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Fabrication of Hydrogen Engine

Rohith S[1], Yashwanth N[2], Pavan Kumar K P[3]

[1-3]*Assistant Professor, Department of Mechanical Engineering, ATMECE, Mysuru*

Abstract - *The aim of this work is to run the engine by using the hydrogen as a fuel; hydrogen is extracted by the water and finally designs a dry cell for hydrogen extraction to evaluate the performance of the hydrogen engine. Many companies are working to develop technologies that might efficiently exploit the potential of hydrogen energy for mobile users. The attraction of using hydrogen as an energy currency is that, if hydrogen is prepared without using fossil fuel inputs, vehicle propulsion would not contribute to carbon dioxide emissions. NASA uses hydrogen to launch Space Shuttles into space. There is even a working toy model car that runs on solar power, using a regenerative fuel cell to store energy in the form of hydrogen and oxygen gas. Honda has also created a concept called the FC Sport, which may be able to beat that record if put into production.*

Key Words: Fossil Fuels, Carbon dioxide emissions, Space shuttles, Solar Power

1. INTRODUCTION

An Internal Combustion Engine (IC Engine) is a type of combustion engine that converts chemical energy into thermal energy, to produce useful mechanical work. In an IC engine, combustion chamber is an integral part of the working fluid circuit. Air-fuel mixture in the combustion chamber (inside the cylinder) is ignited, either by a spark plug (in case of Spark Ignition Engines) or by compression (in case of Compression Ignition engines). This ignition produces tremendous amount of heat and pressure inside the cylinder. This induces reciprocating motion in the piston. Power of the piston is transmitted to a crank shaft which undergoes rotary motion. The rotary motion is ultimately transmitted to the wheels of the vehicle, via a transmission system, to produce propulsion in the vehicle. As the combustion takes place internally inside the cylinder (apart of working fluid circuit), the engine is called internal combustion engine.

Various scientists and engineers contributed to the development of internal combustion engines. In1791, John Barber developed the gas turbine. In1794 Thomas Mead patented a gas engine. Also, in 1794, Robert Street patented an internal combustion engine, which was also the first to use liquid fuel, and built an engine around that time. In 1798, John Stevens built the first American internal combustion engine.

An IC Engine is a heat engine where the combustion of a fuel occurs with an oxidizer (usually air) in a combustion chamber that is an integral part of the working fluid flow circuit. In an internal combustion engine, the expansion of the high-temperature and high-pressure gases produced by combustion applies direct force to some component of the engine. The force is applied typically to pistons, turbine blades, rotor, or a nozzle. This force moves the component over a distance, transforming chemical energy into useful mechanical energy. Typically, an IC Engine is fed with fossil fuels like natural gas or petroleum products such as gasoline, diesel fuel or fuel oil. There is a growing usage of renewable fuels like biodiesel.

1.1 HYDROGEN GENERATOR

Hydrogen is one of the new and renewable energy. 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 generator, which consists of dry and wet type. Electrolysis process at the HHO gas generator will separate the atoms bond 2 HHO into $2H_2$ and O_2, which this gas is known as HHO gas. HHO gas can be used as a fuel extender for gasoline, diesel or CNG gas to then be used in internal and external combustion engines. Although currently HHO gas only used as a fuel extender, but in the future with continuing research, HHO gas is expected to main energy source for Otto and Diesel engines.

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.

1.2 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, i.e., 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. Some of the benefits of a dry cell are that it is much less corrosive than submersion. They are also very efficient, some 90% and up, unlike the average 20% of a combustion engine. In dry cell electrolysis, the electrolyte is stored in an electrolytic tank which also acts as a bubbler and electrolyte enters the cell under gravity. The outlet of the electrolysis is connected to the intake manifold with safety devices. It requires less current as compared to wet cell for production of same amount HHO. The maintenance

cost of the dry cell is also low. From the above description it is clear that the dry HHO cell will be more suitable for HHO gas generation.

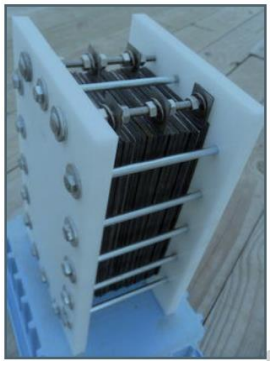

Fig -1: Dry cell Hydrogen Generator

1.3 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. In the wet cell type, all areas of the electrode plate area submerged in water to the electrolysis process produces HHO gas.

Fig -2: Wet cell Hydrogen Generator

2. LITERATURE SURVEY:

Flint Geller et. al., has made many conclusions and stated the properties and characteristics of distilled water in his journal named Properties of Distilled Water. He has drawn a major conclusion that helped us come up with this project i.e., Distilled water is amphoteric in nature, Distilled water can be used as fuel by the process of electrolysis, Distilled water helps in removal of contaminants and Distilled water has a lot of benefits when compared to normal water. Distilled water has a perfect complexion that does not have any toxics and any impurities. [1]

K Venkata Sunda Rao et.al., have given clear observation regarding the usage of alternative fuels for the IC engine in their journal named Review on Performance of the IC Engine Using Alternative Fuels. This journal states the process of conversion of chemical energy into mechanical energy. This journal also provides information regarding the complete phenomena of changes in the state and phase of the fuel that takes place inside the combustion chamber. The calculations and observations drawn by the performance of IC Engine by alternative fuels is compared with normal fuels and the difference in the performance is tabulated and they have proved that alternative fuels are better to use which also reduces the consumption of non-renewable fuels. [2]

Rohith S et.al., have examined Fluid flow dynamics inside an engine combustion cylinder plays an important role for air-fuel mixture preparation. IC Engine model is developed u sing CATIAV5R20 tool. The model is then imported to Finite Element pre-processing tool HYPER MESH for the meshing analysis. The model is then imported to Finite Element solver tool. ANSYS FLUENT is used for post processing the results. The flow dynamics inside the cylinder for different minimum valve lift is studied using FEA. Dynamic motion is visualized, and velocity magnitude is plotted for different crank angle from 0° to 730°. Finally, velocity and crank angles for various valve lifts are compared. [3]

3. PROBLEM STATEMENT

Air pollution due to vehicle exhaust emissions is above the threshold, especially in big cities. The vehicle's exhaust gas is generated by the residue of incomplete combustion of fuel in the combustion chamber to form pollutants in the air.

4. OBJECTIVE

- To find a common practice for the usage of distilled water as fuel.
- To increase the thermal efficiency of the engine by separating the hydrogen component from the distilled water and using the same for combustion.
- To enhance clean combustion process of the fuel and thereby reducing the residual gases and pollution.

5. METHODOLOGY

In the proposed approach, we use Hydroxyl gas as an additional source of fuel. This gas was mixed with air before feeding into the combustion chamber. Hydroxyl gas is also known as HHO, Brown's gas, Water gas and Green gas. HHO stands for Hydrogen-Hydrogen-Oxygen. As the name implies, the Hydroxyl gas consists with 2:1 particle of hydrogen and oxygen.

The basic idea of this HHO production process is to separate the hydrogen and oxygen atoms in a water molecule. Output of this HHO process gives a mixture of hydrogen and oxygen that gives the name as ox hydrogen. HHO can be generated through electrolyzing the water.

In this process the water molecules dissociate using two electrodes. The efficiency of the electrolysis process increases with the purified water i.e., water with less impurities. Rainwater, spring water and tap water has a considerable amount of impurities.
A typical analysis will illustrate those minerals, suspended solids, and other contaminants. When this impure water subjected to electrolysis, the impurities will deposit as brown, black, and green substances. These impurities may cause to clog up the electrodes as well. To overcome this dilemma, distilled water i.e., water without impurities was used in the electrolysis process.

6. WORKING PRINCIPLE

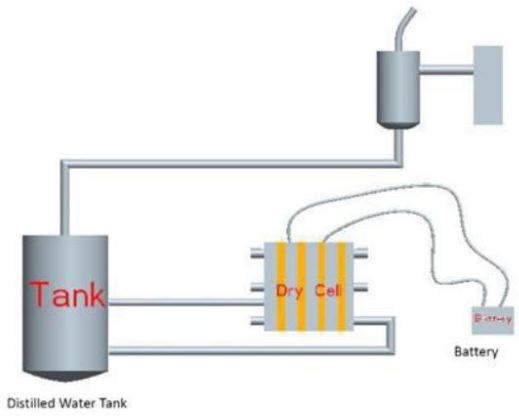

Fig -3: 3D view of the complete setup

Electrolysis involves splitting water into hydrogen and oxygen with the help of electricity. When direct current is passed through water, oxygen appears at the positive anode, while hydrogen is released from the negative cathode. In terms of volume, exactly two times more hydrogen is produced than oxygen. As pure water is not a good conductor of electricity, something like salt is added. If we use an approach on exchange membrane, it is possible to extract hydrogen from pure water as the membrane provides the necessary particle transport between anodes and cathodes. As the figure shown above, we will obtain pure hydrogen that is generated by the process of electrolysis and we obtain pure oxygen at the outlet.

The stoichiometric equation of this process can be expressed as,

Electrolysis: $2H_2O \rightarrow 2H_2 + O_2$
Combustion: $2H_2 + O_2 \rightarrow 2H_2O$

These cells create electrical energy by converting chemical energy into electricity. When dry fuel cells were created, they boosted many advantages over wet cell fuel cells. The dry fuel cell can work under harsh conditions unlike wet fuel cells. Hence, as the diagram shown above, the power for the electrolysis operation to take place is provided by the 12V 10A battery; with the setup of a dry cell, the hydrogen gas is generated by the process of electrolysis which flows through the hose pipe to the bubbler tank. Silica gel chamber is attached to the bubbler tank using a hose pipe, silica gel absorbs all the oxygen content present in the bubbler tank and pure hydrogen is available to drive the engines with the mixture of fuel. Pure oxygen is obtained at the outlet and the hydrogen gas lead to the setup of the engine. The oxygen that is being obtained will be left to the atmosphere as exhaust gas which does not harm the environment. Here the hydrogen generated is not stored which is an advantage because storage of hydrogen is very harmful and dangerous. Hence it is a project which mainly deals with problems regarding environmental harmful gases releasing from the exhaust pipe, it deals with problems with respect to the performance of IC engine and mainly focuses on bringing up alternative source of fuel.

In a dry cell, plates and the connections are sealed from the wet area. A typical dry cell generator. As shown each plate in the generator comes with a gasket to prevent leakage of water. Here, electrolyte was stored in a tank connected to the generator. The HHO gas generated here is served back into the same tank. In this process the electrolyte circulates through the system due to its gravity. Once the tank is filled with HHO gas, it puts pressure on the electrolyte which will help to make the flow. In this design the heat generated inside the system is less than the wet cell generator and also due to the circulation the heat generated inside the system get reduced. So that in this design the HHO gas generates with much higher efficiency. In addition, it consumes less amount of current required for the production.

This process of using hydrogen using as a fuel by the electrolysis process of distilled water, the engine experiences smooth flow, the engine experiences clean combustion by emission of carbon-di-oxide by avoiding emission of carbon-monoxide. The thermal efficiency of the engine also increases, and the mileage of the vehicle also increases by less consumption of fuel. Hence this hybrid fuel can be one of the major invention in limiting the usage of fossil fuels.

6. TESTING & PERFORMANCE ANALYSIS

Specification	Details
Engine Type	99.7 cc, air-cooled, fuel –injection engine, 4-Stroke, Single Cylinder
Compression Ratio	9.8:01
Dimension (L*W*H)	51mm bore, 48.8 mm Stroke
Engine cc	99.7 cc
Max Power	4.4 HP @6000 rpm
Max Torque	6.5 Nm @ 5000 rpm
Valves per Cylinder	2

Table -1: Standard Engine Specifications.

6.1 EXPERIMENTATION

Loading Condition	Time Taken For 100ml Fuel Consumption (Sec) Without Hydrogen Generator
No load	1332 Sec
Half Load	672 Sec
Full Load	340 Sec

Table -2: Time taken by the vehicle for 100ml fuel consumption without hydrogen generator.

Loading Condition	Time Taken For 100ml Fuel Consumption (Sec) Without Hydrogen Generator
No load	2108 Sec
Half Load	1034 Sec
Full Load	572 Sec

Table -3: Time taken by the vehicle for 100ml fuel consumption with hydrogen generator.

6.2 OBSERVATIONS:

Amount of petrol used =100ml
Amount of hydrogen produced by 12V battery = 130-140ml per minute
Amount of distilled water used for 1litre of petrol = 10ml

6.3 RESULTS AND DISCUSSIONS:

Load (Kg)	Time taken for 100ml petrol (Sec)	Specification of Petrol	Torque (Nm)	Brake Power (KW)	Mass of fuel consumption (Kg/hour)		Specific Fuel Consumption (Kg/KWh)	Brake Thermal Eficiency (%)
0	1332	0.71	0	0	0.19			
7	672	0.71	8.93	1.4	0.38			
14	340	0.71	17.85	2.8	0.75			
0	2108	0.71	0	0	0.12			
7	1034	0.71	8.93	1.40	0.25			
14	572	0.71	17.85	2.80	0.45			

7. CONCLUSIONS

- The concept of running an IC engine by generation of hydrogen gas which forms as a hybrid fuel enhances the performance of an IC Engine.
- Practically, there is a magnificent increase in the efficiency by 30-35%.
- The vehicle can be driven a few more minutes with the HHO Generator when compared to fuel consumed without the HHO Generator.
- Experimentally, there is a clear increase in the duration of running of the engine with HHO Generator when compared to the normal engines.
- According to the emission test performed for the same vehicle with HHO generator and without HHO generator, we can observe that HHO generator avoids the emission of CO in-turn it emits CO_2.
- Due to clean combustion process inside the chamber, there are no any harmful effluents or any unburnt particles or gases emitting out of the engine which is harm to the environment. In such a case, HHO generator is environmental friendly and can be used as a “GO GREEN FUEL”.

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BIOGRAPHIES

Mr. Rohith S, currently working as Assistant Professor in the Dept. of Mechanical Engineering, ATME College of Engineering. He is also author of a text book on "Elements of Mechanical Engineering" for 1st year VTU CBCS Scheme in 2018

Mr. Yashwanth N is currently working as Assistant Professor in the Dept. of Mechanical Engineering, ATME College of Engineering, Mysuru. He has research interests in the field of Material Composites & Advanced Manufacturing Processes.

Mr. Pavan Kumar K P is currently working as Assistant Professor in the Dept. of Mechanical Engineering, ATME College of Engineering, Mysuru.