

# AN EXPERIMENTAL INVESTIGATION OF HYBRID FUEL PETROL ENGINE

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**Abstract:** Now a days Mostly Fossil fuels are used in vehicles for combustion cum power generation, but this fuel are depleted, and it will serve next 50 to 60 years with the current population growth of vehicles and this also making huge air pollution and leads to global warming. So, alternate fuel usage for vehicles with less emission is a must for all engines. A hybrid vehicle is a one that uses two or more distinct types of sources of power for its operations. This project aim is to use more than two fuels to an engine application that also with less cost with less emission. In this project a 100 cc four stroke engine is used to use hydrogen, and petrol as a fuel. Hydrogen generator using electrolysis is utilized.

**Keywords:** CC (cubic centimetre), hydrogen, hybrid vehicle, less emission, hydrogen generator.

## 1. INTRODUCTION

In India Fossil fuels are under severe shortage, we are paying huge amount money for oil import. Actually one third of our income was spent for the vehicle fueling. Also after burning usage, the fossil fuels make severe air pollution and associated global warming related climate changes. The vehicle consumes the fuel, gives harmful and dangerous emissions like CO, NO<sub>x</sub>, HC, etc in the form smoke. These carbonaceous materials can affect the atmospheric air quality leads to breathing associated human health issues and pollutes the whole environment. Alternate fuel and other power generation sources is the most solicited requirement for the today scenario. Hybrid vehicle design is the one ,that can utilizes two or more sources of power or multi fuel set up were made and fixed with the necessary control devices in the existing petrol engine that will increase the efficiency of an engine along with least emission without affecting the performance. This work is about to use combination of fuel into an 100 cc Engine with necessary accessories of hydrogen generator and with methane from the methane tank .The devices are HHO Generator, Methane tank with associated bubbler and control valves. Comparing than other types of fuel around the world, water is one of free resources and plenty available. The HHO generator device uses direct current to produce hydrogen gas from water using the principle of electrolysis. There are various ways to produce hydrogen to feed and run an engine. For build this generator that comes with some challenges. It is to ensure that the amount of energy put into the cell to split up the water molecules is lesser than amount of output energy of the generator. This includes coming up with a design will creative to get as much hydrogen out, with the least amount of current running through the dry cell. Considering these aspects into making the HHO generator which includes implementation effective conductivity metals with necessary safety controls.

## 2. WORKING PRINCIPLE

An HHO generator is a device which produces HHO gas. In this process a DC current passed through water, as a result of which, it is divides its primary constituent. Then the produced HHO gas with the help of electrolysis is added in to the air intake manifold and injects in to the cylinder where HHO mix with the fuel ignites and results complete combustion of the hydrocarbon fuel, may lowering emission and increasing fuel efficiency. In this method, electrical energy is used to break water into H<sub>2</sub> and O<sub>2</sub>. In principle, an electrolysis cell consists of two electrodes, commonly flat metal or carbon plates, immersed in an aqueous conducting solution called the electrolyte.

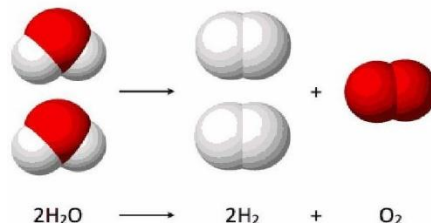


Fig 2.1 HHO hydrogen process

A source of DC voltage connected to the electrodes so that an electric current flows through the electrolyte from anode to cathode. As a result, water in the electrolyte solution is decomposed into H<sub>2</sub> which is released at the cathode and oxygen at the anode. Since water itself is the poor conductor of electricity an electrolyte like KOH is used increase the electric conduction.

## 3. EXPERIMENTAL METHOD

A conventional 100cc S.I engine of Hero Honda passion plus bike is used in the experiment with necessary modifications. Hydrogen generation is carried out by the HHO generator. In the process of electrolysis of water with the help of PWM (Pulse Width Modulator) of the electric wiring of the engine. PWM can sufficiently generate 12V current which is required to carry out HHO generation during electrolysis process.

HHO generator consists of two parts, The first one is container in which S.S plates of 316 grade are used to immerse in the water and second is control box from which generator is connected to the Battery. In this work Battery is connected with PWM of an engine to execute the electrolysis of water. Water needed for this process is of high quality water like distilled water or R.O water or otherwise we can also use water having low TDS below 250-300PPM. The water used for hydrogen generation purpose is changed periodically after 1000 kms. usage or otherwise after water color changes to maroon/red accent.

Methane is a chemical compound with chemical formula CH<sub>4</sub> (one atom of carbon and four atoms of hydrogen). It is a group-14 hydride and the simplest alkane, and is the main constituent of natural gas. Naturally occurring methane is found both below ground and under the seafloor, and is formed by both geological and biological processes. When methane reaches the surface and the atmosphere, it is known as atmospheric methane.

A methane digester unit in house hold with vegetables along with cow dung is used as the digestive material in generation of methane gas was filtered collected in a separate methane storage tank was another alternate fuel in the experiment.

**4. BASIC DETAILS OF HHOGENERATOR**

The HHO generator involves in the production of hydrogen and oxygen with a help of electrolysis process. In this process, Direct Current is passed through electrodes to water. Due to chemical reaction, the positive plates generate Oxygen and negative plates generate Hydrogen. Pure water does not conduct electricity. Adding a base to the water creates an electrolytic solution and increases conductivity, allowing electrolysis to occur. Water with NaCl is the preferred electrolyte.

In the electrolysis device of an electrolyze cell, the electrodes are immersed in the electrolyte, by using DC supply to split water into hydrogen and oxygen. The positive plate emits oxygen and negative plate emits hydrogen. When both are bubbled up and collected together, so called highly burnable fuel is produced. Storing this gas creates explosive effect so directly hosed into the air intake of the engine with necessary bubbler with regulating valves before entering the engine, this HHO gas is automatically mixed with filtered air and then combines with the fuel in engine for firing. By nature HHO supports, combines with gas as well as fuel is another property.

**4.1 DRY CELL HHO GENEATOR**

Two stainless steel electrodes are placed in the HHO cell and are connected with pulse with modulator circuit by external wiring. HHO cell is filled with electrolyte solution which contains mixture of water and electrolyte. The electrolytes used in the electrolytic solution are sodium chloride and baking soda. Electrodes are dipped in the solution for passing the current. The inlet and outlet port of dry cell is connected to water storage tank and bubbler tank by pneumatic hoses with push in swivel fittings respectively. The inlet push in valve is connected to the storage tank that contains water, it travels through dry cell with help of hose and outlet of dry cell is connected to the bubbler inlet to pass the hydrogen gas out of it.

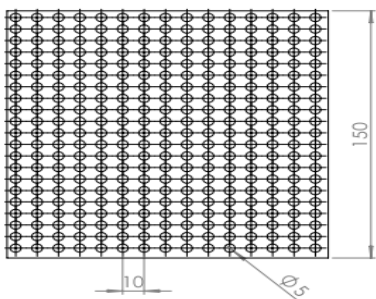


Fig – 4.1 Electrolyte plate (SS 316)

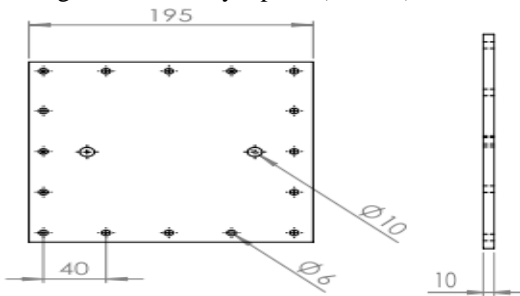


Fig – 4.2 Fiber glass outer sheets

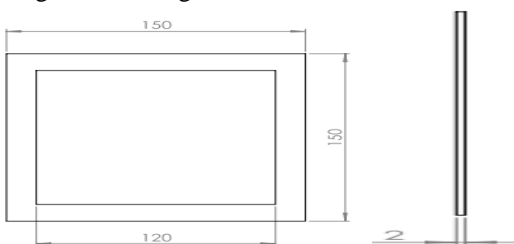


Fig – 4.3 Rubber “O” rings

The above Fig – 4.1 represents the electrolyte plate of the dry cell, Fig – 4.2 represents the fiber glass outer sheets they hold the electrodes inside firmly , Fig – 4.3 represents the rubber O-rings they seals them with electrolyte without any leakage.

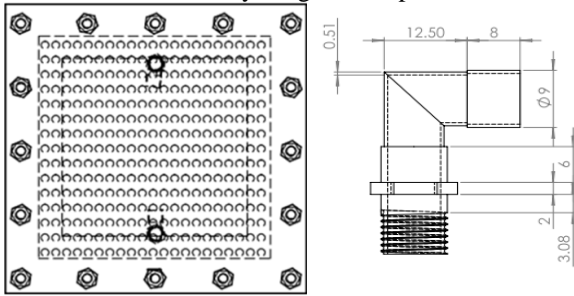


Fig – 4.4 Dry cell assembly and push in fitting

Dry cell designs are cheaper, since they are usually smaller. This design can vary in shape or size, making it very easy to install to a suitable place in the engine setup.

The material used for electrolyte plates is stainless steel 316 for corrosion resistant, and uses regular rubber O-rings to separate in the dry cell.

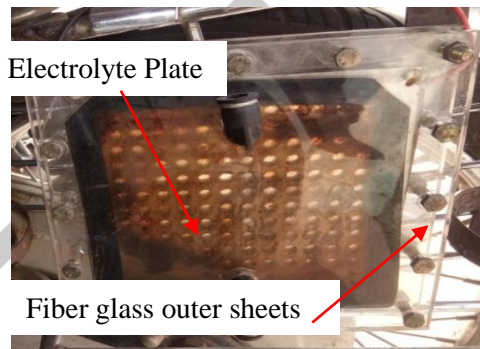


Fig 4.5 HHO Dry Cell fully fabricated

These types of cells have water continuously running through them needs a water tank to supply the water.

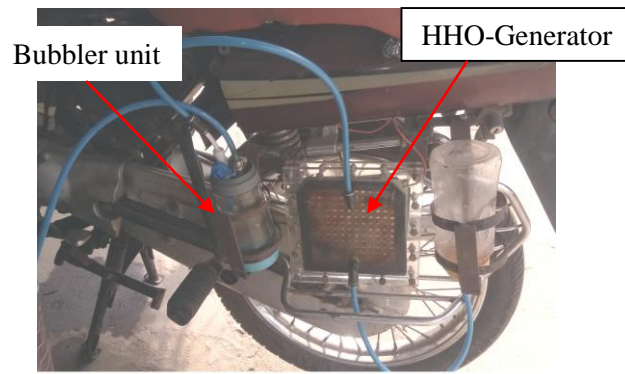
**4. 2 BUBBLER**

Bubbler is otherwise called safety bubbler or gas collector, which has a simple arrangement. The container should be flexible and withstand the vibration and little bit pressure, transparent and should have feet of height. For the gas collecting bubbler requirements a transparent plastic PET bottle is used with necessary connections.

In the bubbler tank bottle cover drills were made to fix the regulator push in fittings. They were connected and perfectly sealed for inlet and outlet of gas flow. The gas out let of the HHO generator fed into inlet of the bubbler unit. The bubbler out let connected to the air filter delivery line of the engine with necessary hose and fittings. For each and every incoming bubbler one way check valve has to be placed to avoid the back flow of the water into the HHO generator side.



Fig 4.4.Bubbler Unit of dry cell



In electrolysis water feeder setup in order to avoid the back firing, the water level in the bubbler to be maintained with required capacity or otherwise it will lead to back fire explosion because HHO is ignited easily.

The three fourth of the bubbler should filled with water. The gas incoming tube from the HHO generator should be dipped into bottom of the water level always. For that purpose the side of the tube is pasted up to bottom level of the bottle with little gap to let gas bubbles from the tube to the top of the water level. The outgoing tube should be connected at the top of the bottle. These arrangements were made as gas tight one without any leakages. This bubbler solves two important problems as the generated HHO bubbles are washed and avoid the chemicals from electrolyze to flow into engine and another important function is protection of flashback effect. Instead of single bubbler we may use more bubbler for our safety and cleaning the HHO brown gas.

### 5. METHANE FUEL FEEDER SETUP

A conventional S.I engine of Hero Honda passion plus bike of 100cc is modified as below mentioned for conducting the experiment. The HHO generator with bubbler unit was fixed LH Side of the pillion foot rest and on the methane storage tank was fixed on RH side near above foot rest, with necessary fixing brackets. The methane from the storage tank is regulated to the required level by the regulator valve , then the gas pass through the pneumatic hoses to reach the methane bubbler unit then to air filter , then gas mixes with air enters into cylinder during the suction stroke.



Methane Feeder unit consists of two parts, First one is the container of 2 kg steel cylinder with regulator used to store methane and second one is the methane bubbler unit is used to avoid the dangerous situation like backfire and misfiring etc, The cylinder outlet regulator controls the gas flow to bubbler. The outlet of bubbler is to pass the methane gas into the air filter of the engine by means of necessary pneumatic hose with fittings.

### 6. RESULT & CONCLUSION

Experimental tests were conducted in the Hero Honda passion plus engine after the above multi fuel feeding setup to investigate the effect of HHO & methane gas on the emission and combustion parameters. A gas analyzer has been used to estimate the concentrations of NOX, HC, CO, CO<sub>2</sub>, and O<sub>2</sub> in the exhaust stream. Tachometer was used to measure the engine speed.

Using HHO along with fuel in the spark ignition engine, CO concentration reduces which reduce the atmospheric emission. The exhaust is sampled by a gas analyzer and the exhaust constituents have been identified and their concentrations have been evaluated. The combustion efficiency has been enhanced when HHO gas has been introduced to the air/fuel mixture, consequently reducing fuel consumption. The concentration of nitrogen oxide has been reduced to almost 50% on average, and the average concentration of carbon monoxide has been reduced to almost 20% of the case where air/fuel mixture was used with HHO. When HHO is introduced to the system, The NOX average concentration has been reduced to about 54%

The below table 6.1 clearly depicts the distance covered by the vehicle for multi fuel firing usage and the table 6.2 depicts the rear wheel rotation in idle load condition, when the fuel combined with hydrogen and fuel without hydrogen in the experimental engine setup. Based on the results there is positive sign of performance improvement and lesser emission of poisonous gases to the environment is observed. Further performance study in detail in future may lead to higher levels.

Trial No.	Fuel Quantity in ml	Distance covered only by petrol (in km)	Distance covered by petrol + HHO (in km)	Distance covered by methane (in km)
1.	100ml	4.8	5.9	5.2
2.	150ml	6.7	8.7	7.8
3.	200ml	9.6	11.9	10.2
4.	250ml	12.0	14.8	13.4
5.	300ml	14.5	17.5	15.7

Table: 6.1 Distance covered by the vehicle for multi fuel firing

Sl. No	Gear	Load Condition	Rear wheel rotation in rpm		Duration in minutes
			Fuel without hydrogen	Fuel with hydrogen	
1.	1st	Idle	36	43	1
2.	2nd	Idle	68	73	1
3.	3rd	Idle	89	97	1
4.	4th	Idle	122	127	1

Table: 6.1 Vehicle rear wheel speed in rpm.

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