

Effects of hydrogen enrichment on performance and emission of 4 stroke SI engine

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Abstract: Hydrogen Fuel Cell consists of a fuel tank and is filled with domestic water and potassium hydroxide (KOH). This is designed in order to operate using the method of Electrolysis by separating hydrogen and oxygen. The fuel cell uses electrochemical process to split the hydrogen and oxygen gas from water, which can be further used for generating heat and electricity. In this project, alkaline electrolysis process is used to produce hydrogen gas from water using DC supply. This hydrogen gas is used for supplementary fuel in the SI engines. Its decreases emission of vehicles.

Keywords: Alternative fuel vehicle, hydrogen, automobile, internal combustion engine, hydrogen economy fuel cell.

INTRODUCTION

Pollution created by automobiles is the major cause for global warming. The number of automobiles on road is increasing day by day as a result of which pollution is also increasing. In order to reduce the emission from automobiles various researches are carried out, one among them is introducing HHO gas as supplementary fuel along with air/fuel mixture. Various methodologies have been followed by many authors to understand the effect of HHO gas on combustion in IC engine. This work was first initiated by YULL BROWN in the year 1977. He used HHO gas for welding application.

HHO gas is prepared by electrolysis of water. Electrolysis is the process in which water gets decomposed to for a mixture of hydrogen and oxygen gas which is known as brown's gas. The electrode used in the electrolyzer is stainless steel of grade 316L. the current is passed through the electrodes which produces the HHO gas by conducting. Pure water will not conduct electricity so an impurity is added to water. So a solution of KOH, NaCl and NaOH are prepared and used as an electrolyte. The elcrolyzer produces mixture of hydrogen and oxygen gas which are known by various names such as HHO gas, hydroxyl, oxy-hydrogen and brown's gas. HHO gas is extremely efficient in terms of fuel. The configuration of HHO gas is such a way that, the mixture contains hydrogen and oxygen atoms which interacts directly without any ignition propagation delays due to surface travel time of the reaction.

The emission testing measure the amount of CO₂, HC, NO and O₂ emitted from the engine. Introducing HHO gas along air/fuel mixture reduces the emission from engine. The presence of HHO gas enables the good combustion due to the presence of oxygen.

2. COMPONENTS

The major components;

2.1 Electrolysis chamber

2.2 Electrodes

2.3 Hydrogen source

2.4 Catalyst

2.5 Power supply

2.6 Gas tubes

2.7 Regulator

2.8 Storage

2.1 Electrolysis chamber

Electrolysis chamber is made up by PVC which is non ferrous material. Inside the electrolysis chamber hydrogen gas is produced by electrolysis process. For safety purpose the chamber has no conducting property. It is constructed by joining of PVC pipe with its end cup. Inside the electrolysis chamber electrolyte and electrodes are placed. Power supply was given by chambers outside bolts.

DIMENSIONS OF ELECTROLYSIS CHAMBER

Width of chamber	- 11cm
Height of chamber	- 35cm
Volume of chamber	- 3.32616 liter

2.2 Electrodes

10 Aluminium plates are used as electrodes. Where 5 is acts as a cathode and 5 is acts as a anode. The cathode and anode placed one by one with minimum distance and connected to DC power supply. Electrodes function is made a chemical reaction inside the electrolyser when DC supply is ON by its conduction property.

Aluminium has very good corrosion resistant in most environments. Aluminium light weight and its density is only one-third that of steel. Aluminium retains its strength at low temperatures and often used for cryogenic applications.

2.3 Hydrogen source

Normal domestic water used as a hydrogen source. Water has a number of unique chemical and physical properties that make it essential for life. One such property is familiar to everyone solid water floats on liquid water. Almost all liquids contract when they get colder and reach a maximum density when they solidify. Water is different. As water cools, it contracts until it reaches 4 C, then it expands until it freezes at 0 C. Ice is less dense than water which allows ice cubes to float in a soft drink, icebergs to float in the ocean, and ponds and lakes to freeze from the top down so that aquatic plants and animals can survive in the unfrozen liquid below.

Water molecules have a simple structure: two hydrogen atoms bonded to one oxygen atom H₂O. This simple structure is responsible for water's unique properties. The bond between each hydrogen atom and the oxygen atom results from a pair of electrons shared between the two atoms. In water, the electrons in the shared pair are not shared equally between the hydrogen and oxygen atoms. Molecules with negative regions and positive regions are called polar molecules. Water molecules are polar molecules. Polar molecules are attracted to each other. The attraction results from the negative region of one molecule, the oxygen atom, being drawn to the positive region of another molecule, the hydrogen atom. The attractions between water molecules are particularly strong. Oxygen atoms have a very great affinity for electrons, and so the hydrogen atoms bonded to an oxygen atom acquire a significant positive charge. These hydrogen atoms are very tiny, so the positive charge is quite concentrated. This concentrated positive charge enhances the attraction of the hydrogen atoms in one molecule for the oxygen atom in another molecule. This attraction is so strong that it has been given particular name hydrogen bonding. The energy associated with hydrogen bonds in water is about 20 kJ.mol, which is about 1/10 the strength of a typical shared-electron bond within a molecule. Mostly normal domestic water has minimum acidity property which depends the impurity level of water.

2.4 Catalyst

Solid KOH (**Potassium hydroxide**) is corrosive. Depending on the concentration, solutions of KOH are non-irritating or corrosive and they cause direct local effects on the skin, eyes and gastrointestinal tract. Systemic effects are not to be expected. Solutions with concentrations higher than 2% are corrosive, while concentrations of about 0.5 to about 2.0% are irritating. Hydrogen gas forms as a by-product on the cathode concurrently, an anodic oxidation of the chloride ion takes place, forming gas as a by-product. Separation of the anodic and cathode spaces in the electrolysis cell is essential for this process.

2.5 Power supply

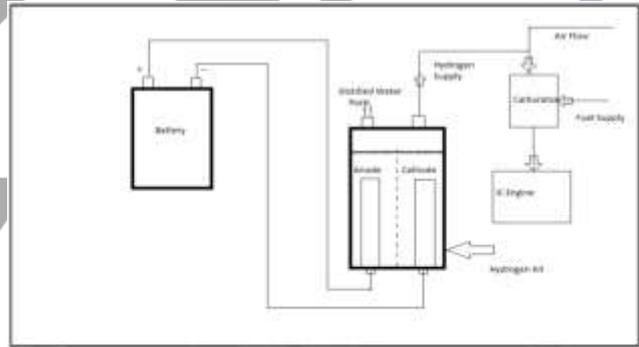
DC battery is used as a power source. An electric battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices. A battery has a positive terminal, or cathode, and a negative terminal, or anode. The terminal marked positive is at a higher electrical potential energy than is the terminal marked negative. The terminal marked negative is the source of electrons that when connected to an external circuit will flow and deliver energy to an external device.

When a battery is connected to an external circuit, electrolytes are able to move as ions within, allowing the chemical reactions to be completed at the separate terminals and so deliver energy to the external circuit. It is the movement of those ions within the battery which allows current to flow out of the battery to perform work. Historically the term "battery" specifically referred to a device composed of multiple cells, however the usage has evolved to additionally include devices composed of a single cell.

3. WORKING PRINCIPLE

Water molecule is formed by two elements: two positive Hydrogen ions and one negative Oxygen ion. The water molecule is held together by the electromagnetic attraction between these ions. When electricity is introduced to water through two electrodes, a cathode (negative) and an anode (positive), these ions are attracted to the opposite charged electrode. Therefore the positively charged hydrogen ions will collect on the cathode and the negatively charged oxygen will collect on the anode. When these ions come into contact with their respective electrodes they either gain or lose electrons depending on their ionic charge. (In this case the hydrogen gains electrons and the oxygen loses them) In doing so these ions balance their charges, and become real, electrically balanced, bonafide atoms or in the case of the hydrogen, a molecule. The reason this system isn't very efficient is because some of the electrical energy is converted into heat during the process.

When the DC supply is given to the electrodes the hydrogen gas is formed from water by the conduction of electrodes. Inside the electrolysis chamber the conduction makes the ionization of molecules. This makes the hydrogen and oxygen in gaseous form from liquid form. Hydrogen gas is lighter than oxygen so it travelled out quickly. Thus hydrogen gas was stored in the bags (7.6 liter volume) without any compression. After the filling of gas inside the bags stop the process or power supply. By making the hydrogen gas out from storage bag can be used as a fuel. And it was done by making compression of bags. After 4 hours of working time the impurities inside the chamber was cleaned and the water was refilled.



4. Experimental details for testing SI engine

- The setup consists of H₂ kit, rubber pipe, electric wires, bike.
- The H₂ kit is attached to the bike. It consists of two electrode anode and cathode and the mixture of distilled water and KOH are used. The H₂ kit is connected to the carburettor through the rubber pipes.
- The cathode of the starter of the bike through the electric wire and anode is connected to the any one.
- Part of the metallic part for the purpose of earthing. The plastic container has treated water and the electrodes such that the electrode is being submerged in the water so that all the stainless steel plates are being submerged inside water. The electrodes are submerged such that hydrogen can be easily formed.



Testing values for hydrogen enrichment

Emission result

From this experiment we study the emission of vehicle (two wheeler) will be decreased to a great extent. See the readings which gives from "AUTO EXHAUST MULTIGAS ANALYSIS MODEL NPMMGA" for petrol engine vehicle. Emission table given follows.

Table 1. Emission Without H₂ kit :

GASES	CONTENT
Hydrocarbon	1034ppm
Carbon monoxide	1.230 %
Carbon dioxide	1.90 %
Oxygen	15.95 %

Table 2. Emission With H₂ Kit:

GASES	CONTENT
Hydrocarbon	70 ppm
Carbon monoxide	0.032 %
Carbon dioxide	2.90 %
Oxygen	15.92 %

5. Conclusion

We all know that generally fuel cell is used for transportation purpose and in portable uses. Here, in this project we have shown the use of hydrogen fuel cell for increasing engines efficiency. We have done the project to simple in construction by low expenses. This is one of the advantageous project conserving the cost and low fuel cost. This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project.

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