A Review on Synthesis of Hydrogen by Splitting the Water and Performance Evalution of Four Stroke Petrol Engine

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***Abstract*— Internal combustion engines continue to dominate in many fields like transportation, agriculture and power generation. Among the various alternative fuels, hydrogen is a long-term renewable and less polluting fuel (Produced from renewable energy sources). In recent years the earth facing from various kind of problems but the major problem is fossil fuel which are decreases day by day so our motive is to replace these fuel by hydrogen gas engine which is highly combustible gas and generate sufficient amount of energy when ignited. So in this project reports we prepare an engine where hydrogen fuel are used through which various problem are overcome like pollutants e.g. HC, NOx, and CO. In the present work, hydrogen is generated from Electrolysis process and produced hydrogen is tested for various the performance and emission characteristics of four stroke petrol engine.**

Keywords— ***Hydrogen, Spark ignition engine, compression ignition engine, performance, Emission.***

I. Introduction

Hydrogen gas is majorly produced from fossil fuels. Developing technologies for production of hydrogen from renewable energy sources such as biomass has gained momentum. Recent advances in energy production using organic matter include the generation of hydrogen in a Microbial Electrolysis Cell (MEC). An MEC is a promising new approach for biological hydrogen production from biodegradable organic matter using exo-electrogenic microbes. Though these systems show immense potential for green energy production, the utilization of these systems are still in infant stage in India. Hydrogen has the potential to be a clean alternative to the fossil fuels currently used in the transportation sector.

Hydrogen is considered as a novel fuel for the twenty-first century, mainly due to its environmentally benign character. Production of hydrogen from renewable biomass has several advantages compared to that of fossil fuels. This is especially true if the hydrogen is manufactured from renewable resources.

Hydrogen is acknowledged to offer great potential as an energy carrier for transport applications. A number of technologies can use hydrogen as an energy carrier, with the internal combustion engine being the most mature technology. Currently, 96% of hydrogen is made from fossil fuels. Based on 2004 data, in the United States 90% is made from natural gas, with an efficiency of 72%. Only 4% of hydrogen is made from water via electrolysis.

The use of hydrogen as an automotive fuel appears to promise a significant improvement in the performance of spark-ignition engines. The self-ignition temperature of the hydrogen/air mixture is greater than that of other fuels and, therefore, hydrogen produces an antiknock quality of fuel. The high ignition temperature and low flame luminosity of hydrogen makes it a safer fuel than others, it is also non-toxic. Hydrogen is characterized by having the highest energy mass coefficient of all chemical fuels and in terms of mass energy consumption it exceeds conventional gasoline fuel by about three times, and alcohol by five to six times. Therefore, the results clearly establish that hydrogen fuel can increase the effective efficiency of an engine and reduce specific fuel consumption.

II. Literature Review

A. S. Bari and M .Esmaeil (2010) [3])

Performed experimentation on four cylinder direct injection diesel engine the experiment were carried out under constant speed of 1500 rpm with three different power level of 19 Kw, 22 Kw and 28 Kw applied. Under each load condition flow rate of diesel and other parameter were recorded without HHO then small amount of HHO mixture was introduced to the engine and measured the performance parameter at each load condition then flow rate of HHO gas was increases and required data were collected. The emissions HC, CO and CO2 were found to be reduced.

B. Ali Can Yilmaz,el al.(2010)[4]

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 result showed that there was 19.1% increment in engine torque when HHO system was used compared to diesel operation. Also about 13.5% reduction in CO emission and 5% reduction in HC .

C. Amman A. Al-Rousan (2011)[5]

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 and result shows 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

D. Musmar and Al-Rousan (2011) [6]

Conducted research on single cylinder 197cc gasoline engine to see effect of HHO gas on combustion emission. The emission test have been done with constant load and varying engine speed (1000- 2300 rpm). Graph between CO Vs engine speed depicts that with addition of HHO gas there is 20% reduction in CO emission because of better combustion efficiency and better efficiency is due to the hydrogen and oxygen atoms interacts directly without any ignition propagation delays and also due to HHOs flame speed is much higher than ordinary fuel. It was also noticed that exhaust gas temperature reduces when HHO gas utilized with gasoline.

E. A.M.Falhat, et al. (2014)[7]

Carried out experimentation on 197 cc SI engine with gasoline and HHO gas as secondary fuel and compared with pure gasoline fueled engine. In this HHO flow meter was employed with HHO production system to add HHO gas at 1,1.5 and 2 lpm and engine speed was varied from 1350 to 2250 rpm and it was seen that the concentration of CO and NOx is decreases with increase of flow rate of HHO gas.

III. METHODOLOGY

A. Electrolysis

The electrolysis of water is the decomposition of water (H_2O) into oxygen (O_2) and hydrogen gas (H_2) due to an electric current passing through the water.

The main advantages of using electrolysers are:

- Low cost due to absence of noble metals/
- Can be connected directly to intermittent power supply (renewables).
- User-friendly containing no dangerous caustic electrolyte.
- Directly compressed hydrogen.
- Safe, reliable and efficient.
- Easy to integrate.

Fig 1: Water Electrolysis

The steps to be followed includes

A. Energy supply

The energy required for electrolysis is generated entirely based on renewable sources.

B. Electrolyser

The electrolyser is the module in charge of generating hydrogen and oxygen from water. In this function was covered by a proton exchange membrane (PEM) electrolyser, where electrolysis is based on the use of a solid conducting polymer that conduces protons from anode to cathode.

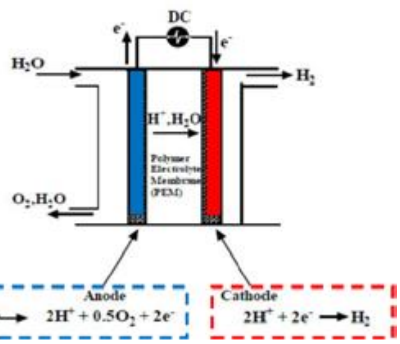

Fig 2: Electrolyser Diagram

C. Hydrogen

The hydrogen generated was tested for its usage as fuel in a vehicle.

D. Performance analysis

Various Engine parameters such as Brake Power, fuel consumption, specific fuel consumption and mechanical efficiency are tested using four stroke petrol engine.

IV. PERFORMANCE AND EMISSION CHARACTERISTICS

A. Break Power

The reduction in the maximum power output produced with hydrogen operation compared to neat gasoline operation can be attributed to the de-aeration effect of the engine while operating with gaseous fuel- “hydrogen”.

It is also evident that the total volume i.e. (volume of air consumed plus the volume of fuel consumed) supplied to the engine for hydrogen operation reaches a maximum at 1.78 kW power output. Any attempt to increase the power output i.e. above 1.78 kW resulted in backfire problems. Inducing more fuel after this point results in a higher value of equivalence ratio, which is a reason for the backfire problem in manifold, injected engines.

B. Break Thermal Efficency

Brake Thermal efficiency is an important parameter, which gives a measure of the conversion efficiency of the chemical energy of the fuel to mechanical power. Figure 6 gives a comparison of brake thermal efficiency with gasoline and hydrogen operations. It is evident from the graph that the brake thermal efficiency with neat hydrogen operation is higher than that of gasoline operation. It can be observed that there is an improvement of BTE from 24.15 % to 31.0 % (approximately) for the entire range of engine operation with hydrogen.

The improvement in brake thermal efficiency is mainly due to the fact that with lean mixtures of hydrogen, in combination with the fast combustion energy release rates around top dead center associated with the very rapid burning of hydrogen-air mixtures results in high-output efficiency values. Moreover lean engine operation leads to lesser throttle loss and more complete combustion.

C. Brake Specific Fuel Consumption

The wide range of flammability of hydrogen permits quality governing, by which engine power can be controlled very effectively. It is observed that, at lean mixture operation, specific fuel consumption gets reduced. However, at very lean mixture operations, the specific fuel consumption tends to increase which due to the fact that at low equivalence ratio, the flame velocity gets very much reduced resulting in increased duration of combustion, incomplete combustion and loss of power and efficiency.

D. Specific Fuel Consumption Emission Characteristics with Hydrogen Operation

Since hydrogen has only H- atoms, there is no possibility of formation of pollutants like CO, CO2, SOx, PM formation. There can be some HC emissions with hydrogen operation, which may arise from the burning of the lubricating oil; however in the present investigation HC emissions are negligible in comparison with gasoline operation. With hydrogen operation the only pollutant of concern is the oxides of nitrogen

V. Conclusion

a) Hydrogen production has been successfully achieved by only using renewable energy sources (solar and wind energy).
b) The H_2 produced can be deployed in the powering of a combustion engine.
c) The present work has shown that conventional S.I. engine can be successfully converted into neat hydrogen operation without major hardware modifications of the engine. This approach is effective in achieving substantial saving of gasoline and at the same time obtains cleaner emissions.
d) Utilization of hydrogen fuel can be readily implemented as it does not face the problems related to fuel storage as in the case of vehicular application.
e) Hydrogen operated engine is 24.15 to 31.0% more efficient than gasoline operation.
f) Specific power output of the hydrogen engine is lesser than the corresponding gasoline version due to de-aeration of the engine.
g) With hydrogen operation, NOx is the only pollutant of concern.
h) However, NOx emissions are 60-100 % lesser than gasoline operation in the entire operation range with hydrogen
i) HC, CO, CO_2 emissions are practically nil for hydrogen operation.

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