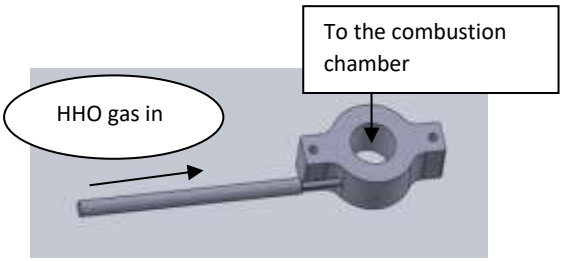


The tank has a fix connection with the pump which sucks the electrolyte and pushes it to the cell, the cell is connected to a 12v 26amph battery which powers the system, and the electrolysis takes place producing the gas, which is sent back to the tank with the electrolyte, as the gas is light it get collected on the top of the tank, which is sent to the bubbler via the housing, in the bubbler the gas bubbles through the water and is further sent to the engine.

DESIGN MODIFICATION TO THE ENIGNE

The most important modification we did was adding copper pipe housing after the carburetor by connecting the copper tube of 6mm to the cast mold. It creates a direct entry for the hho gas to pass to the combustion chamber as it was after carburetor during the starting time it sucked air-fuel mixture from the carburetor along with hho

gas from the 6mm copper tube which was connected to the bubbler.



Solidworks part model (after carburetor)

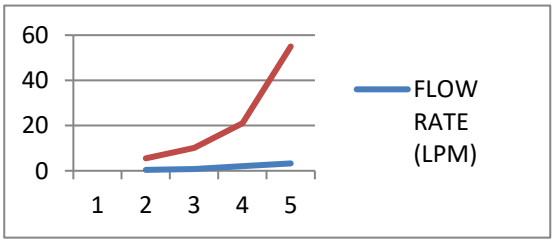
This part is added before installing the carburetor, when it is installed, after this part the carburetor is added, so that with the air fuel mixture the HHO gas is sucked into the combustion chamber.

RESULTS AND DISCUSSION

TESTING AND ANALYSIS: It is found that the KOH per water percentage should be at a ratio of 30%-70%. Also by research it is found that 30gm/l gives better conductivity. The gas flow rate obtained was as follows with various setup of the cell:

Table 1 . Time taken to fill 400 ml against various battery arrangements

Gas flow rate(LPM) against various cell arrangements			
Cell arrangements	Battery (amph) Power supply (A)	gas flow rate	Amps drawn (A)
13 plates (2stacks)	12v 26amph	0.4	5.1
11 plates (2 stacks)	12v 26amph	0.83	10.3
09 plates (2 stacks)	12v 26amph	1.1	23
07 plates (2 stacks)	12v 26amph	1.26	58
16 plates (3 stacks)	12v 30A	2.3	28.6



The graph shown above is flow rate vs. amps drawn, It is seen that more the amps, the flow rate of the gas increases but resulting in lot of heat.

Now to increase the flow rate we performed different combination of batteries (2 batteries of 12v 26amph)

Table 2 . Time taken to fill 400 ml against various battery arrangements

Time taken to fill 400 ml against various battery arrangements			
Cell arrangements	Battery arrangements	HHO gas Flow rate (Lpm)	Amps drawn (A)
13 plates	12v 26amph	0.4	5.1
13 plates	12v parallel (2 batteries)	0.418	5.2
13 plates	12v series (2 batteries)	2.18	48
09 plates	12v 26amph	1.2	23

COMBUSTIVE PROPERTIES OF HYDROGEN (brown gas)

- **Wide Range of Flammability**- As can be seen the flammability limits (= possible mixture compositions for ignition and flame propagation) are very wide for hydrogen (between 4 and 75 percentage hydrogen in the mixture) to gasoline (between 1 and 7.6percentage).
- **Low Ignition Energy**-Hydrogen has very low ignition energy.
- **High Auto ignition Temperature**-The high auto ignition temperature of hydrogen allows larger compression ratios to be used in a hydrogen engine than in a hydrocarbon engine.
- **High Flame Speed**- Hydrogen has high flame speed at stoichiometric ratios. Some basics the burn speed of hydrogen is 0.098 to 0.197 ft/min (3 to 6 cm/min) compared gasoline´s 0.00656 to 0.0295 ft/min (0.2 to 0.9 cm/min).
- **High Diffusivity**- Hydrogen has very high diffusivity. Firstly, it facilitates the formation of a uniform mixture of fuel and air. Secondly, if a hydrogen leak develops, the hydrogen disperses rapidly. Thus, unsafe conditions can either be avoided or minimized.
- **Low Freezing point**- Thus this creates no starting problem in the cold environments.

FINAL OBSERVATIONS:

Table 3. Time noted for fuel consumption by engine

TIME NOTED FOR FUEL CONSUMPTION BY ENGINE	
40ml fuel without HHO gas	3min
40ml fuel with HHO gas(2.3LPM)	3min 46sec

CALCULATION ON AMOUNT OF FUEL SAVED

40ml of fuel lasted for 3min = 180 sec
40ml of fuel with HHO gas lasted for 3mins 46secs = 226 sec
Consumption of fuel/hour
$= (40\ x\ 3600)/180 = 0.8$ L /hr.
Consumption of fuel with HHO gas/hour
$=(40\ x\ 3600)/226 = 0.637$ L /hr.
Percentage amount of fuel (petrol) saved = $(0.8 - 0.637)/0.637 =$ **25.58 %**

Amount of fuel saved is 25.58% for 2.3 LPM of HHO gas.
Therefore it is seen that the fuel efficiency is increased. Also by performing this, one thing is clear that high flow rate results in better average of the engine, much fuel is saved.

CONCLUSION

1. The oxy-hydrogen gas is advantageous, it gave us positive results while testing it on the engine by reducing the fuel consumption and plus reduce in the emission of hydrocarbons and carbon-di-oxide.
2. The Petrol engine performance and emission analysis are conducted with Petrol + HHO and petrol respectively.
3. The HHO gas kit can be easily constructed and easily integrated with existing engines at low cost.
4. This project will help our country to be energy independent, if it is used in a proper way. It will make India free from pollution that is going to be a major problem of the world.

ACKNOWLEDGEMENTS

We have put our efforts in the research paper and therefore it gives us immense pleasure in bringing out our project entitled "HHO GAS AS A COMBUSTION ENHANCER SYSTEM". We are obliged to acknowledge the initiation given by our *prof.Sandeep Sabnis*, who gave us valuable suggestion, ideas and guided us all through our project work whenever in need. Our deep sense of gratitude to "*Mother Mary engineering enterprises*" for their support and guidance for this project. We are immensely grateful to our parents and all our friends who have directly or indirectly helped us, because without their inspiration, support and useful suggestions it wouldn't have been possible.

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