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# Performance Analysis of Four Stroke SI Engine using Oxy-Hydrogen Gas

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**Abstract:** Global air pollution is one of the major threats of 21st century for the developing and developed countries. The existence of petroleum products is reducing day-by-day and the pollution caused by them is increasing drastically, the demand for the alternate fuel is constantly increasing. One such alternate fuel is Oxy-Hydrogen gas or HHO gas. Running the automobile engine using this HHO gas as an alternate fuel and reducing the fuel (petrol/diesel) consumption, thereby reducing the atmospheric pollution is the reason behind the development of this project. HHO gas technology is still considered experimental but it is a supplemental fuel additive of sorts that could help you increase mileage, increase horsepower, reduce emissions while providing a quieter and cleaner engine. Energy must be conserved in one way or other so we are trying to implement this in the future. This might be a good plan to save the environment. It is clear from the various investigations and analyses that hydrogen has the potential to be a very promising eco-friendly fuel. The Hydrogen powered vehicle is an eco-friendly vehicle which uses Hydrogen gas as a fuel for propulsion of the vehicle. The vehicle runs on 40% Hydrogen and 60% Petrol. With high demand for more efficient engines, our mission is to create a device that will increase engine efficiency without jeopardizing its performance. Such device is an HHO Generator. This includes coming up with a creative idea to get as much hydrogen out, with the least amount of current running through the cell.

**Keywords:** Oxy-Hydrogen gas, hybrid fuel, Intake manifold, Electrolysis.

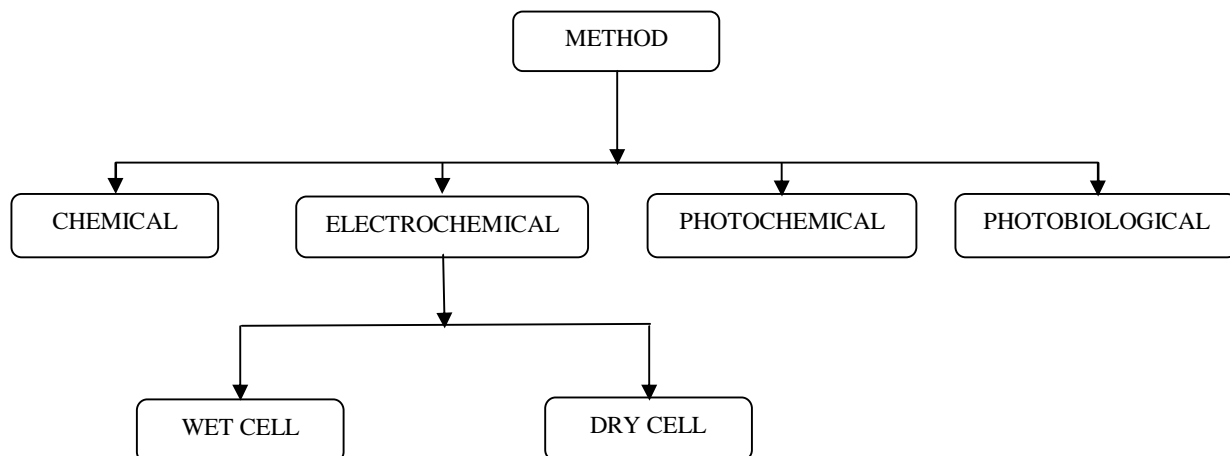
## I. INTRODUCTION

Our main goal is to outline and make a gadget that will expand engine's effectiveness without imperiling its execution. Such gadget is a HHO Generator. This generator utilizes DC current (electrolysis) to yield hydrogen from water. There are two distinctive approaches to run the hydrogen into the engine. The first and most determined route to this is to send it through the injectors, while stopping the fuel line. This might be done if the framework is self-supported, which means the motorcycle can keep running on hydrogen as it were. In the event that this isn't refined because of thermodynamic confinements, at that point the hydrogen will be brought into the combustion chamber of the engine through the air intake manifold. We will try to make the generator minimized and cost efficient, with the goal for it to be attractive to clients. In a Spark ignition engine a perfectly mixed air fuel mixture enters the engine during suction stroke.

## II. METHODOLOGY

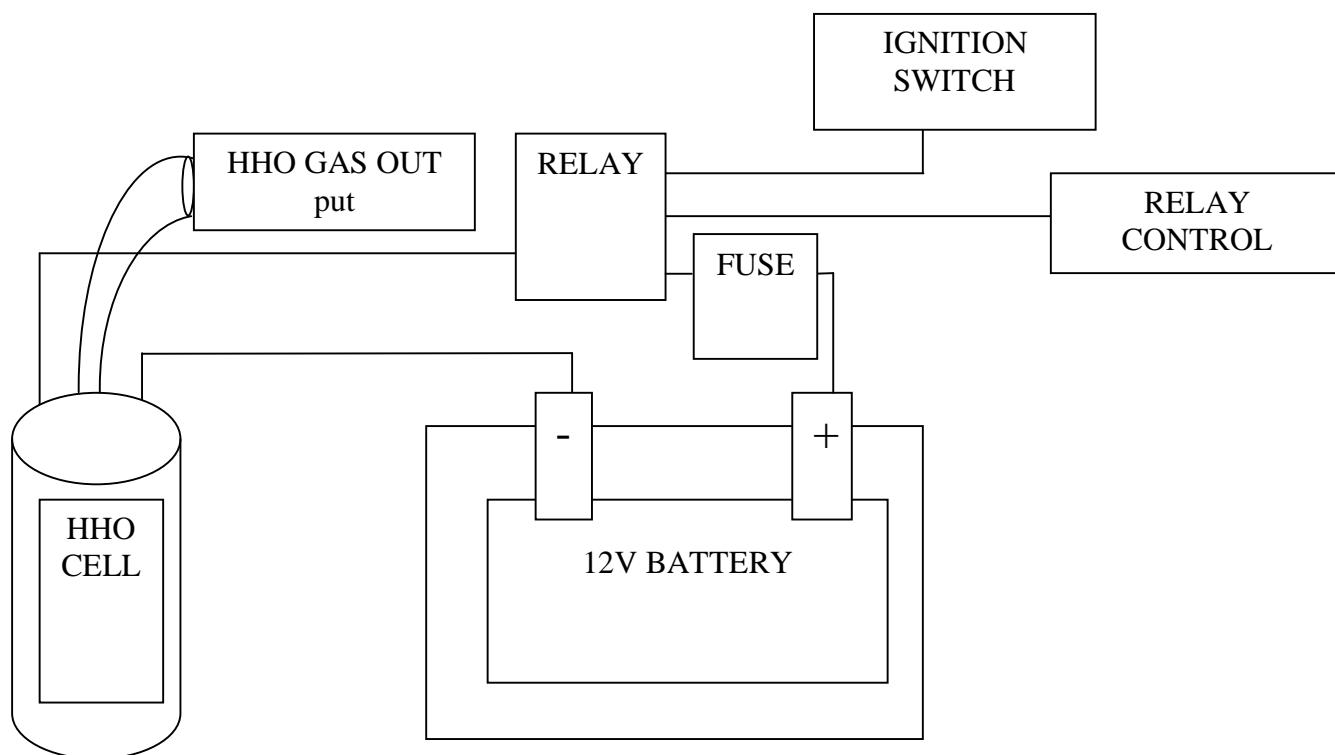
Hydrogen is generated by electrolysis of water, when electric current is passed through water, the water molecules (H-O-H) are split into Hydrogen and Oxygen. The gases are collected. This gas is then passed through a bubbler which acts as a safety valve preventing the back firing of the hydrogen gas. Then the gas is supplied into the carburettor where it is mixed with the atmospheric air to form air-fuel mixture. This air-fuel-mixture is then fed into the engine for combustion.





### III. WORKING

The Hydrogen gas required for combustion process is generated by electrolysis of water, when electric current is passed through the electrolyte the H<sub>2</sub>O molecule is split into Hydrogen and Oxygen gas. This Hydrogen and Oxygen gas combined as HHO gas is collected and injected into the air intake manifold. This HHO gas is further injected into the combustion chamber for combustion, which rotates the crank for propulsion of the vehicle.



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Due to maximum combustion of the fuel, the carbon deposition is reduced to very minimal quantity, which in turn reduces the carbon based emissions such as CO, CO<sub>2</sub>, HC, and also other emissions such as NOX. The thermal efficiency and the fuel economy is increased while using this hybrid fuel. Brake specific fuel consumption and volumetric efficiency was decreasing as the supply of HHO gas was increased. Due to the very minimal deposition of carbon the engines life increases.



Storage Tank & Bubbler Setup

Dry Cell Setup Fixed In Bike

Comparison of properties of hydrogen with petrol.

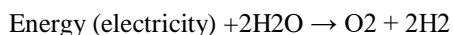
PROPERTIES	H <sub>2</sub>	PETROL
Quenching gap in NTP air, cm	0.064	0.3
Auto ignition Temp, K	849	501-764
Flame Temperature in air, K	2318	2370
Stoichiometric composition in air, volume %	29.53	1.76
Limits of Flammability in air, volume %	4-65	1.0-7.6
Burning Velocity in NTP air, cm/s	325	34-63
Normalized Flame Emissivity	1.0	1.7
Research octane number	130	30
Flame velocity (cm/s)	265 - 325	30
Density at 16 0C and 1.01 bar (kg/m <sup>3</sup> )	0.0838	833 - 881
Net heating value (MJ/kg)	119.93	42.5
Equivalence ratio flammability limit in NTP air	0.1-7.1	0.7-3.8

#### A. Hydrogen Gas Generation

The general methods which are used in this research work for the generation of hydrogen gas, makes use of the basic principle of faradays law. An electrolytic cell is used for the decomposition of distilled water (H<sub>2</sub>O) in to HHO. Heat is generated due to this electrolysis process, so KOH may be added gradually to accelerate the decomposing of H<sub>2</sub>O in to HHO and assure control of the heat generation. An electrical power source is connected to two electrodes, or two plates typically made from some inert metal such as platinum or stainless steel which is placed in the water. In a properly designed cell, hydrogen will appear at the cathode (the negatively charged electrode, where electrons enter the water), and oxygen will appear at the anode (the positively charged

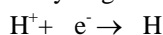
electrode). Assuming ideal faradic efficiency, the amount of hydrogen generated is twice the number of moles of oxygen, and both are directly proportional to the total electrical charge conducted by the solution.

Following are the reactions normally take place at cathode .Splitting water with electricity to produce hydrogen and oxygen the chemical equation for electrolysis is:

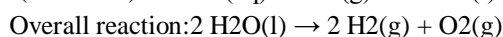
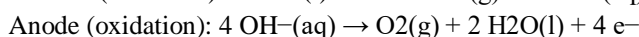
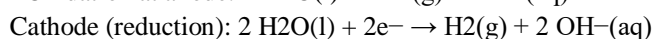
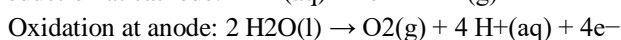
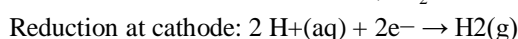


At cathode there is a negative charge created by the battery. This means that there is an electrical pressure to push electrons into the water at this end. At the anode there is a positive charge, so that electrode would like to absorb electrons. But the water isn't a very good conductor. Instead, in order for there to be a flow of charge all the way around the circuit, water molecules near the cathode are split up into a positively charged hydrogen ion, which is symbolized as  $\text{H}^+$  in the diagram above and a negatively charged "hydroxide" ion, symbolized  $\text{OH}^-$ :

The expected that  $\text{H}_2\text{O}$  would break up into an H and an OH (the same atoms but neutral charges) instead, but this doesn't happen because the oxygen atom more strongly attracts the electron from the  $\text{H}^-$  it steals it( we say the oxygen atom is more "electronegative "than hydrogen). This theft allows the resulting hydroxide ion to have a completely filled outer shell, making it more stable. But the  $\text{h}^+$ , which is just a naked proton, is now free to pick up an electron symbolized  $\text{e}^-$  from the cathode, which is trying hard to donate electrons, and become a regular, neutral hydrogen atom



This hydrogen atom meets another hydrogen atom forms a hydrogen gas molecule



#### IV. CONCLUSION

In this project we have proposed a convenient and an efficient method to build up a HHO generator. According to the results observed the amount of HHO increases with increase of current .There was a significant reduction of unburned hydrocarbons as a result of the increase in HHO inclusion . Introduction of HHO led to improved combustion .The use of HHO in 4-stroke SI engine leads to reduction in emission of harmful pollutants such as carbon monoxide and unburnt hydrocarbons. Although an increase in power and a reduction in harmful exhaust emissions were observed as a result of adding HHO which was quite promising, however amongst other load conditions and engine speeds, the results contradict this finding. Thus, further research into this technology would be recommended. There is need for further HHO generator refinement and development, alongside use of more modern engine management and control. Usage of Hydrogen fuel from electrolysis (utilizing automotive alternators) has been promoted for use with SI and CI engine will be efficient and eco-friendly , 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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