



HHO GENERATOR : A REVIEW

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ABSTRACT:

Today, the availability of fuel oil is increasingly limited and combustion results have impact on pollution of the environment. Then, all efforts to save fuel consumption and the green energy utilization of should be continued. One example of energy savings is utilizing HHO Gas (Brown's Gas) in Internal Combustion Engine (ICE).

HHO generator is an efficient approach that used to increase the fuel efficiency in a combustion engine by increasing the energy produced per mole of fuel during the ignition process. Although people use HHO generators in practice a very little research has been carried out in implementing an efficient system.

KEYWORDS: Brown Gas, ICE, HHO Generator

Introduction

Faced with the ever increasing cost of conventional fossil fuels, researches worldwide are working overtime to cost effectively improve internal combustion engine (ICE) fuel economy and emission characteristics. In recent years, many researchers have focused on the study of alternative fuels which benefit enhancing the engine economic and emissions.

A HHO Generator is a device that uses **electrolysis** to convert water into **two moles Hydrogen and one mole Oxygen**(HHO). This gas, also known as Brown's Gas, is a very clean burning, powerful fuel. Efficient HHO Generators are capable of using Distilled Water only, but most HHO Generator uses an electrolyte, or catalyst in addition to the distilled water. The most popular is regular old baking soda.

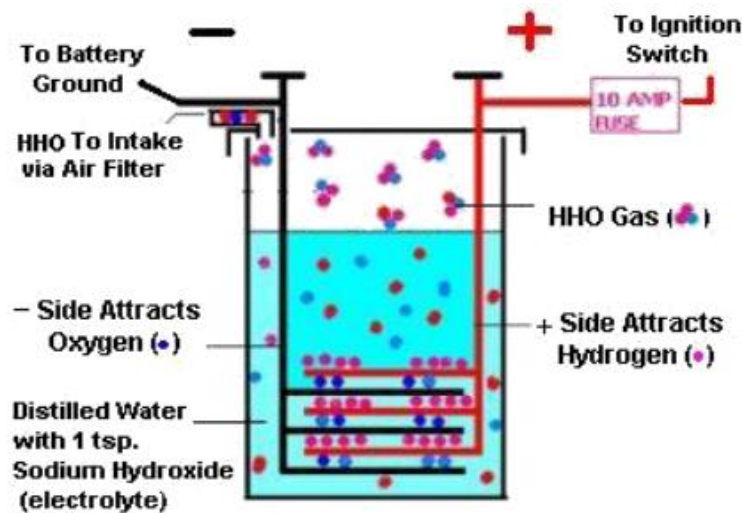


Fig 1: Electrolysis of water

Reactions:



2. $E_0 = +1.229 \text{ V}$

Aim of the study:

To generate HHO gas or brown gas by electrolysis process in such amount that it can be used in combustion process along with the conventional fuels.

Objective of the study:

To reduce the fuel economy in the combustion.

To increase the burning efficiency of the combustion process.

To reduce the pollutants emitted from the combustion of fossil fuels.

HHO Gas Generator Type:

HHO gas generator is composed of two basic components, tube generator and a power source. Tube generator consists of a tube, a pair of electrodes and electrolyte, while the power source such as a battery. This generator works on the principle of water electrolysis. HHO gas generators are classified into two types as follows:

A. Dry Cell

B. Wet Cell

A. Dry Cell Type

HHO gas generator is where partially of the electrode is not submerged in electrolyte and electrolytes only fill the gaps between the electrodes themselves. Advantages types of dry cell HHO gas generator is the first Electrolyzed water less, ie the only water trapped between the cell plates. Heat generated is relatively small, due to the circulation between the hot and cold water in the reservoir. The electric current used is relatively smaller, because the power is converted into heat less.

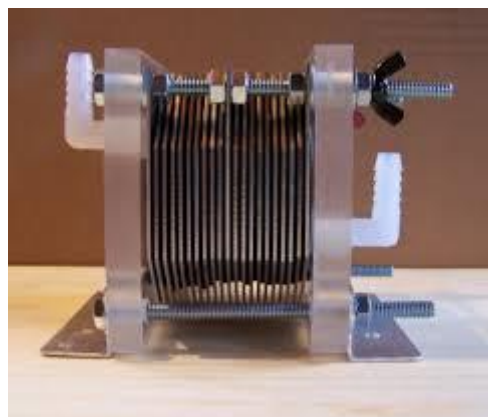


Fig 2: HHO Dry Cell



Fig 3: Schematic diagram of HHO Generator

Area of a circle on the plate electrodes immersed in water is the area occurrence of electrolysis to produce HHO gas, while the other area is not submerged in water and in dry conditions. The area of occurrence of electrolysis process approximately 60% of the total plate area and should be limited to the o-ring or seal with a diameter of 80 mm on each plate were used. Moreover on each plate there are two holes with a diameter of 12 mm for HHO gas line located at the top and at the bottom.

B. Wet Cell Type

A HHO gas generator in which all the electrodes immersed in the electrolyte liquid in a vessel of water. Advantages of the HHO gas generators wet cell type are first, gas production generally more quantity and stable, second, generator maintenance easier and third HHO generator design manufacture easier.



Fig 3: Wet Cell

In the wet cell type, all areas of the electrode plate area submerged in water to the electrolysis process produces HHO gas. So that magnitude of electrolysis area same with an area of each plate used are dimensions of 80 mm x 80 mm.

Reduction of pollutants by using HHO gas

1. Comparison of performance characteristics

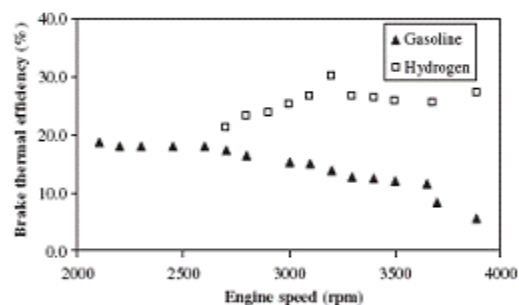


Fig 4: BTE vs Engine

Hydrogen fuel has higher brake thermal efficiency and even can operate at lower engine loads with better efficiency. It can be noticed that brake thermal efficiency is improved to about 31 percentage with hydrogen fuelled engine compared to gasoline fuelled engine.

Comparison of brake thermal efficiency of the fuels is shown in Fig.4 Here brake thermal efficiency of hydrogen is much better than the brake thermal efficiency of gasoline engine even at allow speed.

2. Comparision of emission characteristics

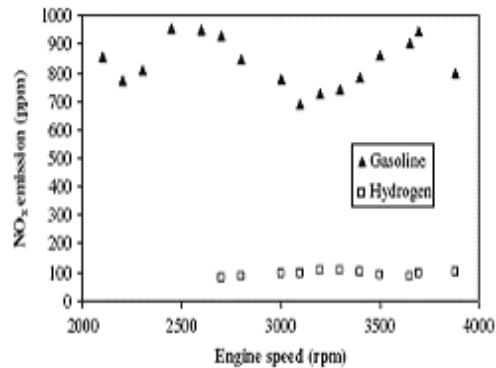


Fig 5: NOx vs Engine

Fig. 5 illustrates NOx levels of both engines. Significant decrease in NOx emission is observed with hydrogen operation.

Almost 10 times decrease in NOx can be noted, easily. The cooling effect of the water sprayed plays important role in this reduction. Also operating the engine with a lean mixture is kept NOx levels low.

Fig. shows CO emission versus engine speed for both engines. Although excess air for complete combustion is present in the cylinder, the engine is not capable of burning the total fuel. It was expected that hydrogen fuelled engine must have zero CO emission.

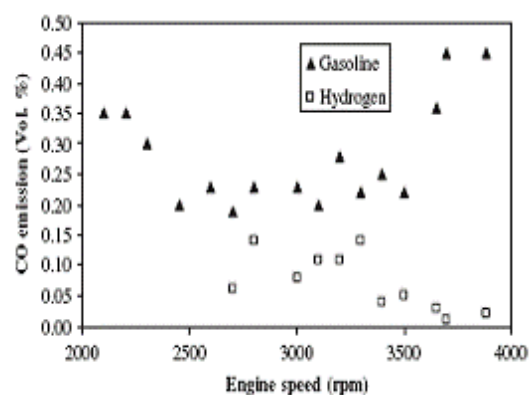


Fig 6: CO vs Engine

As it is seen in Fig.6, some amount of CO is still present. This is due to the burning of lubricating oil film inside the engine cylinder. As engine speed increases, CO emission tends to decrease.

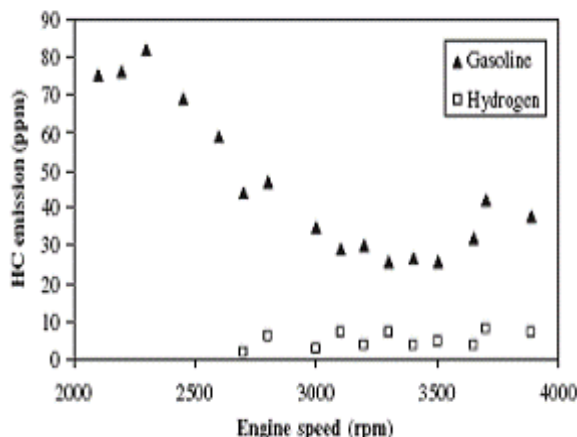


Fig 7: HC vs Engine

The temperature caused by combustion is very high inside the cylinder. As the piston expands the heat evaporates some amount of oil. In addition to this evaporated oil, incompletely burned oil also contributes to HC emission.

Formation of Hexavalent chromium

Hexavalent chromium is a toxic compound which is generated from the electrolysis process when it is carried out with tap water. The tap water contains different types of impurities in water which when current is passed starts reacting with the metal electrodes.

The electrodes that are generally of stainless steel which has some percentage of chromium in them, hence when the current is passed various electrochemical reactions take place in the water and hexavalent chromium is formed.

There are regulations by the EPA related to the safe disposal of any toxic byproducts that result from electrolysis using stainless steel electrodes. There is currently a concern that stainless steel boosters produce hexavalent chromium in the left over electrolyte.

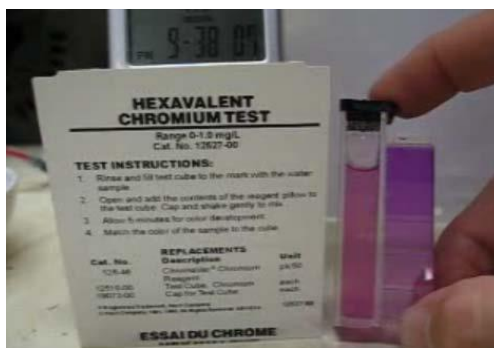


Fig 8: Hexavalent chromium

More information and breaking down Hex testing has been posted in the faculty section. Recently specially coated Ti/MMO (mixed metal oxides) plate electrodes have appeared and have been reported to eliminate this possible by product. However, there is concern that the MMO/Ti plates with iridium and ruthenium oxides may not be compatible with NaOH or KOH electrolyte. Further testing reports on SS and Ti/MMO electrodes will be added to the faculty section as we are able to get data in.

CONCLUSION

From above mentioned two methods of HHO generation, HHO Dry Cell method is more efficient. By performing a small experiment, it had been concluded that if tap water is being used during electrolysis, hexavalent chromium is being generated on the surface, whereas if RO water is used, there is no issue of formation of hexavalent chromium because formation of hexavalent chromium leads to some sort of pollution if that impurity is being discarded. Also the formation of HHO depends on the kind of electrodes used. The best type of electrode is Graphite, but it is costly and not easily available. Instead of graphite Steel electrodes can also be used.

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