Reducing Fuel Consumption by Adding Alternative Substitute for Petrol Engine

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Abstract— Now days, pollution is major problem across the world. There are many causes which arise pollution, among which contribution through automobiles are more. In order to reduce pollution and reduce dependence on fossil fuel, hydrogen is best alternative for I.C. engine. Most economic way to produce hydrogen gas is through electrolysis process. Water is abundant and cheap. The hydrogen fuel is extracted from Brown's gas or HHO gas which in turn is produced from a common ducted electrolyses setup. Water disassociated into Brown Gas (HHO) using efficient electrolyzing techniques. Due to high combustible nature of the brown's gas, both browns gas and fuel completely burns in the IC engine, hence giving no scope for the incomplete combustion. With the introduction of browns gas a 99% decrease in the unburned hydrocarbons and Carbon monoxide has been observed. On other hand by using HHO with petrol results much cleaner exhaust and more power to the engine. The result is increased gas mileage and smoother running; this gas may take as a mileage Booster. HHO boosters help to reduce pollution and save energy and money all over the world. It is observed that when the Brown's gas is introduced into the engine's thermodynamic cycle at the right time, it mixes with gasoline to optimize the engine performance in terms of its thermal efficiency, volumetric efficiency, fuel consumption rate, emissions etc. It also brings down the operating temperature and pressure conditions of different parts of the IC engine, thereby ensuring more sustainability and durability. This project aims to calculate performance characteristics of a four-stroke IC engine that is powered by gasoline fuel in combination with hydrogen fuel, fed through the inlet manifold. Later emission analysis also to be performed. About key words petrol and HHO, brown gas, Oxy-hydrogen gas, electrolytes KOH, NAOH, Hydrogen generator

I. INTRODUCTION

At the present days, Global warming has become a very huge challenge for mankind and one of the reasons is emission of harmful gases due to incomplete combustion of the fuel from automobiles. The problem is becoming severe day by day because of increase in the vehicular density. In the use of gasoline fuels harmful emission products like CO, NOx and HC are left over as an exhaust in to the environment. By using exhaust gas circulation and using some catalytic converter these emissions can be reduced to some extent. Due to raising prices of petrol ,one can be thought of an alternative fuels for petrol engines which help reduce cost of fuel .The scientific community is addressing these problems by an attempt to replace fossil fuels with cleaner and renewable sources of energy such as solar powered vehicles, electric cars. But we have seen that this are either non-reliable, costly or lags the technical advancement and convenience which is provided by the petroleum fuel vehicles. So the idea is not to compete with petroleum fuels but to increase the life of petroleum fuels to exist longer in this ever demanding automobile industry. Every buyer has a mind set to have a vehicle with great looks, good performance and high efficiency. But unfortunately, even with the latest technology, it is difficult to achieve the perfect balance between performance and price. So in order to conserve petroleum fuels for future and to eliminate the above limitations, there is a need of alternative and innovative fuel.

Oxy-hydrogen gas is one of the best alternatives available for us. The oxy-hydrogen gas is obtained by the simple process of electrolysis of water, which has high calorific value 3 times more than petrol .In our project work, we are interested to add this HHO gas as supplement to petrol as fuel in S.I engine for better performance and lower emission values. It has the unequal advantage of being able to remove pollutants from the air during combustion, and even reduces the carbon residue within the engine (similar to the effect of higher octane fuels). Water electrolysis is simply the breaking down of water into its basic hydrogen and oxygen atoms by passing an electronic current through it.HHO is composed of two separate elements of Water, consisting of two atoms one of Hydrogen (H) and one atom of Oxygen (O), thus H2O becomes HHO gas.HHO referred to as Hydrogen gas, water gas, and brown gas (in automotive applications) is a weekly bonded water molecule which exists in gaseous state. It is 2:1 molar mixtures of hydrogen and oxygen. It was produced by electrolysis process of different electrolytes KOH, NAOH with various electrode designs in a leak proof reactor (Hydrogen generator). The most abundant element in the known Universe is Hydrogen, which is the volatile part of this amazing fuel. Oxygen does not burn, but it does support combustion. The technology that is used to extract the two elements from water is known as electrolysis. Electrolysis of water has been used for experimentation and other industrial processes for over a hundred years. The HHO fuels systems use today are used primarily as a supplemental fuel rather than are placement for gasoline. The electrolyses, a device for producing HHO, are connected to the engine's air intake duct by a hose and HHO is mixed with the air and gasoline as its drawn into the combustion chamber. The design is consider on demand system, meaning that HHO fuel is produced one is needed, having no storage tank, and stopping when the ignition key is turned off. Fuel mileage is increased because the gasoline burns more completely, producing cleaner exhaust emissions, and you can save money on fuel costs and help the environment by reducing air pollution.

Our aim is to design and create a device that will increase engine efficiency without jeopardizing its performance. Such device is an HHO Generator. This generator uses electric Current (electrolysis) to produce hydrogen from water. This hydrogen which enhances the engine efficiency and zero emissions also. The hydrogen fuel when mixed with air produces a combustible mixture which can be burned in a conventional spark ignition engine at an equivalence ratio below the lean flammability limit of a gasoline/air mixture. The resulting ultra lean combustion produces low flame temperatures and leads directly to lower heat transfer to the walls, higher engine efficiency and lower exhaust of NOx emission.

II. PROCEDURE FOR PAPER SUBMISSION

HHO referred to as Hydrogen gas, water gas, and brown gas (in automotive applications) is a weekly bonded water molecule which exists in gaseous state. It is 2:1 molar mixtures of hydrogen and oxygen. It was produced by electrolysis. Brown gas holds significant promise as a supplemental fuel to improve the performance and emissions of spark ignited and compression ignited engines. Some of the properties which justify the use of hydrogen as fuel are as follows:

Tabl-1

PROPERTIES	H_2	Petrol
Limits of Flammability in air, vol %	4-75	1.0-7.6
Stoichiometric composition in air, vc	29.53	1.76
Minimum energy for ignition in	0.02	0.24
Auto ignition Temp,]	858	501-744
Flame Tempera	2318	2470
Burning Velocity in NT	325	37-43
Quenching gap in NTP air, cm	0.064	0.2
Normalized Flame Emissivity	1.0	1.7
Equivalence ratio flamr	0.1-7.1	0.7-3.8

Wide Range of Flammability: The flammability limits are very wide for hydrogen gas. This means that the load of the engine can be controlled by the air to fuel ratio. Nearly all the time the engine can be run with a wide open throttle, resulting in a higher efficiency.Low Ignition Energy: The amount of energy needed to ignite hydrogen is about one order of magnitude less than that required for gasoline. This enables hydrogen engines to ignite lean mixtures and ensures prompt ignition.

Small Quenching Distance: Hydrogen flames travel closer to the cylinder wall than other fuels before they extinguish.

High Auto Ignition Temperature: The high auto ignition temperature of hydrogen allows larger compression ratios to be used in a hydrogen engine than in a hydrocarbon engine. High Flame Speed: Hydrogen has high flame speed at stoichiometric ratios. This means that hydrogen engines can more closely approach the thermodynamically ideal engine cycle. High Diffusivity: It facilitates the formation of a uniform mixture of fuel and air Additional Characteristics of Brown Gas:

(i) Brown Gas is implosive nature; when burned in its pure mixture.

(ii) Brown Gas can cut materials that ordinary torches cannot touch, like iron oxide because the Brown Gas flame instantly causes the material to raise its own temperature until it is sufficient to melt or burn it.

(iii) Brown Gas power potential is much greater than 116.3MJ/kg.
(vi) It appears that the unique nature of the extreme thermal energy produced by Brown Gas is from interactive effects with the particular material being heated.

THEORY ON BROWNS GAS:
Hydrogen is a combustible gas and water on electrolysis splits into two molecules of hydrogen and one molecule of oxygen, hydrogen and oxygen though evolve separately in the electrolysis setup but combines immediately to form Oxy hydrogen gas(HHO) or commonly called as Brown's gas in the collection tube. On introduction of the brown's gas and air fuel mixture through the air-inlet manifold of the carburetor into the IC engine, the highly flammable Browns gas ignites a fraction of a second earlier than the fuel. No flash points, explosive points or temperatures soaring, takes place during the combustion within the cylinder. The flame speed of hydrogen is very high compared to that of gasoline. Hence there is no delay in combustion between two points in the cylinder ensuring a smoother performance, this helps in uniform and complete combustion of the additive and fuel mixture inside the cylinder of the engine. In addition to this the life and performance of the engine improves. And because of the complete combustion of the fuel and Browns gas mixture, it ensures that there are no unburned hydrocarbons and also oxidizes the partially oxidized carbon i.e. carbon monoxide (CO) into completely oxidized carbon dioxide (CO2) which is less harmful compared to carbon monoxide. This results in significant decrease in hydro carbon level in the exhaust of the engine. The brown's gas doesn't cause any pollution as the product after combustion is steam. The brown's gas is liberated using the electrolysis process, where the current is passed through the solution of Distilled water and potassium hydroxide (electrolyte), this liberated volume of brown's gas directly depends on:
i. Concentration of Electrolyte.
ii. Current sent into the solution.
iii. Area of contact between the electrode and the solution.

Figures

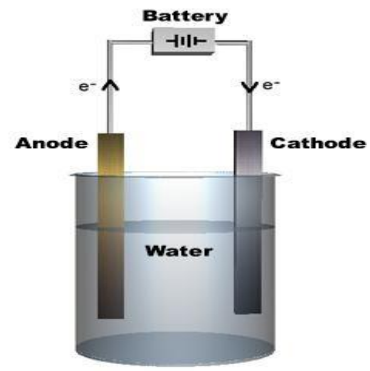


Figure.1 principle of electrolysis

Electrolysis of water is the decomposition of water (H2O) into oxygen (O2) and hydrogen gas(H2) due to an electric current being passed through the water. This electrolytic process is used in some industrial applications when hydrogen is needed. An electrical power source is connected to two electrodes (typically made from some inert metal such as Platinum or Stainless Steel etc.) which are placed in water. Hydrogen will appear at the Cathode (the negatively charged electrode), and Oxygen will appear at the Anode (the positively charged electrode). The generated amount of hydrogen is twice the amount of oxygen, and both are proportional to the total electrical charge that was sent through the water. Electrolysis of pure water is very slow, and can only occur due to thyself-ionization of water. Pure water has an electrical conductivity about one millionth that of seawater. It is sped up dramatically by adding an electrolyte (such as a salt, an acid or a base).

Method of Oxy-Hydrogen Gas Generation:
Electrolysis is the general method which is used for the generation of oxy-hydrogen gas. This method makes use of the basic principle of faradays law. 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 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: $2\ H_2O \rightarrow 2\ H_2\ (g) + O_2\ (g)$
electrolyze shown in Figure 2 is based on the common-duct series-cell electrolyze concept originally developed and patented by William Rhodes, Ernest Sprig, and Yull Brown and later refined by Bob Boyce, George Wiseman, etc. It uses an alkaline (NAOH, KOH) electrolyte to split distilled water into hydrogen and oxygen components very efficiently. The produced hydrogen and oxygen gasses are not separated to separate containers, but kept mixed. The produced oxy- hydrogen gas is a stoichiometric mixture of hydrogen (2 parts vol.) and oxygen (1 part vol.) and can be combusted in vacuum. The combination of series-cell topology is very efficient, because it allows the cells to operate as close to their optimal cell voltage (1.47V) as possible. The electrolyze runs fairly cool, at about 30- 50 °C depending on the current and electrolyte. The electrolyze shown in this report has about 80-90% total efficiency when all things are considered (ambient temperature, ambient pressure, accurate measurement of gas volume and current) and powered by straight DC.

Brown gas Electrolyses

The construction of electrolyses can vary, but in this experiment transparent fiber glass material is used .it is non-corrosive and high strength to density ratio. it can with stand high temp. The electrolysis is done within the electrolyses, thus it contains terminals for power supply which is done by the 12 volts battery. It is also equipped with an adjustable air bubbler due to safety issues. Inside the electrolyses, the electrodes are made from stainless steel (ss) hallow cylindrical rods of 316L grade which is commonly available are used and a glass plate with internal holes taken, in which electrodes are placed .to avoid short circuit we arrange glass plate. Nylon caps are glued around a core of fiber to make it leak proof. Now copper wire having 10 sq.grade is used to connect battery and electrodes.. These are great electricity conductors for the electrolysis process. As for the electrolysis distilled water is used and filled up to 3/4th of the height, the electrolyte preferably is KOH (Potassium Hydroxide) for better conduction and it is generally about 2-3% of the total water filled. It is also equipped with air bubbler adjuster and electric terminals for power supply as well as the outlet valves. The chemical reactions that take place inside the electrolyses when 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

The electrolyses are arranged in line with the 'bubbler' as the safety backup, it is filled with almost half by volume with normal or distilled water. as the name says, it provides the safety during any misfire from the engine, if occurs, as the HHO gas is highly flammable and during the combustion of the engine, if any accident happens then the gas will back flow to the electrolyses, to avoid this situation it has to pass through the back fire protection tube which will cease the fire and prevents, thus it is an important measure of safety which is used.

SELECTION OF ELECTRODE MATERIAL:

According to reference of some scientific based results electrode shape was selected as tube structure. But material was selected according to my design because of production of hydrogen was purely on material. So some experiments were done on different materials like Platinum, Titanium, Nickel, Stainless Steel (304 or 316), Carbon, Iron, Aluminum, Copper, Brass, and Graphite. Among these materials platinum, Titanium are costly but production of hydrogen was very pure and next level materials was Copper, Iron, and Stainless Steel (304 or 316) these are cheap in cost, easily available materials in any structure and production of hydrogen is almost 90% pure by electrolysis process. Among these materials Stainless Steel (304 or 316) got the better results for production of hydrogen. Moreover stainless steel resists corrosion, maintains its strength at high temperatures, again in stainless steel I was compared results by doing the experiment using electrolysis process stainless steel 316 is better than stainless steel 304. So, I was selected Stainless Steel 316 material as electrode for HHO generator. These are the test results while electrolysis process is going on and electrical energy as input. Battery values: 12V-24AMPS.

Electrolyte as KOH: 1-2%.

Figure.2 Stainless steel 304 Electrode

Tube Specifications

Stainless Steel Grade 316L is used where corrosion resistance and good mechanical properties are primary requirements. It is also widely used in applications where corrosion resistance is required. This cell is an electrolysis cell similar to Stan Meyer - hydrogen oxygen (HHO) - Energy cell. Stanley Meyer was a pioneer in electrolysis. This cell is built with 4 hallow 316L grade stainless steel seamless pipes and fibre glass plate.

Stainless steel tubes of 2mm thick, 1” inch diameter and 15cm long stainless steel (316L Grades). The electrodes are welded with small copper wire at the end position for electrical contact. After the electrical connection the tubes are arranged in a very close manner such that the gap between the anode and cathode is 8-10mm. The gap between the electrodes is as small as possible, to increase the active surface area of the tubes and seems necessary for ultra high efficiency. The electrical connections are sealed with Teflon tape for minimizing the electrical losses

V. HELPFUL HINTS

Figures and Tables

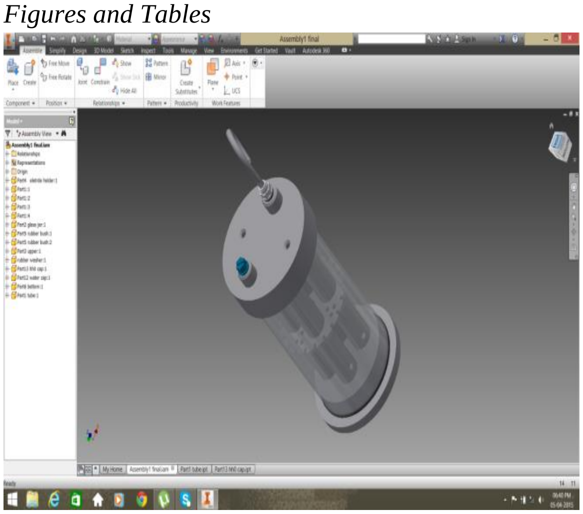


Figure.3 Electrolyze design
(Using auto desk inventor)

Figure.4 Electrolyses jar

The production of browns gas is done by a hydrolyser kit, designed for this purpose. The kit contains one cylindrical fiber glass (below fig) filled with 2-3% KOH solution till the electrodes are completely immersed. The electrodes are made up of 316L stainless steel (150mm length x 25mm breadth x 2mm thick), the electrical connections are made with the Teflon coated wires. the electrodes are separated by using glass plate to avoid short circuiting. These electrolyze are electrically connected to maintain constant current. The evolved brown’s gas from hydrolyser is directed to flow through Pressure equalizer tubes and the gas from the electrolyses is sent into the gas control valve and then to the Inlet manifold of the carburetor. The electrolyses are sealed using Teflon tapes and m-seal to avoid leakage of brown’s gas.

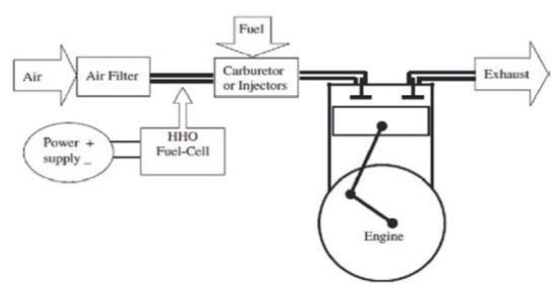


Figure.5 Simple Layout of Petrol –HHO Engine Set up

Fuel is supplied from the petrol tank to burette with the help of valves and the fuel from the burette is supplied to the carburetor, from the carburetor the intake of petrol + HHO + air is supplied to the engine cylinder during the suction stroke. During power stroke the crank shaft is driven by the piston and the crank shaft is coupled to the gear box by the help of clutch. A sprocket is attached at the output of the gear shaft. With the help of chain drive brake drum is driven by the gear shaft sprocket. Brake drum and sprocket is mounted on the shaft which is made up of EN 8. The shafts simply supported at the two ends by bush bearings. One end of shaft is centre drilled and the purpose of centre drill is to take speed of output shaft by the help of tachometer. The flat belt is attached to the brake drum to apply the load by to and fro motion of lead screw while rotating the hand wheel. The applied load is shown in the spring balance. Two spring balances are attached to the belt one at the tight side and another at the slack side and tangential to the brake drum

EXPERIMENTAL METHODOLOGY:

The experiment was conducted on TVs star city of 4 strokes, 100cc displacement, air cooled, and 7.2 BHP engine. The brown's gas from the hydrolyser generator is sent into the cylinder of the engine. Here the approximation was made on the volume flow rate of the browns gas from the hydrolyser. Different flow rates were obtained for different values of current through the electrolyze which is connected with a 12V Variable Supply. The sequence explains, the Current from the 12Volts and 7 Ampere hours, commercially available lead acid battery is drawn by the hydrolyser kit and the liberated brown's gas is sent to the flow control valve and the gas from the flow control valve is sent into the cylinder of the engine through the air intake manifold of the carburetor and the fuel, air and brown's gas mixture is burned in the cylinder. The emission testing was done for different flow rates but for one particular flow rate, the effluents from the emissions were reduced to a very large extent.

Engine specifications:

Engine	TVs star city, Air cooled
Cubic Capacity	109.4 cc
Stroke	4 Stroke
Brake Power	7.37 HP (5.4KW) @ 8000 RPM
Speed	1500 RPM
Number of Cylinders	Single
Radius of the Brake Drum	0.06m

Equations Numbered equations consecutively with equation numbers in parent hoses flush with their ightmargin, assign (1).First use the equation editor to create the equation. Then select the "Equation "mark up style. Press the tab key and write the equation numbering parentheses. To make your equations more compact, you may use this olidus (/), the expfunction, or appropriate exponents. Use parentheses to avoid ambiguities in denominators. Punctuate equations when they are part of a sentence,

FUEL SUPPLY ARRANGEMENT

Supply of Hydrogen Gas to Engine Cylinder:

The HHO gas which is generated from the HHO generator is supplied to the engine in between the air filter and carburetor, for efficient mixing of HHO gas with atmospheric air. It is supplied to the engine through the bubbler for reducing the risk of explosion. HHO gas is supplying through the PVC hose pipe of 8 mm diameter, and a nozzle is arranged at the exit of the tube for increasing the velocity of the outgoing HHO gas into the carburetor, where it is efficiently mixed with atmospheric air and is sucked in to the cylinder. Arrangement was shown in figure

Figure.6 Electrolyses jar

PERFORMANCE CHARACTERISTICS

Brake Power (BP)

Brake Power is the actual work output of the engine available at the crankshaft and is obtained by the means of some form of a brake. Fig 3 shows the characteristic curves of load with brake power for gasoline fuel and gasoline with Brown's gas. Figure illustrates that there is a increase in the Brake power for gasoline with Brown's gas fuel.

$$BP=\frac{2\Pi NT}{60}\,kw$$

INDICATED POWER (IP): It is the power developed in the cylinder and thus, forms basis of evaluation of combustion efficiency or the heat release in the engine

$$IP=\frac{p_m LAnk}{60}\,kw$$

FRICTION POWER (FP):

The difference between indicated power and brake power is called friction power. It is the indication of power lost in the mechanical components of the engine.

$$FP=IP-BP\ kw$$

Mechanical efficiency:

Mechanical efficiency is defined as the ratio of brake power (delivered power) to the indicated power (power provided to the piston).

$$\eta_{mech}=\frac{BP}{IP}$$

Brake Thermal Efficiency (BTE)

Brake Thermal Efficiency indicates the fraction of heat supplied that is transformed into engine shaft work. Fig 4 shows the variation of load with Brake thermal efficiency values for gasoline and gasoline with Brown's gas fuel. Graph shows the steep increase in the Brake thermal efficiency for gasoline with Brown's gas.

$$\eta_{bth}=\frac{BPx3600}{m_f xCV}$$

INDICATED THERMAL EFFICIENCY:

Indicated thermal efficiency is the ratio of energy in the indicated power to the input fuel energy in appropriate units.

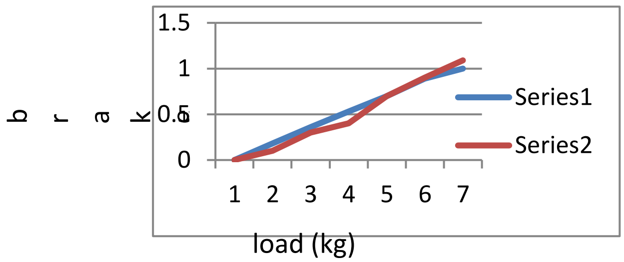
$$\eta_{Ith}=\frac{IPx3600}{m_f xCV}$$

Specific Fuel Consumption (SFC):

Specific fuel Consumption is the fuel flow rate per unit of power. Fig 6 shows the curves for Specific fuel Consumption at various loading conditions for gasoline fuel and Brown's gas enriched fuel. There is a decrease in the Specific Fuel Consumption of Brown's gas enriched fuel when compared to that of gasoline.

$$SFC=\frac{m_f}{BP}\,Kg/_{kw\text{-}hr}$$

We conduct performance analysis on Petrol-HHO engine by supplying petrol and Petrol+HHO Fuels respectively. After analysis it has been found that the specific fuel consumption, brake power and the thermal efficiencies are increased with the Petrol+HHO fuel. The reading and graph



VII. CONCLUSION

As the load increases Brake power increases. The brake power developed by the engine operated on HHO gas is more as compared with pure Diesel. Mechanical Efficiency of the engine increases, for engine operated with HHO gas is more as compared with pure diesel. Brake thermal efficiency, indicated thermal efficiency of the engine increases, for engine operated with HHO gas is more as compared with pure diesel. Total fuel Consumption of the engine increases, for engine operated with HHO gas is more as compared with pure diesel.

At full load, Brake Power for Brown's gas enriched engine operation gives 5% higher than conventional engine Operation. At full load, Brake thermal efficiency for Brown's gas enriched operation gives 7% higher than conventional Engine operation. Total fuel consumption for Brown's gas enriched operation at full load gives 6% lesser than conventional engine Operation. Specific fuel consumption for Brown's gas enriched operation at full load gives 11% lesser than conventional Engine operation. Lowered values of CO and HC in exhaust gas as well as more efficient combustion leads to lower Amount of CO2 gas as well.

Higher efficiency, gain up to 15% is noted in the Consumption of fuel. Lowered the temperature of engine thus longer life of coolant and better performance figures.

Reliable method of fuel saving.

The Petrol HHO engine performance and emission analysis are conducted with Petrol + HHO and petrol respectively. Thus the performance and emission analysis results are compared after conducting the tests with petrol + HHO and petrol respectively. The following conclusions are observed as follows

i) The use of HHO in gasoline engines enhances combustion efficiencies, consequently reducing the fuel consumption by 20%.

ii) Use of HHO in gasoline engines leads to reduction in emission of harmful pollutants such as carbon monoxide and unburnt hydrocarbons.

iii) Use of HHO in gasoline engine increases the power output of the engine around 5.7%.

IV) The HHO gas kit can be easily constructed and easily integrated with existing engines at low cost.

v) Thermal Efficiency increases around 6%. The investigation of the effects of HHO

Supplement in a single cylinder SI engine was carried out on the 100cc engine. Hydrogen enhancement was used for the comparison based on the current supplied for the production of HHO through electrolysis. The effect of engine operating conditions on the exhaust gas emissions was also investigated and the following observations were Madera smooth and stable operation of the engine has been achieved with least modifications of the vehicle hardware.

An observation with both HC (ppm) and CO% emissions where the levels began to drop.

The combustion efficiency has been enhanced when HHO gas Has been introduced to the air/fuel mixture, consequently Reducing fuel consumption. Brake thermal efficiency of brown gas engine enriched operation gives higher than `normal conventional S.I.Engine. At full load brake thermal efficiency of a brown Brake gas boosted engine operation gives 30% more than normal conventional engine.

The baseline measurements, for the engine in stock condition, provided curves that conformed to the expected behavior Introduction of HHO led to increased power and torque The engine tended to run richer under higher loads There was a significant reduction of unburned hydrocarbons as a result of the increase in HHO inclusion

Introduction of HHO led to improved combustion particularly at low loads although an increase in power and a reduction in harmful exhaust emissions were observed as a result of addition 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

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