

# Analysis of hydrogen production using water electrolysis method to experiment it on a IC engine

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**Abstract** - The goal of this project is to create a straightforward yet inventive HHO producing system using water electrolysis and assess the impact of adding hydroxyl gas HHO to petrol, which is utilised as fuel in 4-stroke engines. The HHO cell is designed to produce the most HHO gas per unit of input power. As the ideal system, potassium hydroxide is used to increase the electrical conductivity to separate the hydrogen in water. The outcome of the project HHO produced 8.4 L/hr Using 6g of KOH with 1litre of water used. This hydrogen is performed with IC engine to achieve more fuel efficiency and to reduce toxic gases.

**Key Words:** Analysis, Hydrogen Production, IC Engines, Electrolysis, KOH.

## 1.Introduction

In the modern world, fossil fuels are the in the modern world, fossil fuels are the main energy source for power plants, autos, etc. When engines burn using fossil fuel, they release noxious gases such carbon dioxide, carbon monoxide, nitrogen oxides, and unburned hydrocarbons. These pollutants have a number of negative effects, including acid rain, global warming, and several health problems. Recently, a number of alternative fuels have been investigated in an effort to lesson reliance on fossil fuels and cut emissions. The state of the art for HHO petrol, a renewable alternative fuel with a number of advantages over fossil fuels, is presented in this study. Water is electrolyzed to create HHO gas using KOH chemical. After adding an electrolyte, a direct current is run through water to initiate the electrolysis process. It causes the solution to become electrically conductive. Water is broken down into other elements as a result of the ensuing ionisation reactions Many names for approximate stoichiometric mixture of hydrogen and oxygen gas that electrolyser produces including the hydrogen gas, oxy-hydrogen, and HHO.

## 2. Materials

The stainless-steel plate is used as electrode plates. Dimensions of electrode plates 30×60×2 mm. The hydrogen production shell is made of PVC (polyvinyl chloride) material. The production shell is fully shield to avoid leakage of hydrogen gas during production

process. KOH (potassium hydroxide) is a chemical used. KOH is mixed water and the electricity is passed into it. The KOH increases the electrical conductivity for hydrogen production.

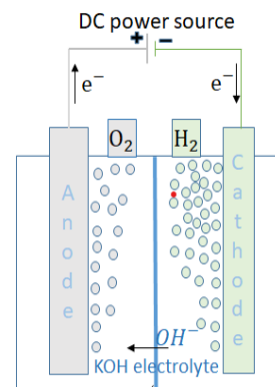


Fig -1: Electrode Plates.

PU (polyurethane) tube is used to transfer hydrogen from one place to another. Here a plastic can acts as storage can. The can is filled with water, this water helps to prevent backfire while performing test in a IC engine.



Fig -2: separation process of hydrogen and oxygen

### 3. Engine specification

Table - 1: IC engine specification.

Engine type	4 stroke single cylinder
Displacement	97.2 cc
Maximum power	8.02bhp @ 8000rpm
Maximum torque	8.05Nm @ 6000rpm
Bore and stroke	50 × 49.5 mm
Idle speed	1100 rpm
No. of cylinders	1
Cooling system	Air cooled

The produced hydrogen is transferred to the engine and calculating the efficiency at a particular millilitre of petrol with and without hydrogen to calculate the efficiency correspondingly.

(Note: - before performing ensure the safety measurements and check for leakage of hydrogen, petrol and engine condition and start the experiment.)

### 4. Methodology

#### 4.1 Hydrogen production process

The 1litre of water is mixed with 6g of KOH and poured into the production shell. The According to the faradays rule 1.24 volt minimum was based on the use of battery acid. The KOH minimum voltage is 1.67 voltage drop. So, the electrolyte solution is affected by the drop. Due to the low voltage drop KOH was chosen. It can be calculated from one plate, the production of H<sub>2</sub> is 0.035 lit/min and O<sub>2</sub> is 0.017 lit/min.

Electrodes plates anode and cathode are immersed into the mixture of water and KOH. The potassium hydroxide helps to increase the electrical conductivity and helps the produce hydrogen quick and easy. The DC (direct current) is used throughout the experiment because it is more efficient and has high power comparing to AC (alternating current). The hydrogen is collected using PU (polyurethane) tube and passed to a storage can. The can which acts as a storage reservoir is filled with water. The water in reservoir because when the experiment is performing engine may miss fire and leads to back fire. This back fire can lead to burn and explosive into the production shell. According to the faradays rule 1.24 volt minimum was based on the use of battery acid. The KOH minimum voltage is 1.67 voltage drop. So, the electrolyte solution is affected by the drop. Due to the low voltage drop KOH was chosen. It can be calculated from one

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#### 4.2 Calculation

Total production of gas from one plate (H<sub>2</sub>O)

Hydrogen = 0.035 lit/min

Oxygen = 0.017 lit/min

So, by adding the hydrogen and oxygen we get,

$$= 0.035 + 0.017$$

Total gas = 0.052 lit/min.

The amount of hydrogen generated from the experiment is about,

S.No	Amount of water (millilitre)	Amount of KOH (grams)	Voltage (volt)	Ampere (amps)	Amount of hydrogen produced (ml/sec)
1	1000	2	12	1.7	104/54
2	1000	4	12	3.4	104/45
3	1000	5	12	4.4	104/33
4	1000	6	12	5	104/26
5	1000	8	12	7.3	104/21

Table - 2: Parameters for producing hydrogen gas.

= N × total amount of gas generated.

Here N = no of electrode plates

$$= 2 \times 0.052$$

Amount of hydrogen generated = 0.104 lit/min.

Calculation for the parameters in table 2;

The voltage and ampere were calculated using the digital multi-meter and amp meter. The amount of 104 ml of hydrogen in seconds is using the stopwatch. The KOH grams are varied like 2g, 4g, 5g, 6g and 8g mixture with water and measuring it at which time it achieves 104ml using stopwatch. Here the measure values are in milli litres.

We know that the total amount of hydrogen generated = 0.104 litre

Total amount of hydrogen × 1000

= 0.104 × 1000

= 104 ml.

This hydrogen gas is held into the IC engine and measured the difference between hydrogen with petrol and without hydrogen is calculated for the measurement of efficiency.

**5. Literature survey**

[1] The Water electrolysis method consists of decomposing water molecules into hydrogen and oxygen. We choose alkaline electrolysis which uses hydroxide aqueous solution of potassium (KOH) as electrolyte.

[2] This one can maximize the conversion of solar radiation into chemical energy in the form of hydrogen by water electrolysis hybridizing the solar hydrogen production system, namely using both electrical energy as well as thermal energy in the form steam.

[3] Green hydrogen is booming and the preferred Technology is solar photovoltaic pulse electrolysis. The solar concentrators may produce thermal energy at a cost less than the cost of nuclear thermal energy.

[4] This is because of its advantages for the environment, the electrolysis of water to produce hydrogen (HHO) has drawn interest as a possible alternative fuel source. HHO addition to petrol may enhance engine performance, resulting in higher fuel economy and lower emissions, according to research. To completely comprehend the impact of HHO addition on engine performance and emissions, more research is necessary.

[5] promise of HHO petrol as an alternative fuel is highlighted in this literature review, which also emphasises its production methods, thermodynamics, and chemical kinetics. Additionally, it talks about how HHO petrol affects the performance of IC engines, demonstrating increases in torque, power, and efficiency as well as a decrease in pollutants. But obstacles including system complexity, cost, safety, and electrolysis efficiency continue to be major concerns for broader use.

**6. Performance test**

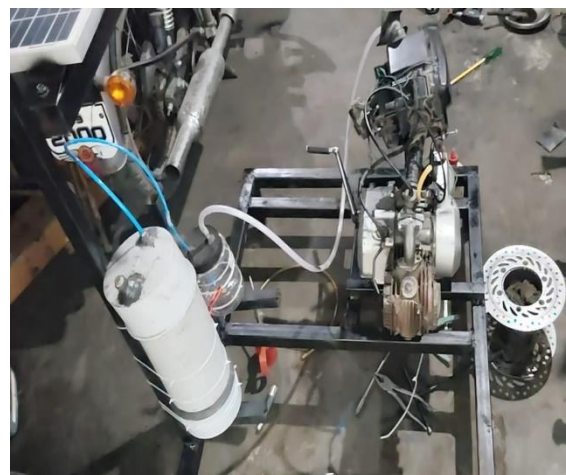
The hydrogen is held with into the IC 4 stroke engine to calculate the efficiency that how long the engine is running at constant idle speed of 1100 rpm with and without hydrogen is measured in the table below.

**Table - 3:** Performance Measure

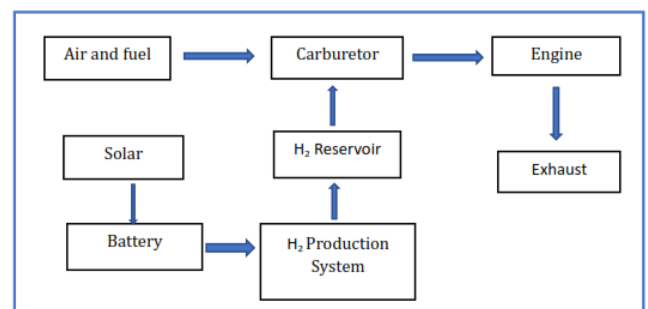
S.No	Petrol (ml)	Engine running time with petrol (min)	Engine running time with petrol and H <sub>2</sub> (min)
1	10	2.2	3.3
2	10	2.1	3
3	10	2.2	3.1
4	20	4.5	5.35
5	20	4.5	5.35
6	20	4.6	5.39

**7. Fabrication**

The base frame is made and the IC engine, production shell, reservoir is mounted. The production shell is shield without leakage and the experiment has held by running the engine using petrol and hydrogen gas.



**Fig - 3 :** Hydrogen Production and running on a IC engine.



**Fig - 4:** Arrangement to Connect the H<sub>2</sub> Production System into IC engine.

Engine Modification: Install a hydrogen fuel injection system and make sure the engine's parts are hydrogen-compatible. To account for the altered air-fuel ratio needed for hydrogen combustion, the engine's air intake system must be modified.

### 8. Result

The difference while the 4 stroke IC engine runs with and without hydrogen gas is plotted into a bar chart. This chart says the increase in efficiency of an IC engine with hydrogen.

(Note: - the use of hydrogen in a normal air-cooled engine causes more heat. So, to rectify this problem the cooling system like oil cooled and liquid cooled can be employed. The tail pipe emission is reduced by varying the air - fuel mixture in the carburettor by adjusting the fuel screw into lean mixture.)

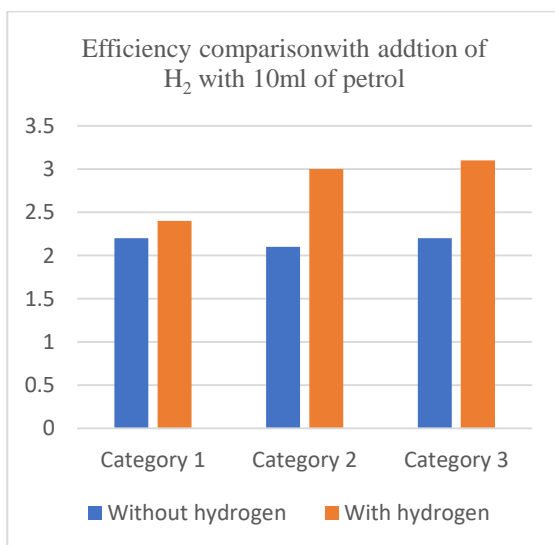
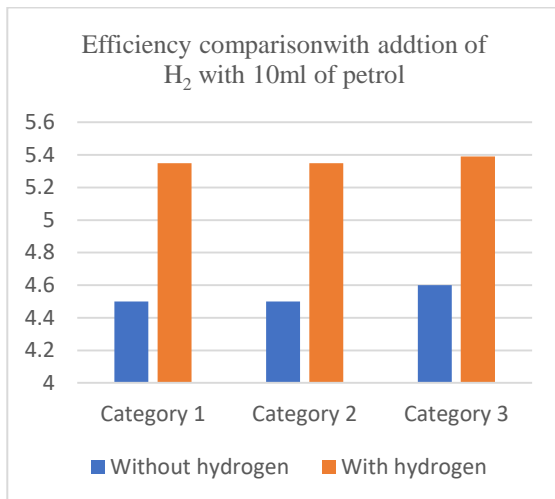


Fig - 5: Efficiency difference with use of hydrogen gas into the IC engine.

### 9. Conclusion

The hydrogen production using electrolysis method is very easy and quick to produce hydrogen. This can be made into a small compact size that suits in a automobile engine to run the engine using h<sub>2</sub> gas which gives even more efficient running and low tail pipe emission. Apart from air cooled engine it is easy to employ it into liquid and oil cooled engines which has a several temperature ranges and cool the engine temperature accordingly and reduce the heating issues. This can be connected in the vehicle battery for generation process. The vehicle battery will automatically charge while the vehicle is in motion.

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