International Journal of scientific research and management (IJSRM)
\||Volume||3||Issue||7||Pages|| 3275-3284||2015||
Website: www.ijsrm.in ISSN (e): 2321-3418

Improving the fuel economy and reduction of pollutants from Automobiles using HHO gas

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ABSTRACT

The consumption of fossil fuels spawns environmental considerations in addition to issues of energy demand, national security and resource availability. At global level, scientists warn that the combustion of fossil fuels is significantly changing the world's climate system. So help the fossil fuels to exist longer life in turn to help survive this in ever automobile industry. In order to overcome the draw backs of the fossil fuels it is the time to completely or partially replace this fuel. So an innovative idea to overcome these problems is the HHO gas**.** HHO gas is also known as brown gas produced from splitting water into hydrogen and oxygen from electrolysis and allowing the gas to stay in a premixed state for use on demand without the need of storage.

This project work describes about implementing the HHO fuel in diesel engine and comparing the fuel consumption of normal fuel (diesel) to secondary fuel (HHO) and showing the reduction of carbon emissions from the vehicles using this HHO fuel. Also the performance of the engine is also tested under normal diesel and diesel with HHO. Based on the experimental results the advantages of diesel with HHo over normal diesel are reported.

Key words: Fossil fuels, Alternative fuels, HHO gas, carbon emissions.

1.0 INTRODUCTION

Fossil fuels (i.e., petroleum, natural gas and coal), which meet most of the world's energy demand today, are being depleted rapidly. Also their combustion products are causing global problems, such as the greenhouse effect, ozone layer depletion, acid rains and pollution, which are posing great danger for our environment, and eventually, for the total life on our planet. Many engineers and scientists agree that the

solution to all of these global problems would be to replace the existing fossil fuel system with the clean hydrogen energy system. Hydrogen is a very efficient and clean fuel. Its combustion will produce no greenhouse gases, no ozone layer depleting chemicals, and little or no acid rain ingredients and pollution. Hydrogen, produced from renewable energy (solar, wind, etc.) sources, would result in a permanent energy system which would never have to be changed. Fossil fuels possess very useful properties not shared by non-conventional energy sources that have made them popular during the last century. Hydrogen has long been recognized as a fuel having many desired properties, as a fuel in engines. It is the only fuel that can be produced entirely from the plentiful renewable resource water, though through the expenditure of relatively much energy. The use of only hydrogen results in higher temperatures and cause damage of the vehicle; hence it is simplified into HHO.

The outline of this study is to research the effects of HHO produced on-demand combined injection as an additive for combustion in a diesel engine. The effects of phenomena of HHO and diesel mixture on diesel engine exhaust emissions and fuel consumption will be discussed. This study will describe the design of the experiment – stating the controls and variables. The experiment analysis shows the fuel consumption of diesel along with HHO fuel and carbon emissions. The results of this test will be focussed at proving the quality and magnitude fuel consumption and exhaust emissions of HHO on-demand systems similar to what is currently available on the market.

1.1 HHO Gas

1.1.1 HHO Gas Definition

HHO stands for two parts of hydrogen and one part of oxygen. HHO gas is a mixture of hydrogen and oxygen, in the atomic ratio of two is tone. Combustion is a process by which a substance burns to produce heat energy and it brought about when a substance is heated to its auto ignition temperature. Temperature is defined to be the minimum temperature at which the substance will ignite spontaneously in normal atmosphere without the help of an external source such as a spark or flame. For HHO gas the auto ignition temperature is 1065 F and the minimum energy required for its ignition with an external source is 20 Micro joules. Once ignited, HHO gas converts into water vapors and releases energy, which automatically sustains the reaction.

The HHO gas is nothing but the electrolyte form of water. It is also called as oxy-hydrogen or brown gas. It is produced by electrolysis process, where an electrical power source is connected to two electrodes and which are placed in a mixture of water and electrolyte. Oxy hydrogen appears to be a favourable alternative fuel on account of its high specific energy per unit weight, its all-time availability as a component of water, good combustion characteristics and eco-friendly, fast burning and higher flame propagation rates are the attractive features of HHO gas. HHO gas is a mixture of hydrogen and oxygen gases, typically in a 2:1 atomic ratio; the same proportion as water. At normal temperature and pressure, oxy hydrogen can burn when it is between about 4% and 94%hydrogen by volume, with a flame temperature around 2000. Oxy

hydrogen will combust (turning into water vapour and releasing energy which sustains the reaction) when brought to its auto ignition temperature. For a stoichiometric mixture at normal atmospheric pressure, this is about 570(1065).The minimum energy required to ignite such a mixture with a spark is about 0.02mJ. The quantity of heat evolved, according to Julius Thomson, is 34,116 calories for each gram of hydrogen burned. This heat-disturbance is quite independent of the mode in which the process is conducted; but the temperature of the flame is dependent on the circumstances under which the process takes place. It obviously attains its maximum in the case of the firing of pure" oxy hydrogen" gas (a mixture of hydrogen with exactly half its volume of oxygen, the quantity it combines with in becoming water, German Knell-gas). It becomes less when the "oxy hydrogen" is mixed with excess of one or the other of the two reacting gases, or an inert gas such as nitrogen, because in any such case the same amount of heat spreads over a larger quantity of matter.

1.1.2 Production of HHO Gas

Hydrogen is not a fuel that occurs free in nature like fossil fuel. Primary source of energy like solar, nuclear or hydro-electric is necessary to separate it from original combined state. The following methods are considered suitable for hydrogen production:

- Thermo chemical method.
- Electrolysis of water.
- Photo bialysis.
- Thermal decomposition of water.

Thermo chemical method

This method is considered potentially most promising. It depends on complex series of interactions between the primary energy, water and some specific chemicals to produce hydrogen at temperatures substantially lower than thermal decomposition. The chemicals used are recyclable. A variety of compounds of iron, iodine, lithium and cadmium are used.

Electrolysis of water

In this method, electrical energy is used to break water into H_2 and O_2. In principle, an electrolysis cell consists of two electrodes, commonly flat metal or carbon plates, immersed in an aqueous conducting solution called the electrolyte.

A source of DC voltage connected to the electrodes so that an electric current flows through the electrolyte from anode to cathode. As a result, water in the electrolyte solution is decomposed into H_2 which is released at the cathode and oxygen at the anode. Since water itself is the poor conductor of electricity an electrolyte like KOH is used increase the electric conduction.

Extraction of HHO from Water:

An HHO Generator utilizes electric current to break up into water into hydrogen and oxygen. The electricity enters the water on the left side at the "cathode"(a negatively charged electrode). The electricity passes through the water and exists via the "anode" (the positively charged electrode), shown on the right side. Hydrogen can be collected at the cathode, while Oxygen can be collected at the anode. It is also possible to let these gases mix on their way and the combined mixture is known as HHO.

Photobialysis

In this process, action of certain catalyst to produce H_2 from water by use of directs sunlight at ambient temperature. Though, it appears attractive, the present efficiency of production is only 1%.

Thermal decomposition of water

In this method, heat at high temperature (3000^0C) is used to thermally decompose water into H_2 and O_2.

1.1.3 Advantages of HHO gas as a fuel in Diesel engine

- HHO gas mixture burns nearly 10 times faster compared to gasoline air mixture.
- HHO ignition limits are much wider than gasoline's. So it can burn easily and give considerably higher efficiency.
- High self ignition temperature but very little energy is required to ignite it.
- Its clean exhaust is the most attractive feature of all.

1.1.4 Disadvantages of HHO gas as a fuel in Diesel engine

- Produces toxic emission of NO_x.
- One of the major practical difficulties using HHO as car fuel is its very low density either in gas or liquid form.
- The handling of HHO gas is more difficult and storage requires high capital and running cost.

1.1.5 Applications of HHO

Lighting:

Lime lights used an oxy hydrogen flame as a high-temperature heat source. Many forms of oxy hydrogen lamps have been described, such as the limelight, which used an oxy hydrogen flame to heat a piece of lime to white hot incandescence. Because of the explosiveness of the oxy hydrogen, lime lights have been replaced by electric lighting.

Oxy hydrogen blowpipe

Nineteenth century bellows-operated oxy-hydrogen blowpipe, including two different types of.The oxy-hydrogen blowpipe was developed by English mineralogist Edward Daniel

Clarke and American chemist Robert Hare in the early nineteenth century. It produced a flame hot enough to melt such refractory materials as platinum, porcelain, fire brick, and corundum, and was a valuable tool in several fields of science. It is used in the Vermeil process to produce synthetic corundum.

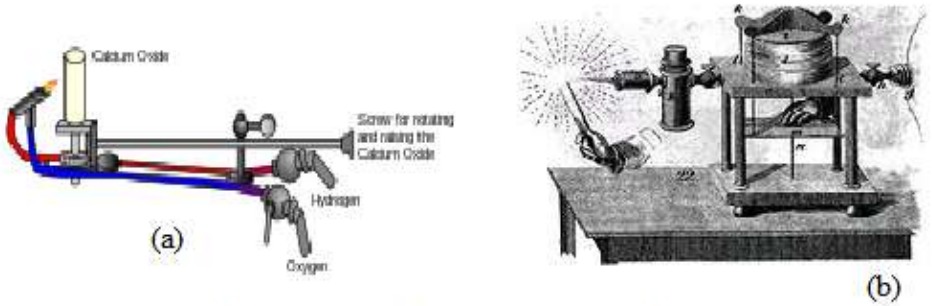

Fig (1) Application of HHO (a) Lighting (b) Blow Pipe

Oxy hydrogen torch

An ox hydrogen torch is an oxy-gas torch, which burns hydrogen (the fuel) with oxygen (the oxidizer). It is used for cutting and welding, metals, glass, and thermoplastics. Due to competition from the acetylene-fuelled cutting torch and from arc welding, the oxy hydrogen torch is seldom used today, but it remains the preferred cutting tool in some applications see oxy-fuel welding and cutting. Ox hydrogen was once used in working platinum because at the time such a torch was the only device that could attain the temperature required to melt the metal 1,768.3 °C (3,214.9 °F). These techniques have been superseded by the electric arc furnace.

2.0 EXPERIMENTATION

2.1 Basic components of HHO kit

HHO kit basically consists of the following components namely:

- HHO fuel container.
- ECU (electronic circuit unit).
- Elbow pipe.

HHO fuel container

The fuel bottle mainly consists of HHO fuel in it as shown in the fig.., The electrolysis of water using electricity. Splitting the water using electricity into hydrogen and oxygen is called as HHO fuel is stored in a container The HHO fuel which is in the container is the essential part of increasing the mileage of our motor vehicles which is sealed and having to types of wires at the top of the container. The HHO fuel container consists of 2 wires blue and green .The blue wire of HHO fuel container is connected to the blue wire of Electronic Circuit Unit.The green wire of HHO fuel container is connected to the green wire of Electronic Circuit Unit.The following fig shows the arrangement of fuel container to the engine

Fig (2) HHO fuel container

Electronic circuit unit (ECU)

ECU mainly consists of 4 different wires as shown in the figure those wires are green, blue, red and black. The blue wire of the circuit is connected to blue terminal of the container as shown in fig1.., similarly the green wire is connected to green terminal of container as shown below.

Fig (3) Electronic circuit unit (ECU)

The black wire is connected to the negative terminal of the battery and the red wire is connected to the positive terminal of the battery as shown in the below fig...,The capacity of Electronic Circuit Unit we are using is upto 500 cubic centimetre motor vehicles. Electronic circuit in it consists of 4 switches. Switch 1 is used up to 99 c.c., Switch 2 from 100 c.c to 200 c.c., Switch 3 from 200c.c to 300 c.c., Switch 4 is used from 300 c.c to 500 c.c.

2.2 INSTALLATION PROCESS OF HHO FUEL TO DIESEL ENGINE

The HHO fuel container is kept only in vertical position; it should not be placed at any angle because the fuel will not be supplied to the engine. To install HHO fuel to the diesel engine, the diesel engine the manifold is dismantled from the engine as shown below.

Fig (4) Experimental set up

This project deals with the installation of the HHO technology on the diesel engine. The experimental setup comprises of royal enfield diesel engine motor cycle, along with the measurement bottle of about 300ml bottle with the lock. Where the lock helps to prevent flow of the fuel through the pipe as shown in the fig(5).

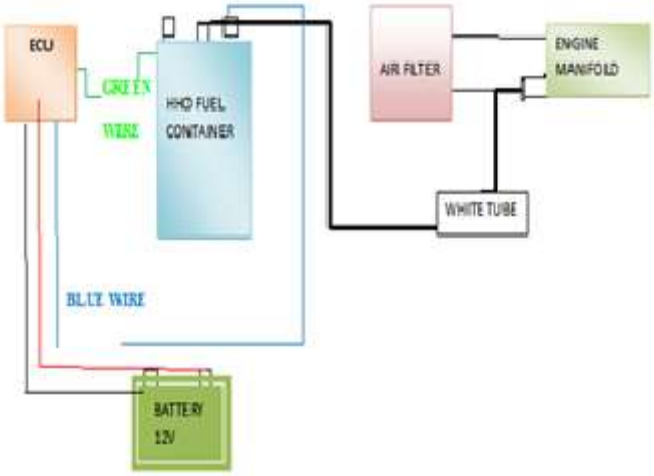

Fig (5) Installation diagram of HHO fuel

2.3 Observations and Calculations:

Table: 1 Comparing time taken for consuming 10ml of fuel with and without HHO in Diesel engine

Sl. No.	Fuel Consumed	Time taken under normal fuel in min. (Diesel)	Time taken with secondary fuel in min. (HHO)
1	50	15.07	15.10
2	50	14.63	17.36
3	50	11.23	13.09
	Average	13.64	15.45
		844 Sec	945 Sec

For Diesel

For every 50ml the time taken to consume the fuel is 844 sec

Therefore consumption of fuel per hour:

$$\frac{50 \text{ X } 3600}{844} = 213.27 \frac{\text{ml}}{\text{hr}} = 0.213 \frac{\text{l}}{\text{hr}}$$

Similarly for HHO fuel

For every 50ml the time taken to consume the fuel is 945 sec. Therefore fuel consumption per hour is

$$\frac{50 \text{ X } 3600}{945} = 190.47 \frac{\text{ml}}{\text{hr}} = 0.191 \frac{\text{l}}{\text{hr}}$$

Percentage calculation of the fuel being saved

$$\frac{Normal\ fuel\ consumption - HHO\ fuel\ consumption}{HHO\ fuel\ consumption}$$

$$\frac{0.213 - 0.191}{0.191} = 0.115 = 11.5\%$$

Therefore 11.5% of fuel is being saved per hour using HHO fuel.

2.4 Carbon emissions

Carbon dioxide (CO_2) emissions are the common type of gas emitted from the burning of fossil fuels. The higher the carbon content in the fossil fuel or the more inefficient the burning process is, generally the more CO_2 that is produced. When this CO_2 is released into the atmosphere it remains there until it is absorbed in some form. For example approximately 50% of all CO_2 released into the atmosphere is absorbed by the oceans. Animals and plants also absorb CO_2. The carbon emissions measured from experiment is as shown in table (2) and in graph (6).

Table: 2 Carbon Emissions:

Sl. No.	Fuel	Carbon Emissions
1	Diesel	1.20
2	HHO fuel	0.69

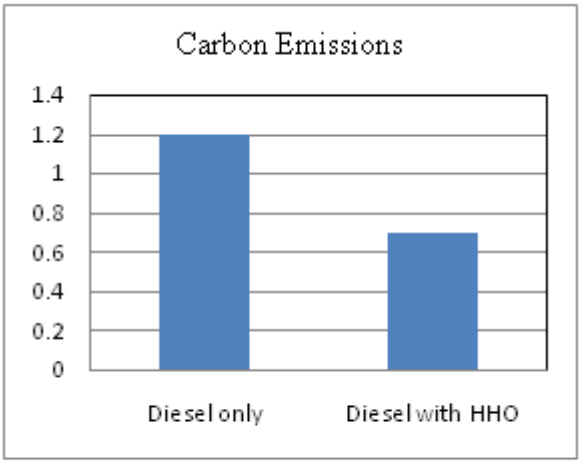

Fig (6) Carbon emissions of diesel engine with & with out HHO

2.5 Performance of the Engine:

The diesel engine is tested under different loads with diesel only and diesel with HHO. The results are given in the table (3) and (4). The mechanical efficiency of the engine with diesel and diesel with HHO is as shown in figure (7)

Table: 3 Performance test on four stroke diesel engine by mechanical loading using diesel only

S. No	Load (kg)	Fuel consumption(kg/hr)	Brake power (KW)	Specific fuel consumption(kg/kw.hr)	Indicated power (KW)	η_m (%)	η_{bt} (%)	η_{it} (%)
1.	2	0.169	0.45	0.377	1.15	39	22	57.4
2.	4	0.170	0.914	0.185	1.164	78	45	57.8
3.	6	0.225	1.373	0.163	2.073	66	51.5	60
4.	8	0.30	1.574	0.344	2.274	69.2	44.3	64.0

Table: 4 Performance test on four stroke diesel engine by mechanical loading using HHO only

S. No	Load (kg)	Fuel consumption(kg/hr)	Brake power(KW)	Specific fuel consumption(Kg/kw.hr)	Indicated power (KW)	η_m (%)	η_{bt} (%)	η_{it} (%)
1.	2	0.08	0.376	0.077	0.876	42.6	28.2	60.2
2.	4	0.12	0.914	0.154	1.164	78.5	43.7	58.2
3.	6	0.20	1.28	0.123	2.06	67.2	50.2	62.5
4.	8	0.25	1.56	0.225	2.35	70.2	47.2	64.6

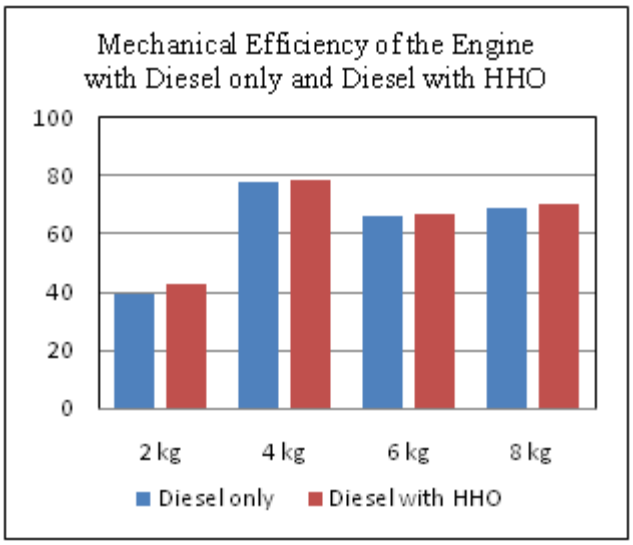

Fig (7) Mechanical efficiency of the engine with diesel only and diesel with HHO

3.0 CONCLUSION

HHO technologies are very promising and can serve as an important foundation in increasing the mileage of all vehicles by saving fuel and saving environment. HHO gas is a supplement fuel additive that helps to increase mileage, increase horsepower, reduce emissions while providing quieter and cleaner engine. From this study it was concluded that using HHO fuel in diesel engine the fuel is saved up to 11.5% per hour and the carbon emissions are reduced from 1.20 to 0.69. From the above values the efficiency has been increased from normal fuel to the alternate fuel HHO.

Hence HHO technology is the innovative idea of saving depletion of the fossil fuels. HHO technology is still considered experimental and the research is further going on this technology to overcome the disadvantages of this fuel.

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