# Hydrogen Petrol Mixture SI Engine

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***Abstract- The threat posed by climate change and the striving for securities of energy supply are issues high on the political agenda these days. Governments are putting strategic plans in motion to decrease primary energy use, take carbon out of fuels and facilitate modal shifts. Taking a prominent place in these strategic plans is hydrogen as a future energy carrier. Energy stored in hydrogen would be available at any time and at any place on Earth, regardless of when or where the solar irradiance, the hydropower, or other renewable sources such as biomass, ocean energy or wind energy was converted. The fundamental variations in the times and places of solar energy supply and human energy demands can be overcome using hydrogen. Hydrogen gas combined with the standard air/fuel mixture increases the mileage. This form of alternative fuel is provided by a hydrogen generator mounted in the vehicle. Once set up is ready, the hydrogen gas (fuel) will be produced from water, an electrolyte compound, and electricity supplied from a battery provided. Here we are designing a mixed fuel two wheeler engie.ie in a conventional SI engine we are incorporating traces of hydrogen along with gasoline in order to minimize the consumption of gasoline as well as to increase the power of vehicle. Here in addition, a hydrogen generating unit is made to produce hydrogen .It is actually an electrolysis unit having high grade stainless steel/graphite/semiconductors as electrodes in a closed container and mixture of distilled water & suitable ionic solution(KOH or NAOH) as electrolyte. Power for electrolysis is taken from an additional battery provided (12V).This battery can be recharged from a dynamo/alternator/motor provided on the vehicle. Recharging process is in such a way that a circuit is provided which includes dynamo/alternator/motor and the battery and which completes only when the brake applies while running.ie in spite of using the energy from the bike alternator directly here waste energy is used for the process of electrolysis.***

***Keyword- KOH, NAOH, SI engine, Hydrogen, Hydropower.***

## I. INTRODUCTION

Combustion of fossil fuels has caused serious problems to the environment and the geopolitical climate of the world. The main negative effects on the environment by Fossil fuel combustion are emissions of NOx, CO, CO2, and unburned hydrocarbons. The main negative effect of burning fossil fuel on the geopolitical climate is the lack in supply of these fuels and the effect pollution has on politics. There are several possible solutions to alleviate the problems of using fossil fuels, but most of them would require years of further development and additional infrastructure. This method involves burning hydrogen gas along with hydrocarbon fuels in engines.

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Hydrogen has long been recognized as a fuel having some unique and highly desirable properties, for application as a fuel in engines [8]. It is the only fuel that can be produced entirely from the plentiful renewable resource water, though through the expenditure of relatively much energy. Its combustion in oxygen produces uniquely only water but in air it also produces some oxides of nitrogen. These features make hydrogen an excellent fuel to potentially meet the ever increasingly strict environmental controls of exhaust emissions from combustion devices, including the reduction of greenhouse gas emissions [1]. As a promising fuel, H2 can be used in traditional internal combustion engine, gas turbine and also the innovative fuel cell. Among these, operation of the most fuel cells requires pure H2. The presence of other components such as CO could deactivate significantly the catalyst of fuel cells and reduce significantly the service life. Such excessively demanding requirement for high purity H2 makes the operation of hydrogen fuel cells economically uncompetitive though high thermal efficiency could be achieved without formation of pollutant. In comparison to fuel cells, internal combustion engine can burn almost any low purity H2. For example, the reformed gas containing mainly H2 with the presence of CO, CO2, H2O and N2, has been demonstrated as a good fuel showing H2-like desirable combustion properties. The application of H2 or its mixtures with traditional fuels offers also opportunity of optimizing engine performance and reducing exhaust emissions [7].These finds a new scope in the field of alternative fuels that can be used in IC engines. These fields include alternative fuels like high FFA rubber seed bio diesels[14][15], hydrogen, alcohol and cotton oil etc. Here in the proposed journal we explain the possibilities of using hydrogen as a fuel. Hydrogen is a clean fuel which on combustion produces water vapor as the only product. The use of hydrogen in IC engines not only help increase the efficiency of it but also it helps to reduce pollution and reduce the poisonous gases like carbon monoxide, nitrous oxide etc. The use of hydrogen helps to reduce their use and hence prevent the depletion of these precious natural resources. The principle of this mode of combustion is to add a percentage of hydrogen gas to the combustion reactions of either compression or spark ignition engines. The addition of hydrogen has been shown to decrease the formation of NOx, CO and unburned hydrocarbons. Studies have shown that added hydrogen in percentages as low as 5-10% percent of the hydrocarbon fuel can reduce that hydrocarbon fuel consumption [5]. The theory behind this concept is that the addition of hydrogen can extend the lean operation limit, improve the lean burn ability, and decrease burn duration. There are varieties of electrode materials used for electrolysis of water. During electrolysis splitting up of molecules is accompanied by heat release. Effectiveness of electrolysis is based on the reaction that takes place at electrode electrolyte interface and electrical conductivity. In conventional methods we are using copper for electrolysis of water. But the electrode reacts quickly and it degrades



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away. Copper is poor at resisting corrosion. Nowadays the materials preferred are stainless steel, graphite, platinum, MMO coated titanium etc [11].They have better chemical as well as physical properties. Stainless steels of different grades are used(grade 302,306.316L etc).Among these grade 316L is used mostly.it is thermally and chemically resistant and have melting point about 500 degree Celsius. Platinum, Titanium are costly materials thus using stainless steel will be economically feasible.[6]. Some users implements the electrolysis unit which consumes engine power to electrolyze the water. They claim that this increases the mileage of vehicle.in this case they directly consumes the alternator power for electrolysis or we can say that the engine power.it is a violation of first law of thermodynamics since by consuming engine power, it is impossible to increase the power of same engine. Thus here the system is modified ie the energy for electrolysis is taken by utilizing the waste energy. There are different modes of waste energy in a vehicle and that depends on the driving conditions also.one among is braking process. So in the following experiment the utilization of hydrogen along with gasoline is described and the modes of waste energy recovery for the process of hydrogen generation is explained [4].

## II. EXPERIMENTAL DETAILS

### 2.1 Principle of Electrolysis

An electrical power source is connected to the two electrode materials which are placed in the water. Hydrogen will appear at the cathode (the negatively charged electrode, where electrons enter the water), and oxygen will appear at the anode material (the positively charged electrode).ie reduction at cathode and oxidation at anode occurs. According to ideal faradaic efficiency, the amount of hydrogen generated is twice the number of moles of oxygen, and both are proportional to the total electrical charge conducted by the electrodes solution.

### 2.2 Electrolysis Unit

Hydrogen is produced using a hydrogen generating unit. It consists of a sealed container that contains the high grade stainless steel/graphite electrodes distilled water and electrolyte solution. Source of power is an external battery provided. Battery can be recharged from a dynamo/alternator provided, which works when we apply brake & accelerator releases. The electrode material used is stainless steel grade 316L, which has suitable properties like corrosion resistant in hard water areas and thermal resistant. The casing is made of un-plasticized PVC or uPVC, which is a good thermal resistant material and have better mechanical properties [13]. The electrolysis unit will be fixed in the vehicle at a convenient position. The produced hydrogen is given to the intake of the carburetor. In the inlet of carburetor hydrogen is mixed along with the intake air and it sucks into the engine when engine starts. The basic block diagram of the electrolysis unit is shown as below.

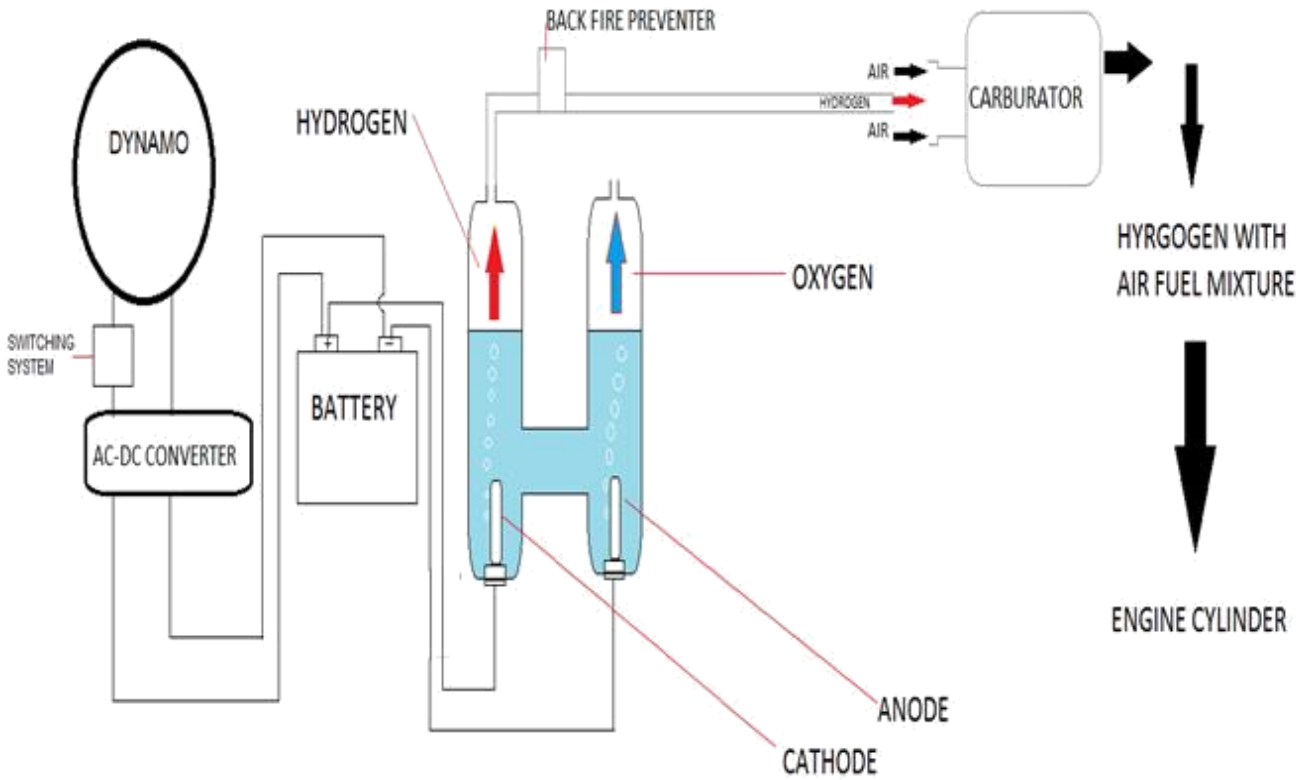


**Fig. 1 Schematic Diagram of Hydrogen Production**



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Reduction reaction occurs at the cathode of electrolysis unit and oxidation occurs at the anode of the electrolysis unit. Cathode is negatively charged electrode and anode is positively charged. Thus hydrogen appears at the cathode during electrolysis and oxygen appears at the anode. Both the hydrogen and oxygen production are depend up on the electric charge conducted. in order to carry out the electrolysis the electrolyte used should be a good electric conductor. Here water is used for electrolysis and the conductivity of water is very low. Thus along with water traces of potassium hydroxide [KOH] or sodium hydroxide [NaOH] is mixed to increase the conductivity of electrolyte solution.ie here water. Thus subsequently the rate of hydrogen generation also increases [3].

### 2.3 Recharging system for the battery used for electrolysis

The process of electrolysis needs an external energy source in order to produce the hydrogen gas. There are many ways we can utilize the energy from a running vehicle.it can be either the alternator of the bike itself or from some regenerative methods. The system incorporated here utilizes the energy from the bike alternator as well as from regenerative methods.

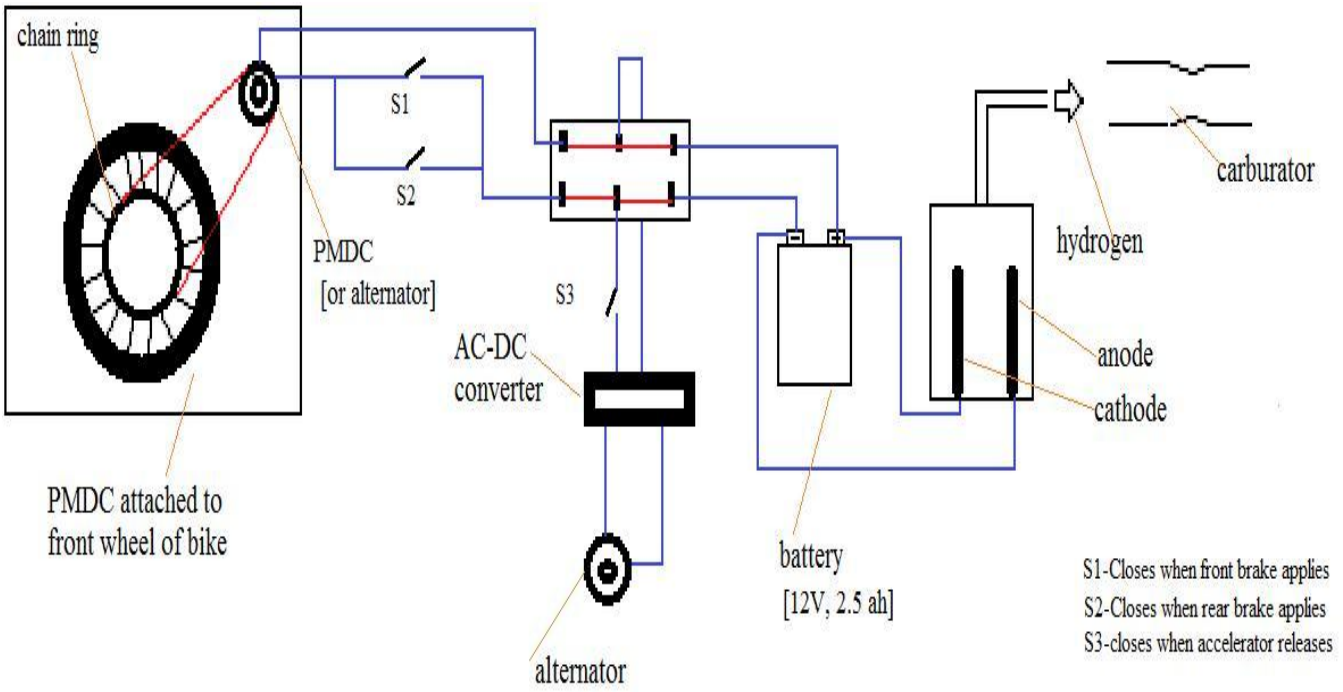


**Fig. 2 Recharging System**

As shown in figure the recharging system consists of an alternator connected to the front wheel of bike via chain drive, and assistance of bike alternator itself and an external battery. A chain ring is attached to the front wheel and chain drive is taken to the alternator. Alternator shaft rotates always whenever the vehicle also moves. But the circuit from the alternator completes only when the front or rear brake applies and thus recharging circuit to the battery completes at those instants. Similarly energy from the bike alternator also utilized.it is a circuit which completes when accelerator releases during the running conditions. Thus a continuous recharging process will not occur. Energy recovery during different conditions is different.ie during braking and during cruising the rate of recovery will be different. During cruising condition electrolysis is carried out by the battery alone and the process of recharging will not occur.ie at this time all the switches will be in open condition. While running at higher speeds or during changing of gears we need to release the accelerator. So at this time the energy from the inbuilt alternator can be harnessed since no comparable fuel is consumed but still the alternator is running. At this time switch s3 will be in closed position.ie the circuit from bike alternator is completed. Similarly when brakes applied switches s1 or s2 will be closed depend upon the brake applied. Thus respective circuit which including the battery for electrolysis gets completed and recharging occurs.

## III. RESULTS AND DISCUSSIONS

### 3.1 Test. 1 [using test rig]

**Experiment on four stroke petrol engine with and without the addition of hydrogen along with petrol.**

At first gear the torque produced is high so the fuel consumed will be higher as compared to other gears TFC vs. BP curve without hydrogen lies above the curve with hydrogen. This indicates that fuel consumed in kg per hour is reduced when hydrogen is mixed with petrol when rpm is held constant. From this graph it is clear that at constant fuel consumption the brake power is more when hydrogen is added also at constant brake power the fuel consumed is reduced.



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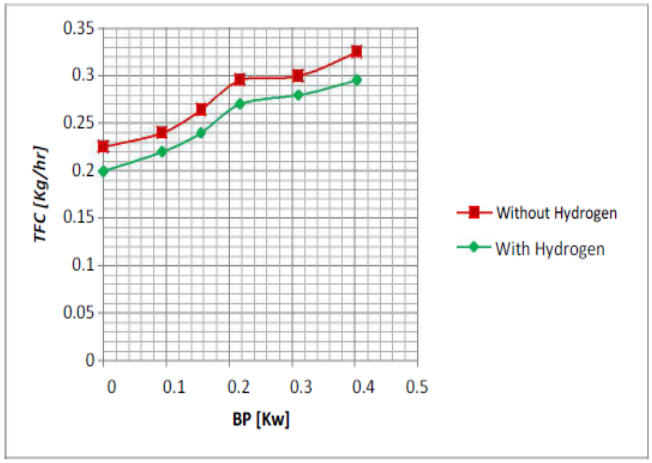
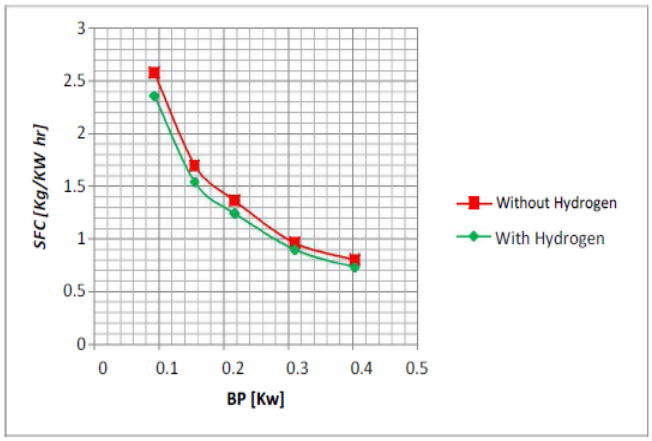
TFC vs. BP [rpm 105]

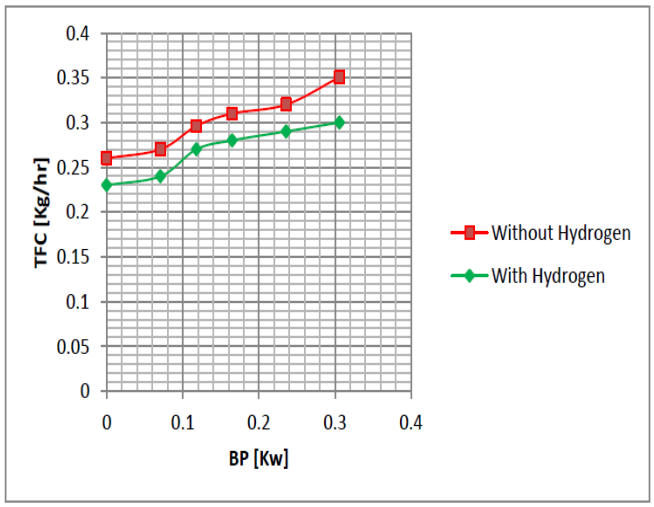



SFC vs BP

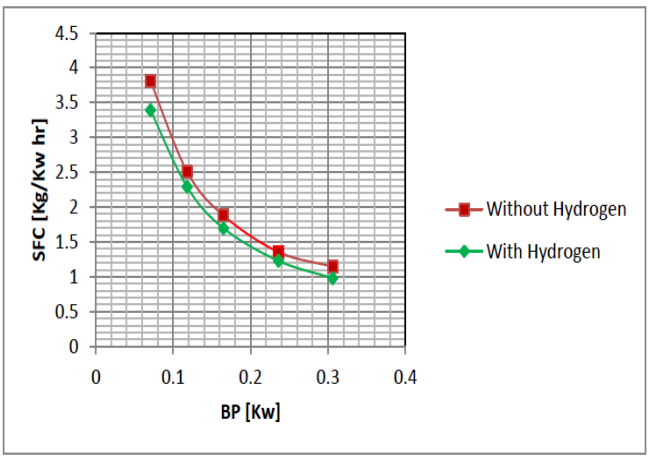



TFC vs. BP curve without hydrogen lies above the curve with hydrogen. This indicates that fuel consumed in kg per hour is reduced when hydrogen is mixed with petrol when rpm is held constant. From this graph it is clear that at constant fuel consumption the brake power is more when hydrogen is added also at constant brake power the fuel consumed is reduced. This is because when hydrogen burns more .heat energy is produced. Specific fuel consumption is plotted vs. brake power. Fuel required for one kilowatts brake power is reduced when hydrogen is added. At second gear the fuel consumed is lower than that consumed in first gear.

TFC vs BP [rpm 190]

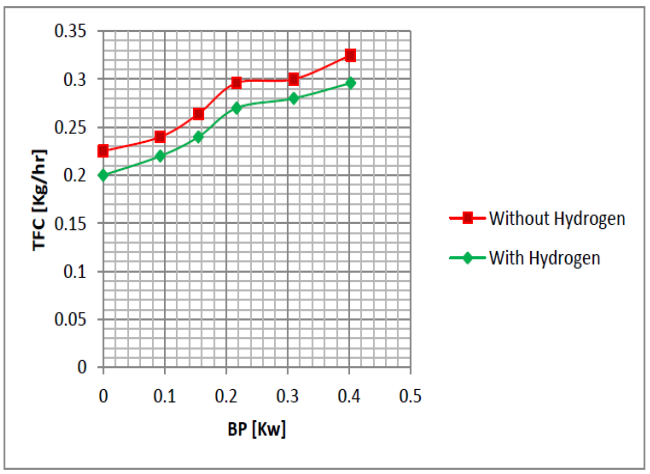



SFC vs BP

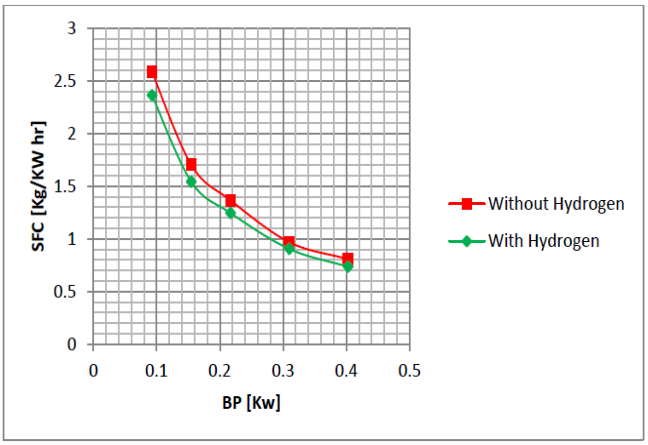



At third gear fuel consumed is lower than that of first and second gear due to lower torque produced

TFC vs. BP [rpm 250]




SFC vs. BP




TFC vs. BP curve without hydrogen lies above the curve with hydrogen. This indicates that fuel consumed in kg per hour is reduced when hydrogen is mixed with petrol when rpm is held constant. From this graph it is clear that at constant fuel consumption the brake power is more when hydrogen is added also at constant brake power the fuel consumed is reduced. This is because when hydrogen burns more .heat energy is produced. Specific fuel consumption is plotted vs. Brake power. Fuel required for one kilowatts brake power is reduced when hydrogen is added.



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**3.2 Test .2 [**road test]

**Experiment in running condition**

This test is done to ensure the reliability of using hydrogen in a running vehicle. Vehicle is made to run with and without hydrogen and change in mileage is found out. The electrolysis unit along with recharging system is installed in a two wheeler and a road test is conducted.

Type : air cooled, OHC
Stroke : 4 stroke
No of cylinders : 1
Displacement : 97.2 cc
Power : 7.7 hp @ 7500 rpm
Torque : 7.5 @ 5000 rpm

The connection from petrol tank is removed and the mileage tester is connected to the carburetor inlet connection for petrol. The vehicle is made to run with and without the presence of hydrogen supply to carburetor.at the same time the distance covered in a specific consumption of petrol.it is observed that while the hydrogen generating unit or electrolyzing unit active the distance covered for the specified amount of petrol is increased .

1. without hydrogen

**Table 7**

| Trial. | Amount of fuel consumed | Distance covered [in km] | Distance covered for 1 litre of petrol [in km] |
|---|---|---|---|
| 1 | 100ml | 4.8 | 48 |
| 2 | 100ml | 5.2 | 52 |
| 3 | 100ml | 5.0 | 50 |
| 4 | 100ml | 5.2 | 52 |
| 5 | 100ml | 5.0 | 50 |

2. with hydrogen

**Table 8**

| Trial. | Amount of fuel consumed[in ml] | Distance covered [in km] | Distance covered for 1 litre of petrol [in km] |
|---|---|---|---|
| 1 | 100ml | 6.2 | 62 |
| 2 | 100ml | 6.0 | 60 |
| 3 | 100ml | 6.0 | 60 |
| 4 | 100ml | 5.8 | 58 |
| 5 | 100ml | 5.8 | 58 |

From the above observations we observe that mileage of vehicle is increased in second case i.e. when vehicle is made to run with hydrogen petrol mixture. We can observe than on an average the mileage of vehicle is increased by 9 km/litre of petrol.

## IV. CONCLUSIONS & FUTURE SCOPE

Hydrogen is a fuel with heat content nearly three times that of gasoline. From our work we experimentally found out that the efficiency of an IC engine can be rapidly increased by mixing hydrogen with gasoline. We conducted two tests. Experiment with test rig and a road test with two wheeler.in both cases we observed reduction in fuel consumption.it is a clear evidence that addition of hydrogen along with petrol can results in increase in the power of the engine or increase in mileage. Moreover the various emissions normally produced from IC engines can be reduced. Thus use of hydrogen in IC engines as a fuel can be considered a huge leap in the field of automobile engineering. In this project we have proved that the mileage of the bike can be increased up to 9-10% by adding hydrogen with the petrol. The study and analysis can be extended to the following levels.

- Variation in combustion characteristics on adding hydrogen including ignition delay, effect on knocking the effect on cylinder lining as a result of hydrogen combustion[9].
- Exhaust gas analysis which includes variations in the quantities of the various combustion products including nitrogen oxides, carbon monoxides, sulfur dioxides etc. When hydrogen is employed the harmful emissions can be reduced since the combustion product of hydrogen is water vapors only[2]
- Volumetric analysis of hydrogen including flow rate and variations in the amount of hydrogen with variations in the supply current. High sensitive flow rate measuring instruments are can be used for the measuring hydrogen flow rate. Quantity of hydrogen produced can be increased when the supply voltage is increased and the corresponding improvements in the mileage can be assessed. The recharging system can be also be modified by using solar energy.
- Efficiency of the electrolysis can be increased. The conventional modes of electrolysis have efficiency of about 50 to 80 %.PEM [polymer electrolyte membrane] electrolysis is a new method of electrolysis which have efficiency above 95%.Use of such methods increase the production of hydrogen[12].

## V. ACKNOWLEDGEMENT

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