PERFORMANCE ANALYSIS OF GASOLINE ENGINE USING HHO GAS AS FUEL

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Abstract - *Oxy Hydrogen gas has recently been introduced to the auto industry as a new source of fuel. This work proposes the invention of a new device attached to the engine to integrate on HHO generating device is compact and can be installed with the engine . This modified device was integrated and tested on a two stroke petrol engine. HHO gas kit was installed with engine. Performance analysis and emission analysis has been done by using petrol and HHO separately on engine. It has been found that reduction in fuel consumption is achieved by using HHO and appreciable amount of reduction in emission of pollutants such as CO, unburned hydro carbons and CO_2 particularly during the ideal condition own.*

Key Words: Emissions, Oxy Hydrogen gas, Spark ignition engine, Specific fuel consumption, Thermal efficiency

1. INTRODUCTION

Now a day's petrol is very common to use alternative fuel in internal combustion engine to enhance the engine performance and to reducing the emission. Hydrogen gas is more efficient and clean fuel and low in economic. Aim of Our project is to analyse the separation of hydrogen gas from water. To separate hydrogen gas from water by using Titanium electrode. Titanium is used to extract the hydrogen from water continuously. In addition of KOH in electrolysis process for producing more amount of hydrogen. To analyse performance test like Brake thermal efficiency, overall efficiency, specific fuel consumption, Brake horse power, fuel horse power, Indicated horse power, mechanical efficiency, Indicated thermal efficiency and etc., also analyse emission NO_X, CO, CO_2, HC and O_2.They conducted experiments at different speeds and under different load conditions and different flow rates of HHO gas. Results showed compared to oxy hydrogen gas and petrol. The diluted solution is prepared by adding 900ml of distilled water to 50 to 60ml of electrode. The generator is filled with the diluted solution of the electrolyte and mounted on the engine. When electric current is passed through the diluted solution, generator produce 0.6litres of HHO gas per minute. Adding a small amount of hydrogen gas to the air intake of a combustion process can reduce the emission and fuel consumption. Production of hydrogen rich gas from the electrolysis of water at the point of use could solve many of the potential difficulties of using hydrogen as fuel supplement to improve hydrocarbon combustion. This gas has been shown to exhibit properties that make it a much more reactive gas than standard bottled hydrogen. Brown gas generating system powered by the engine electrical system, can significantly improve engine emissions, performance and fuel efficiency.

1.1 Literature Survey

According to the studies of hydrogen gas as a fuel to the internal combustion engine is difficult earlier but now a days the usage of hydrogen fuel that can take place in the automotive generation. The various new design and the modifications are invented in automobile industries, but one of the difficult job is that to store hydrogen in a tank .The specialized tank is required to store hydrogen, which reduces the risk of storing highly explosive gas. Anyway we require high amount spending on storage tank but it will have sufficient fuel for the certain requirement and also the various performance changes will happens in the internal combustion engine such as ignition ratio, decrease in the internal temperature of the engine, increase in the engine rpm, increase in the load capacity which is really a most benefit for the automotive industries. Hydrogen gas was used as a supplementary fuel in four cylinder, four strokes, compression ignition (CI) engine without any modification and without need for a storage tanks.

1.2 EXPERIMENTAL DETAILS

Engine

Fig -1 Engine

Here in this experiment the TVS 50 engine is used for the test, while in this engine no modification is required. The

produced oxy-hydrogen fuel is introduced in the engine as a fuel. It is a two stroke internal combustion engine which completes a power cycle with two strokes (up and down movements) of the piston during only one crankshaft revolution. In two stroke engine, the end of the combustion stroke and the beginning of the compression stroke happen simultaneously, with the intake and exhaust function occurring at the seam time. Two stroke engines often have a high power-to-weight ratio, power being available in a narrow range of rotational speeds called the "power band". Compared to four-stroke engines, two-stroke engine have a greatly reduced number of moving parts, and so can be more compact and significantly lighter, the specification of TVS50 engine are in the below table,

Table -1 Engine specification

Max torque	5 Nm @ 3750 rpm
Max power	3.5bhp @ 5000rpm
Cubic capacity	50cc
Bore	46mm
Stroke	42mm
Mileage	66kmpl
Speed	50kmph
No. Of cylinder	1
No. Of stroke	2

Oxy-Hydrogen Generator

The oxy-hydrogen generator is a device that is designed to produce hydrogen and oxygen gas from water by the electrolysis process. The generator setup is of closed container containing electrodes of Titanium which formulates the continuous formation of Oxy-hydrogen gas and being the electrodes are connected to two terminals of the power source, here the electrolyte used is potassium hydroxide which is more reactive with the electric charges, the generator housing is made from low density plastic, with a cover made from the plastic material. The exit valve for the gas is situated at the middle of the cover connected to hose and it to the oxy-hydrogen storage tank and then to the engine with a constant and controlled condition.

The Electric current is passed through the titanium electrodes to the water to break down the water molecules

to produce hydrogen and oxygen gases. If there is partition in the generator chamber, the pure hydrogen and oxygen gases can be collected separately but in this case, they are collected together as a mixture of hydrogen and oxygen gases called oxy-hydrogen gas, the oxy-hydrogen material details are on the below table;

Table -2 Materials of HHO generator

S.NO	PARTS	MATERIAL
1	Cover	Thermosetting plastic
2	Anode	Titanium
3	Cathode	Titanium
4	Housing	Conventional plastic
5	Vent	PVC

1.3 Electrolysis Process

Electrolysis is the chemical process of using an electrical current to stimulate non-spontaneous reactions. A non – spontaneous reaction is one that needs energy to work while it proceeds. In other words, the process would not happen on its own, as it goes in an unfavorable, or a reversed, direction. Important uses include its role in separation metals from a natural source, such titanium ore. Other useful benefits for electrolysis include the purification of metals and decomposition of compounds like water.

The site where electrolysis occurs is in an electrolytic cell, which is a type of electrochemical cell that drives an electrical current using a non-spontaneous reaction. So, not like a cell in your body, but a container. Thus, these cells must have an energy source to drive the reaction in the reverse or opposite direction, like a battery.

This process will require an anode, a positively charged electrode, and a cathode negatively charged electrode. In this case, an titanium metal is the electrode. The electrodes are placed inside the container with the presence of electrolyte and electric current. The goal is to use electrolysis for the purpose of producing oxy hydrogen gas from the water. An electrolyte is a substance, frequently an ion conducting polymer that contains free ions, which carry electric current in the electrolyte. The potassium oxide is used as the electrolyte.

Which is more efficient for the production of oxy hydrogen gas with the presence of electric current. The amount of electric current must be added equal the change in Gibbs free energy of the reaction plus the losses in the system. The losses can be arbitrarily close to zero, so the maximum thermodynamic efficiency equals the enthalpy change divided by the free energy change of the reaction. The

electric input is larger than the enthalpy of the reaction, so sum energy is released in the form of heat. In some cases for instant, the electrolysis of water in to hydrogen and oxygen at high temperature and the heat energy is observed. This heat absorbed from the surrounding, and the heating value of the produced hydrogen is higher that the electric input.
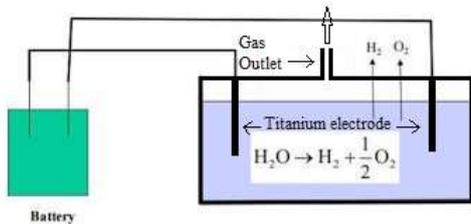

Fig -2 Electrolysis Process

1.4 Electrolysis of acidified water

The energy efficiency of water electrolysis varies widely. The efficiency of an electrolyses is a measure of the enthalpy contained in the hydrogen (to undergo combustion with oxygen, or some other later reaction), compared with the input electrical energy. Heat/enthalpy values for hydrogen are well published in science and engineering texts, as 144MJ/Kg. Note that fuel cells(not electrolyses), cannot use this full amount of heat/enthalpy, which has led to some confusion when calculating efficiency values for both types of technology. In the reaction, some energy is lost as the heat. Some reports quote efficiencies between 50% and 70% for alkaline electrolyses, however, much higher practical efficiencies are available with the use of PEM (Polymer electrolyte Membrane electrolysis) and catalytic technology such as 95% efficiency.

NREL estimated that 1 kg of hydrogen (roughly equivalent to 3 kg, or 4 l, of petroleum in energy terms) could be produced by wind powered electrolysis for between $5.55 in the neat term and $2.27 in the long term. About 4% of hydrogen gas produced worldwide is generated by electrolysis, and normally used onsite. Hydrogen is used for the creation of ammonia for fertilizer via the Haber process, and converting heavy petroleum sources to lighter fractions via hydro cracking.

The electrolysis of water produces hydrogen,

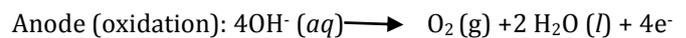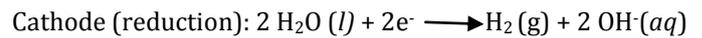$2 H_2O$ (*l*) $2 H_2(g) + O_2(g)$

## 1.5 Electrodes of the process

An electrode in an electrochemical cell is referred as either an anode or a cathode. The anode is now defined as the electrode at which electrons leave the cell and oxidation occurs, and the cathode as the electrode at which electrons enter the cell and reduction occurs. Each electrode may become either the anode or the cathode depending on the direction of current through the cell. A bipolar electrode is an electrode that functions as the anode of one cell and the

cathode of another cell. The anode and cathode both are of titanium material which is more reactant with the electric current and the electrolyte is potassium oxide, the titanium used for the continuous formation of oxy-hydrogen gas, the other electrodes like copper, stainless steel, iron, etc are not more effective to the continuous formation of gas.

The anode undergoes the oxidation process and the cathode undergoes reduction process, the chemical reactions of the electrode are:

Cathode (reduction): $2 H_2O$ (*l*) + $2e^-$ ⟶ H_2 (g) + 2 OH$^-$(*aq*)

Anode (oxidation): $4OH^-$ (*aq*) ⟶ O_2 (g) + $2 H_2O$ (*l*) + $4e^-$

Combining either half reaction pair yields the same overall decomposition of water into oxygen and hydrogen:

Overall reaction: $2 H_2O$ (*l*) ⟶ $2 H_2(g) + O_2(g)$
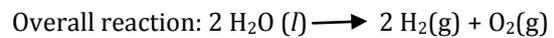
Storage Tank

Storage tanks are containers that hold liquids, compressed gases or medium used for the short or long term storage of heat or cold. Storage tanks operate under no pressure, distinguishing them from pressure vessel. Storage tank are often cylindrical in shape, perpendicular to the ground with flat bottoms, and a fixed flangible or floating roof .There are usually many environmental regulations applied to the design and operation of storage tanks, often depending on the nature of the fluid contained depending on the nature of the fluid contained within. Here the pressure gauge is used to monitor the pressure under the tank and two valves are used one for gas inlet, which is of non return valve and other one is normal flow control valve, which supply the gas for the engine.
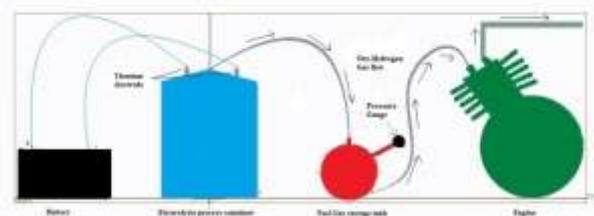

Fig -3 Storage Tank

2. DESIGN

Fig -4 Experimental Design

2.1 ANALYSIS

Storage Tank Analysis

The storage tank analyse for the pressure as assuming the inlet pressure at 5bar and outlet pressure at 3bar, the gas enters at velocity of 0.5m/s into the tank.
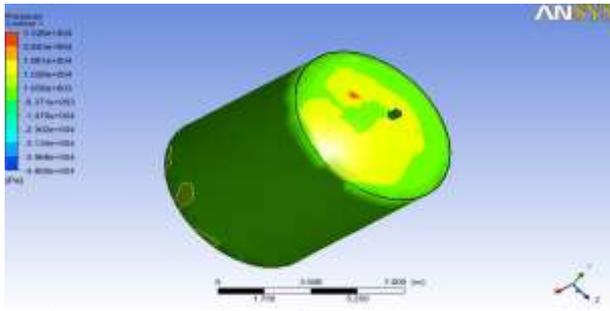

Fig -5 Storage Tank Analysis

Temperature Analysis

The figure 6 shows the temperature variation inside the combustion chamber when oxy-hydrogen is introduced as the fuel, .the temperature is high at the bottom corner of the chamber.
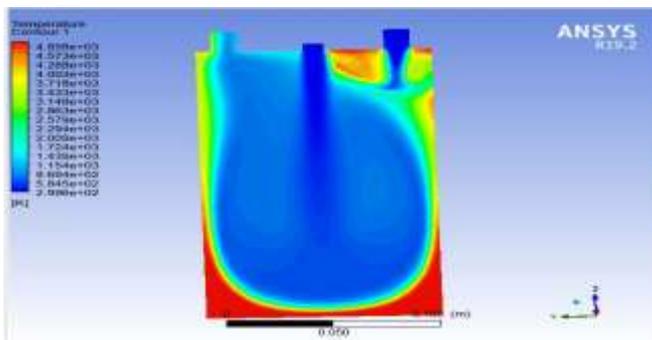

Fig -6 Temperature Analysis

Mass Fraction Analysis

The figure 7 shows the hydrogen mass fraction present in the combustion chamber while the combustion takes place, it is concentrated at the center of the chamber.
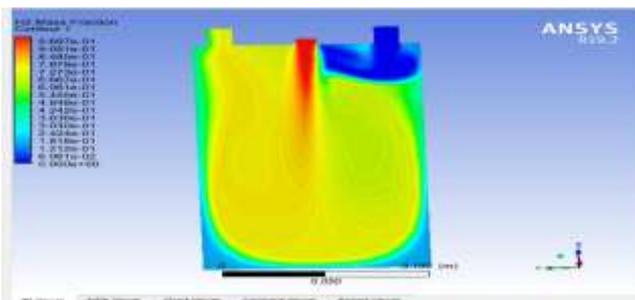

Fig -7 Mass Fraction Analysis

Pressure Analysis

The figure 8 shows the pressure produces inside the combustion chamber when the oxy-hydrogen gas introduced for the combustion while the compression takes place. It is mostly circulate in the entire volume of the chamber.
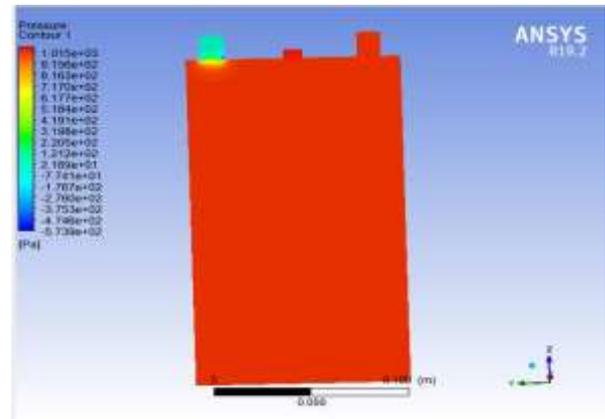

Fig -8 Pressure Analysis

Velocity Analysis

The figure 9 shows the velocity of the oxy-hydrogen gas while in the beginning of the compression process so, it is higher at the inlet valve.
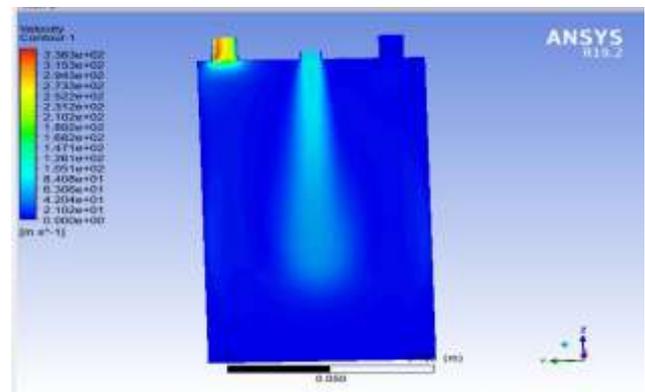

Fig -9 Velocity Analysis

3. CONCLUSIONS

By using the oxy-hydrogen gas as fuel for the two stroke bike engine, the various improvements as been analyzed from the engine performance and exhaust gas. The exhaust consist of water vapor which helps to reduced the temperature of the engine. The mileage of the engine will able to increase, increase in horsepower, also reduce the emissions levels and the engine life became longer. By using Titanium as the electrodes for the electrolysis process the continuous formation of Oxy-hydrogen is obtained which tents to continuous running of the engine.

REFERENCES

1. Automotive radiator performance-Review by Pawan S. Amruthkar, Sangram R. Patil

2. Performance analysis of automobile radiator by P. Monika and Rajesh. K . Sharma.

3. Kalyan A & Puri I K, combus sci Engine, CRC press.

4. Szwaja S, Rogalinski KR. (2010), Hydrogen combustion in a compression ignition engine.