

# Modification of IC Engine Running on Water Fuel

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**Abstract**— In this research paper, we use single cylinder spark ignition engine with oxy-hydrogen generator, bubbler to run Bajaj 110cc engine on water as secondary fuel. In which Bubbler is component used for the safety purpose in case of backfire from engine. As we uses mixture of gasoline and hydrogen as fuel. It reduce the consumption of gasoline & increases the mileage of vehicle. The performance and emission characteristics with hydrogen and gasoline are compared. From the results, it is found that there is a reduction of about 20% in the peak power output of the engine when operating with only hydrogen. The brake thermal efficiency with hydrogen is about 2% greater than that of gasoline. CO, CO<sub>2</sub> and HC emissions were negligible with hydrogen operation. However, for hydrogen operation, NO<sub>x</sub> emission was four times higher than that of gasoline at full load power.

**Key words:** IC Engine, Water Fuel

## I. INTRODUCTION

As the current scenario, use of fuel in engine increasing with the time. Fuels are used to run many machines & vehicles. Most of these are use the fossil fuels which are limited and decreasing very quickly and also increase contribution in pollution. Fossil fuels such as petroleum, natural gas and coal meet most of the world's energy demand at present time. But combustion products of these fossil fuels, such as carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), oxides of sulphur (SO<sub>x</sub>), oxides of nitrogen (NO<sub>x</sub>), hydrocarbon (HC), toxic metals, and as it have been causing many environmental problems and posing great danger to human health and also for the world. So we have to find the way to solve this problem as soon as possible. Solution of this problem is by finding the alternative way to use fuel. This problem is solve by reduce the fuel consumption by increasing efficiency of engine, control the pollutant and harmful emission or by finding other engine which are running on alternative fuels. The alternates are electric engine, compressed air engine & oxy-hydrogen gas engine. Electric and compressed air engine can't use where high torque is require.

The main objective of this project is to develop the hydrogen-fuelled vehicles in automobile field. In this project the hydrogen is produced by electrolysis process. Exhaustive lab test on engine & vehicle will done to access the hydrogen behavior at different running conditions. We develop the engine based on hydrogen fuel. Then this fuel characteristic is compare with the petrol's characteristic based on performance and emission in same engine.

As showing on to the ordinary fuels ordinary fuel's low quantity problem, it must to find the way for its replacement.

Hydrogen is use as a fuel because of its properties like high flammability, high calorific value etc. which are fulfil the basic requirements as a fuel. "A small amount of hydrogen can produce a large amount of energy". Hydrogen is produce by many methods, but in all this methods

electrolysis of water is an easy and economical method in bike because the battery is recharge by the dynamo mechanism. Electrolysis of water was first performed by Nicholson and Carlisle after the invention of voltaic piles in 1800 and gained further popularity with the newer sources of electricity. Electrolysis remains a standard method of producing high purity hydrogen, though it is much more cost feasible to produce large volumes of hydrogen from fossil fuel hydrocarbons. The use of oxy-hydrogen as an alternative engine fuel fulfils certain basic criteria such as availability, high specific energy content, minimum pollution. But to use oxy-hydrogen in engine some external components are require to connect with the existing engine. A setup on 110cc SI engine is shown in research paper.

Oxy-hydrogen is an enriched mixture of H<sub>2</sub> & O<sub>2</sub> bonded molecularly & magnetically. It is known as Brown's gas. The ignition temperature of gaseous oxy-hydrogen is 570 C (1065 F) (843 K) which is in the range of 800-1000[K] with a minimum required concentration of 22 to 26%. Minimum energy required for ignition of oxy-hydrogen is 20 micro joules.

For the next generation, it can be impossible to run vehicle with the ordinary fuel and our project is the solution of that problem.

## II. EXPERIMENTAL SET UP

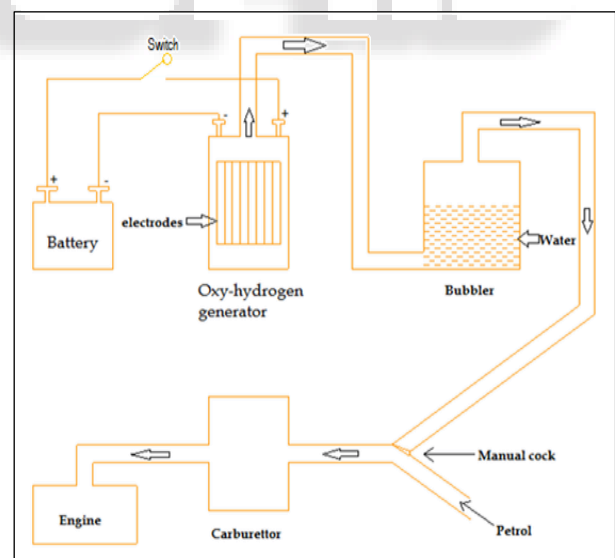


Fig. 1: Block diagram of oxy-hydrogen unit mounted on engine

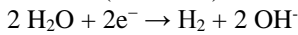
### A. Oxy-hydrogen generator

Oxy-hydrogen generator generates we can produce oxy-hydrogen gas as discussed earlier By Electrolysis process.

#### 1) By Electrolysis process:

This method makes use of the basic principle of faraday's law. Following are the reactions that normally take place at cathode and anode:

Cathode (reduction):



Anode (oxidation):  $4 \text{OH}^- \rightarrow \text{O}_2 + 2 \text{H}_2\text{O} + 4 \text{e}^-$

Overall reaction:  $2 \text{H}_2\text{O} \rightarrow 2 \text{H}_2 (\text{g}) + \text{O}_2 (\text{g})$

An electrical D.C. power source which is continuous charge by dynamo of bike is connected to two electrodes, or two plates typically made from some inert metal such as stainless steel which is placed in 0.357 M (page 17) KOH solution of water (KOH + Distilled water)

In this generator 15 plates are used which have dimension of 20cm×5cm. The plates have three types of charge positive, negative, neutral. As we know this method makes use of the basic principle of Faraday's law & According to Faraday's law 1.73-2.4 V is required for separation of hydrogen & oxygen from water by electrolysis process. If the voltage goes below 1.73 the process will stop and if voltage goes above 2.4 generation of heat occurs which creates wastage of battery power. So the neutral plates are placed between positive & negative to divide the voltage and bring it in range of 1.73-2.4.

The positive, negative & neutral plates are assembled. In this type of assembly we increase the production by increasing the voltage difference between two consecutive plates and also increase the surface area of neutral plates. The plates are mounted on plastic bolts and separated by rubber washers & SS washers alternately. The sequence of assembly is P(+)-2n-2n-2n-N(-)-2n-2n-2n-P(+) as shown in fig 5

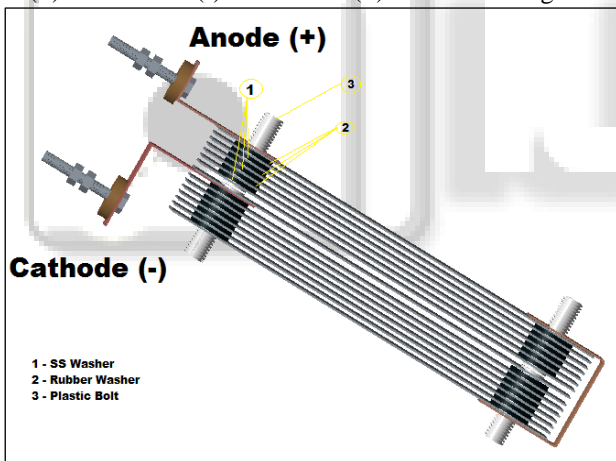


Fig. 2: Plate Assembly TYPE B

In this the voltage difference between two consecutive plates is 3V which is more than 2.4 but for high production this assembly is used in generator.

As tested on engine, one electrolyser of small size is insufficient to provide the necessary quantity of gas; hence number of generators may be used. But using many generators creates problems like where to place them because they occupy large space. And we also need number of power source for each generator which makes setup very difficult and inefficient. So instead of using only hydrogen as fuel we are using Blend of oxy-hydrogen & petrol as fuel to reduce the consumption of petrol and increase the efficiency of vehicle.

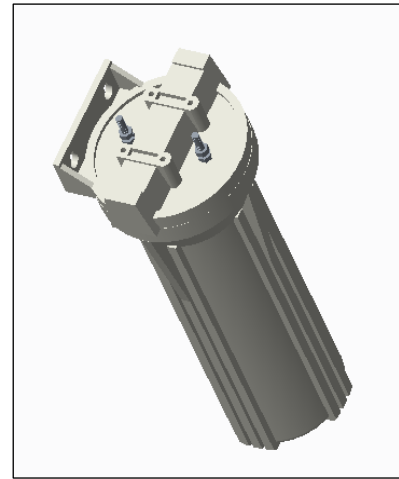


Fig. 3: Oxy-hydrogen generator

### B. Bubbler

Bubbler is a component used for safety purposes in case of backfire from the engine. It is filled with water, through which 'oxy-hydrogen gas' is allowed to pass; also if steam is generated in the generator, it is condensed inside the bubbler. Thus it allows only pure gas to enter the engine.

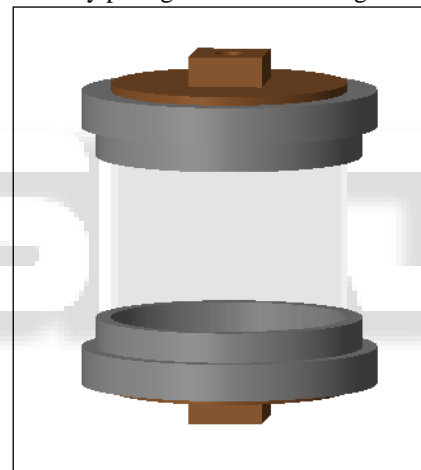


Fig. 4: Bubbler

### C. Carburetor

An engine carburetor is used for controlling the proper A/F ratio and to mix the fuel properly with air. The carburetor is placed before the engine inlet manifold and after the air filter. We supply hydrogen into the engine between the air filter & carburetor, in this one small hole is created on the hose pipe. The hose pipe is a component which joins the air filter and carburetor. The hydrogen pipe is inserted into that hole, and hydrogen is supplied with the other air which the engine takes from the atmosphere. In this hydrogen flows with the help of pressure generated into the generator and also with engine suction pressure.

While running the engine on a mixture of petrol & hydrogen we have to set the carburetor for increasing mileage. The setting of the carburetor is shown below.

### D. Carburetor setting

After having installed the generator and electrical connections made properly, we set the carburetor correctly to

achieve better mileage. The process of setting the carburetor is shown below.

- 1) Adjust the Idle adjusting screw so that the fuel supply is decreased to minimum and engine runs in idle condition smoothly. Finer setting of fuel supply will result in increased mileage of the vehicle.
- 2) Make sure to Fine Tune the Air screw and Idle adjusting screw after running the vehicle for every 200 - 300 Kms until better mileage is achieved. As the carbon deposits on the inside wall of the engine is removed, the vehicle performance will increase gradually.
- 3) Trick is to find Fine setting by "Allow Maximum Air" at maximum RPM and "Reduce Fuel Supply".

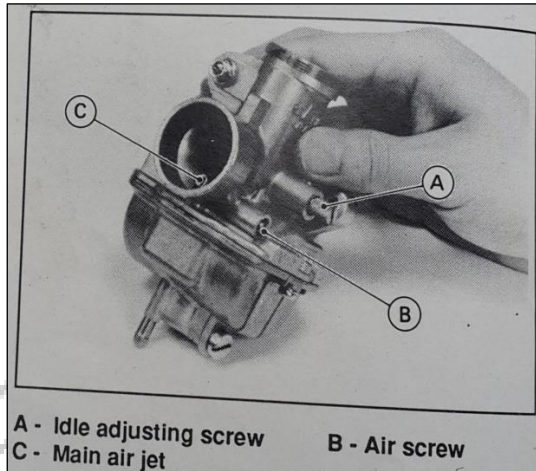


Fig. 5: Setting of carburetor

### III. RESULTS (CONCLUSION) & DISCUSSION

- Mixture of petrol and hydrogen
- Data collected from experiment
  - Time taken to use 30 ml gasoline in ideal condition = 15 minutes
  - Time taken to use 30 ml gasoline and hydrogen in ideal condition = 23 minutes
- From the above data we can say that in 1 min 2ml gasoline is used. so to run the engine for 1 min required energy = volume of gasoline  $\times$  density  $\times$  calorific value  
 $= 2 \times 0.73 \times 10^{-3} \times 45.8 \times 10^6 \text{ J}$   
 $= 66.868 \text{ kJ}$
- So to run the engine for 23 min required energy =  $66.868 \times 23 = 1573.96 \text{ kJ}$
- Total energy consume in 23 min = gasoline's energy + hydrogen's energy  
 $1573.96 = 1003.02 + \text{hydrogen's energy}$
- hydrogen's energy =  $1573.96 - 1003.02 = 570.94 \text{ kJ}$
- % of hydrogen energy =  $(570.94 / 1573.96) \times 100 = 36.27\%$
- % of gasoline energy = 63.73%

Here we say that out of total energy 63.73% energy is taken from gasoline and 36.27% energy is taken from hydrogen to run the engine.

### A. Test 1 - Time taken to burn the identical volume of fuel with only fuel & with mixture of petrol & hydrogen



Fig. 6: Setup for Test 1

Experiment No.	Type of Fuel	Time taken to burn 30ml petrol (min)
1	Only petrol	15
2	Mixture of petrol & hydrogen	20
		22
		23

Table 1: Time taken to burn 30ml petrol  
With the help of this we can find the increased efficiency of engine which is shown below.

- Running time of engine only on petrol = 15min
- Maximum running time of engine on mixture of petrol & hydrogen = 23min
- Minimum running time of engine on mixture of petrol & hydrogen = 20 min
- Maximum Increased time due to hydrogen = time on mixture - time on engine  
 $= 23 \text{ min} - 15 \text{ min} = 8 \text{ min}$
- Maximum Increased efficiency of engine = Increased time  $\times$  100  
 $= 8 \times 100 = 80\%$
- Minimum Increased time due to hydrogen = time on mixture - time on engine  
 $= 20 \text{ min} - 15 \text{ min} = 5 \text{ min}$
- Minimum Increased efficiency of engine = Increased time  $\times$  100  
 $= 5 \times 100 = 50\%$

From this we can say that using mixture of petrol and hydrogen will increase the efficiency of engine around 33% - 53%

### B. Test 2 - Exhaust emission Test

In this test, the exhaust gas of engine is tested with the help of Gas Analyser. This shows that how much amount of different elements are present in exhaust gas. This gas

analyser shows the reading of CO, HC, CO<sub>2</sub>, O<sub>2</sub>, NO<sub>2</sub>, RPM/λ.

Elements in exhaust gas	Only Petrol	Mixture of Petrol & Hydrogen
CO (%)	0.134	0.120
HC (ppm)	580	737
CO <sub>2</sub> (%)	4.55	3.90
O <sub>2</sub> (%)	14.18	15.13
NO <sub>2</sub> (%)	-	-
RPM/λ	2.921	3.273

Table 2: Elements in exhaust gas

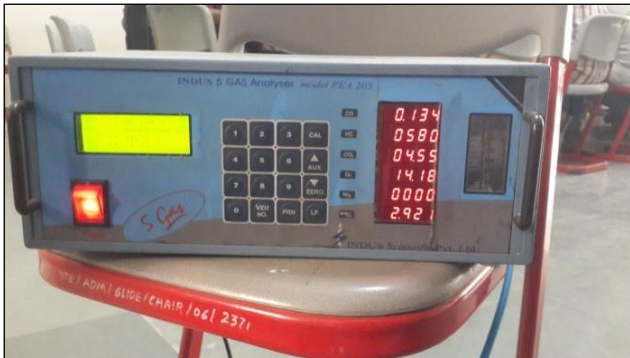


Fig. 7: Gas Analyser readings for petrol



Fig. 8: Gas Analyser readings for mixture of petrol & hydrogen

As shown in table 5.2 and fig 5.1 & 5.2 there is a change in reading of gas analyser for both case. There is a reduction in CO which means exhaust gas is less pollutant. Increase in HC which means there is a unburned fuel is present. Increase in HC is due to additional hydrogen supplied from generator. Reduction in CO<sub>2</sub> which is good for environment. Increase in O<sub>2</sub> which is also good for environment. Increase of O<sub>2</sub> is because of external O<sub>2</sub> is supplied from generator. Increase in value of RPM/λ which indicates there is either increase in rpm or decrease in λ. The λ value reflects whether or not the air/fuel ratio was rich or lean before it enters the cylinder for combustion. Reduction in CO is 10.44% and CO<sub>2</sub> is 14.28% increment in RPM/λ is 12.05% , HC is 27.06% and in O<sub>2</sub> is 6.69%

1) *Advantages:*

- Eliminate harmful exhaust emission like CO, CO<sub>2</sub> that pollute the environment and contribute to global warming. Your engine will add oxygen to the environment instead of polluting it.
- Increase in mileage of vehicle 20% to 40%.
- Increase in life of engine oil more than 2 to 3 times.
- Increase in pick-up of vehicle.

- Better smoother running engine.
- Remove carbon deposits up to 50% and prevent future carbon build up.
- Reduce knocking of engine.
- Reduce the operating temperature of the engine.
- Decreases oil consumption of engine.

Fuel Saving can be between 30% to 50 % depending up on viscosity of fuel, Driving style, Road conditions & other parameter.

IV. CONCLUSIONS

It is advantageous to use Brown's gas enriched air as a fuel in internal combustion engines. Significant impact on brake thermal efficiency and brake power is observed upon the addition of Brown's gas enriched air. Fuel consumption and other emissions viz: NO<sub>x</sub> and smoke emissions are reduced to considerable amount. Hydrogen fuel enhancement from electrolysis (utilizing automotive alternators) has been promoted for use with gasolinepowered and diesel trucks, although electrolysis-based designs have repeatedly failed efficiency tests and contradict widely accepted laws of thermodynamics. This project will help our country to be energy independence 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.

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