Experimental Performance of SI Engine Supplied with Blend of Brown Gas (HHO) and Gasoline Fuel at 2500 rpm

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ABSTRACT

Today, the whole world is facing two major problems, one is increasing pollution and rapid use of fossil fuels. So there is a need to control pollution and reduce fuel consumption. Incomplete combustion of fuel causes pollution and reduction in fuel utilization. We are looking for such source of energy which helps for complete combustion of fuel and increases fuel utilization which ultimately reduces the pollution. In order to overcome the drawbacks of the regular petroleum fuel, it is the need of time to completely or partially replace the petroleum fuel. But alternative options to petroleum fuel are having disadvantages. An electric or compressed air driven cars cannot be used where high torque is required or using hydrogen as fuel requires very costly storage equipment's. In this project work an attempt has been made to reduce the drawbacks of petroleum fuels. Electrolysis of water can give us hydrogen in form of brown gas which can be used as an alternative fuel for any internal combustion engine. This project work discusses methods designed for the production of Brown gas. All together it has been observed that the blend of 'brown gas' and gasoline instead of only conventional fuel improves the performance of the engine.

Keyword - *Pollution, Fossil fuels , Electric cars , Electrolysis , Brown gas*

1. INTRODUCTION

Brown Gas is a mixture of di-atomic and mono-atomic hydrogen and oxygen. Brown gas is produced by electrolysis of water using caustic soda or KOH as the catalyst. When electric current passed through water, it divides into hydrogen and oxygen. The hydrogen and oxygen rise from the liquid water as gas. This gas is called HHO Gas or Browns gas. Due to using 'Brown gas' in I.C. Engines during combustion process decreases the 'brake specific fuel Consumption' and also increases the 'brake thermal efficiency. In this process water is by-product of the combustion process which also decreases the temperature of the combustion process. It is safe to use 'brown gas' as it is not stored but is produced and used when required. All together it has been observed that the blend of 'brown gas' and petrol instead of only conventional fuel improves the performance of the engine.

2. LITERATURE SURVEY

Most of the work has been done on the use of pure hydrogen as an additive, thought it gives better performance than any other alternative fuels available but, at same time which brings problem of storage, hydrogen supply infrastructure and wide flammability range makes it hazardous therefore viable solution to this problem is to produce it on board through water electrolysis and utilised it in the form of hydrogenoxygen mixture and a very few research has been done on this concept therefore researches done in the recent years have been reviewed as follows:

Leelakrishnan and Suriyan investigated the effects of HHO gas enriched air on the performance of a single cylinder, four stroke, 5.4 kW SI petrol engine. Enriched air was supplied to the engine through a passage between the air filter and the carburettor. Results reported indicate 5% improvement in brake power, 7% improvement in thermal efficiency, 6% reduction in fuel consumption, 88% reduction in unburnt hydrocarbons (HC), 94% reduction in CO

and 58% reduction in NOx. These values were reported at full load. However, no information was given on the rate of production of the Brown gas or whether there was variation in gas production during the test.

Ali Can Yilmaz, el al. produced HHO gas with different electrolytes KOH (aq.), NAOH (aq), NACL (aq) with various electrode design in a leak proof plexiglass reactor. Engine used was four cylinder, four stroke compression ignition engine. Dynamometer used has a torque range of 0-1700 Nm and speed range of 0-7500 rpm. Performance parameter were measured by computer via a data logger software. Results showed that there was 19.1% increment in engine torque when HHO system was used compared to diesel operation where as 14% gain was achieved on specific fuel consumption using hydroxyl gas. Also about 13.5% reduction in CO emission and 5% reduction in HC but experiment showed that at low engine speed with constant HHO flow rate turned into disadvantage for torque,CO,HC, and SFC this is because of long openingtime of intake manifold at low speed which cause excessive volume occupation of HHO in cylinder which prevents correct air to be taken into combustion chamber due which volumetric efficiency decreases and decrease in volumetric efficiency influenced combustion efficiency which had adverse effect on performance parameter. Therefore hydroxyl electronic control unit (HECU) is used. It sense engine speed. As soon as it lower, HECU decreases HHO flow rate by decreasing voltage and current automatically and compensate disadvantage under lower engine speed.

Ammar A. Al-Rousan conducted performance test on the single cylinder spark ignition air cooled 197cc engine and HHO production system was designed, constructed, integrated with a gasoline engine. i.e. the output of fuel cell connected to the intake manifold of the gasoline engine and performance test was performed before and after attaching fuel cell with constant load and variable speed (from 1000 to 2500 rpm). Result showed that brake thermal efficiency increases about 3% and 20 to 30% reduction in fuel consumption and exhaust temperature. And research showed that use of HHO in petrol engine enhances combustion and optimum surface area needed to generate enough amount of HHO is about twenty times that of piston surface area also, the volume of water needed is about one and half times engine capacity.

3. PROBLEM STATEMENT

To modify low capacity Spark Ignition Engine for analyzing its performance for Gasoline and HHO blended Gasoline fuel at various engine-operating conditions. The project work has aim to raise awareness, about hydrogen and Brown gas (HHO) as an additives and alternative fuels in future to improve the performance of low capacity Spark Ignition engines.

3.1 OBJECTIVES

- To Improve the Performance of Engine .
- To Increase Combustion Efficiency .
- To achieve normal combustion with better flame propagation .
- To lower down after burning .
- To improve lean burn capability of fuel .

4. BROWN GAS GENERATION UNIT

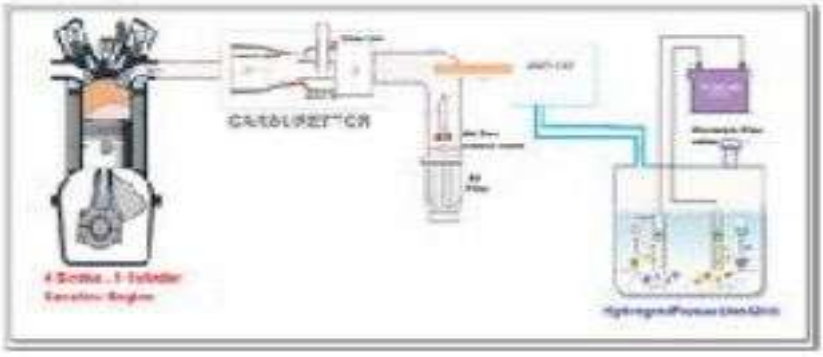
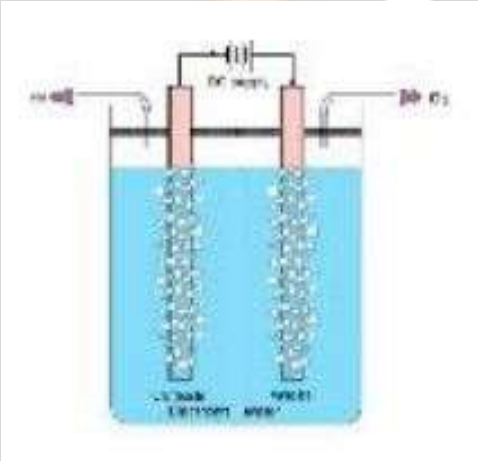


Fig -1 Layout of Generation Unit Components of Brown Gas (HHO) generation unit

- Battery (12 volt)
- Two electrodes: Stainless steel
- Electrolyser (Distilled water and sodium hydroxide)
- PVC tube
- Elbow

5. WORKING PRINCIPLE OF ELECTROLYSIS PROCESS

By the use of basic principle of Faraday's Law, An electrical power source is connected to two electrodes, or two plates typically made from some inert metal such as titanium or stainless steel which is placed in the water. In a properly designed cell, hydrogen will appear 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 that normally take place at cathode and anode.



Cathode (reduction):

$2\ H_2O + 2e^- \rightarrow H_2 + 2\ OH$

Anode (Oxidation):

$4\ OH^- \rightarrow O_2 + 2\ H_2O + 4\ e$

Overall reaction:

$2\ H_2O \rightarrow 2\ H_2\ (g) + O_2\ (g)$

The production of browns gas is done by a Brown's Gas Generation kit, designed for this purpose. The kit contains rectangular plastic container (8 cm x 11 cm x 10.5cm) filled with 15 Grams NAOH solution till the electrodes are completely immersed. The electrodes are made up of STAINLESS STEEL SS316L (50mm length × 50mm breadth × 1mm thick). The electrical connections are made with the coated wires and the electrodes are held with plastic screw, nut and washers so as to resist the heat produced and to provide insulation, also the electrodes are separated using to avoid short circuiting. There are 9 steel plates which were used as electrodes. This container is electrically connected to maintain constant current in the container. The evolved hydrogen gas from container is directed to flow through tube to engine inlet manifold.

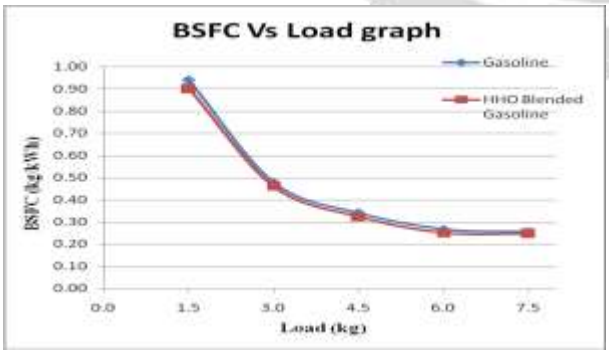
6. Specifications of Engine

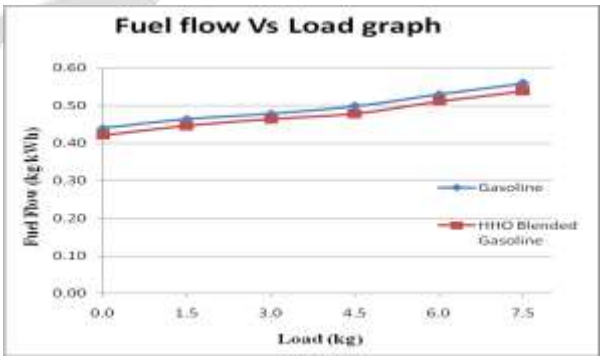
Company – HONDA
Type - Air cooled,4 stroke SI Engine
Displacement - 109.19cc
Max Net Power - 5.84 kW (8bhp) @ 7500 rpm
Max Net Torque - 8.74 Nm @ 5500 rpm
Bore - 50 mm
Stroke - 55.6 mm
Compression Ratio - 9.5:1
Starting Method - Kick/Self

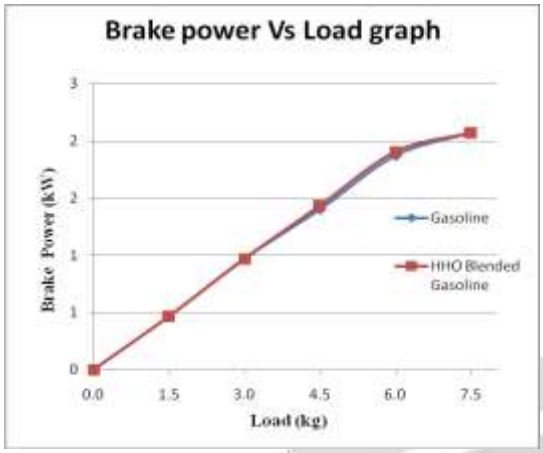
7. EXPERIMENTAL TEST RIG

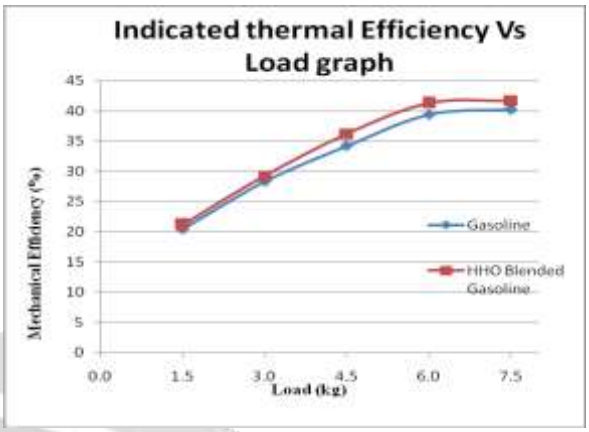
8. Result

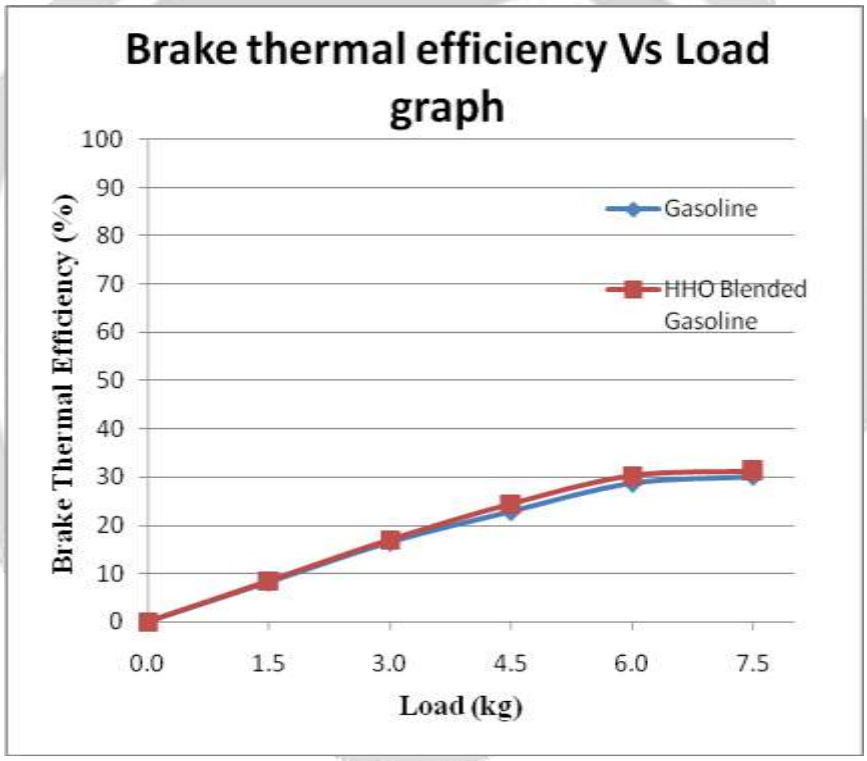
. Performance Characteristics Curve for 2500 rpm











9. SCOPE FOR FUTURE WORK

In this project work we are making an attempt to improve the brake thermal efficiency of engine and to reduce the exhaust emissions by using blends of Brown Gas with Gasoline fuel. In future by the use of micro-controllers and efficient electrolysis system regular vehicles can be made to operate partially on hydrogen at different speeds. The programming in micro-controller itself decides the hydrogen injection duration by sensing the speed of the vehicle.

10. Conclusion

Brake specific fuel consumption of engine is decreased by 3.71% at 2500 rpm, 2.77% at 3500 rpm, and 3.29% at 4500 rpm when HHO is introduced in gasoline engine. Brake power increases with the addition of HHO inside the gasoline engine. From calculations, it is noted that indicated power increases when HHO is introduced inside the gasoline engine. Brake thermal efficiency is increased by 4.74% at 2500 rpm, 3.52% at 3500 rpm and 4.86 % at 4500 rpm when HHO is added as an additive inside the combustion chamber. Indicated thermal efficiency is also increased by 4.38% at 2500 rpm, 3.23% at 3500 rpm and 4.54% at 4500 rpm when HHO is introduced inside the gasoline engine. Fuel consumption is reduced by 3.71% at 2500 rpm, 2.77% at 3500 rpm and 3.29% at 4500 rpm when HHO is introduced inside gasoline engine.

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