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An Experimental Investigation on 4-Stroke Single Cylinder Petrol Engine by Using HHO Kit

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Abstract: ***The rapid depletion of fossil fuels and rising of oil prices has led to the search for Secondary fuels. The Secondary fuels that we are using should have the same efficiency or greater efficiency of the engine that uses ordinary fuel. In this research the secondary fuel used is HHO gas. HHO otherwise known as hydroxyl or Browns Gas is the 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 for storage. This reduces the exhaust gas emitted during the working of engine, and the temperature of the engine is also reduced which is produced by the burning of ordinary fuels. The HHO gas is injected into the inlet manifold of the combustion chamber through the air filter of the engine. From this design the fuel utility is reduced from 10% to 30% which minimizes the carbon deposition in the cylinder thereby increasing the changing period of engine oil, it also improves the efficiency of the engine and the life span. Engine torque also increased and pollution gets reduced to maintaining the greenhouse effect.***

Keywords: IC Engine, SI Engine, Brown gas, Exhaust Emissions.

I. INTRODUCTON

Hydrogen being the most abundant element in the universe is a highly flammable diatomic gas having a gross calorific value of 141790 kJ/kg.[1] Free hydrogen does not occur naturally, and thus it must be generated by electrolysis of water or another method. Hydrogen is therefore an energy carrier (like electricity), not a primary energy source (like coal). The utility of a hydrogen economy depends on issues of energy sourcing, including fossil fuel use, climate change, and sustainable energy generation [2]. In general, fuel economy is better and the combustion reaction is more complete only when an IC engine runs on a lean mixture. Hydrogen has a wide range of flammability when compared with all other fuels [3]. HHO production occurs by electrolysis process by using different electrolytes such as KOH, NaOH, NaCl, in different electrode designs in a leak proof reactor [4]. HHO (oxyhydrogen) comprises two hydrogen atoms and one oxygen atom, and it is possible to attain HHO by water electrolysis considering on-board vehicle applications [5].The unique combustion characteristics of hydrogen that allow clean and efficient operation at low engine loads present difficulties at high engine loads. Here, the low ignition energies of hydrogen–air mixtures cause frequent unscheduled combustion events, and high combustion temperatures of mixtures closer to the stoichiometric composition lead to increased NOx production. Both effects, in practical application, limit the power densities of H_2ICEs. The recent research thrust and progress on this front is the development of advanced hydrogen engines with improved power densities and reduced NO_X emissions at high engine loads The rationale behind the research objectives are derived from the research gap in testing hydrogen on demand by other researchers, as well as the need to experimentally prove or disprove the validity of the claims of hydrogen on demand vendors.

The experimental objectives of this research include: Accurately automate and data log the experiment with an industrial control system, where water injection rate, HHO production and generator load are the independent variables.

Optimize HHO and water injection ratios to yield lowest brake specific fuel consumption, if HHO is shown to have a positive effect on fuel economy.

Record and discuss the effects of HHO on oxides of nitrogen (NOx) emissions.

II. DETAILS OF EXPERIMENT

A. Properties of Brown Gas

BROWN'S GAS is created via the process of water electrolysis where the hydrogen and oxygen are allowed to stay mixed. Water contains a ratio of 2 parts hydrogen to one part oxygen bonded in a tetrahedral molecular arrangement with two lone pairs of electrons and two bonding pairs of electrons connecting the hydrogen atoms to the central oxygen atom. Eckman proposed that

when water is electrolyzed and the gas products are not separated by a semi-permeable membrane, Rydberg clusters may be formed. These clusters are of a mixture of hydrogen and oxygen species including linear water molecules in the highly energized trigonal-by pyramidal geometry, monatomic and diatomic hydrogen, free electrons and oxygen.

B. Hydrogen Production

1) *Electrolysis of water:* The electrolysis of water is a simple method of producing hydrogen. A low voltage current is run through the water, and gaseous oxygen forms at the anode while gaseous hydrogen forms at the cathode. Typically the cathode is made from platinum or another inert metal when producing hydrogen for storage. If, however, the gas is to be burnt on site, oxygen is desirable to assist the combustion, and so both electrodes would be made from inert metals. (Iron, for instance, would oxidize, and thus decrease the amount of oxygen given off.) The theoretical maximum efficiency (electricity used vs. energetic value of hydrogen produced) is in the range 80–94%.$2H_2O \rightarrow 2H_2$ (g) $+O_2$ (
2) *Characteristics Of Hho:* Water molecule HHO stands for 2 parts Hydrogen & 1 part Oxygen. When 2 Hydrogen atoms are bound to 1 Oxygen atom you have water, but when we separate the atoms from each other you have Hydrogen & Oxygen mixed gas. The correct term for this gas is Ox hydrogen (HHO). HHO will combust when brought to its auto-ignition temperature. A pure HHO may be obtained by water electrolysis, which uses an electric current to dissociate the water molecules
3) *Preprocessing of burning Hydrogen:* Before burning of Hydrogen, which is a lightest gas with one proton and one electron and more efficient fuel three times of the explosive power when camper to fuel gas and five times than petrol. Actually, the Hydrogen requires little bit of energy of ignition to produce wide level of tremendous flammable temperature in the speed of lighting and there is no chance to compare with other fuel in this world. As a result of fact it increases the engine performance, torque, and millage and minimums fuel consumption
4) *In the process of Hydrogen:* During burning the HHO into the engine with a tremendous explosion on that area and gives off high power of energy and automatically reverts to water vapour at once. Due to this action the engine not only getting higher torque but also gets easily cooled from 10 to 20 times faster than other fuels. Thus the engine life period gets wider, and reduces lubricating oil degradation beyond the limit of Km. Then oil changing period also gets lengthened. It leads in decrease of the maintenance cost and increase of interval of maintenance
5) *Post processing of HH:* After burning the HHO, the engine gives steam and some percentage of oxygen on the exhaust side and the steam is automatically converted into water form in the atmosphere thus the exhausts emission also controls from 10% to 50%. The pollution also reduces and remaining Oxygen comes out from the exhausts.

C. Chemical Equation

HHO is popular and common gas produced from electrolysis. It is really a combination of two gases hydrogen H_2 and Oxygen O_2.The simple chemical equation for conversion of water (liquid) to HHO (gas) can be written as H_2O (l) HHO (g) Connected with a help of Direct current to Electrolytic cells is to dissociate water into hydrogen and oxygen.

$$2H_2O + \text{ENERGY} \rightarrow 2H_2 + O_2$$

The chemical process could be easily speed up by using catalyst and during the process the selected compound does not change its property. The main purpose of the catalyst is to reduce the amount of energy required for conversion. The following chemical equation describes the function of catalyst.

$$2H_2O + \text{CATALYST} + \text{ENERGY} \rightarrow 2H_2O + O_2$$

As a result, Hydrogen (H_2) as well as oxygen (O_2) will be produced while splitting up of water.

Chemically the following process is going on

$$\text{Electrolysis: } 2\,H_2O \rightarrow 2\,H_2 + O_2$$

D. Engine Details

All automobile engines are categorized into its CC. For example an engine has single cylinder is 100CC. 1000 CC is equal to one liter. The HHO requirements also depend upon the level of engine CC and other devices. Approximately 100 CC engine requires 0.05 liter of HHO per minute.

Type of vehicle - 2- wheeler
Type of engine - 4-stroke

Make	-	Bajaj
Model	-	CT-100
Manufacturing year	-	2005
Fuel	-	Petrol

E. Design Of Hho Generator

1) *Basic Details of HHO:* The HHO generator involves in the production of hydrogen and oxygen with a help of process of electrolysis. In this process, Direct Current is passed through electrodes to water, due to chemical reaction, the positive plates generate Oxygen and negative plates generate Hydrogen. Pure water does not conduct electricity. Adding a base to the water creates electrolytic solution and increases conductivity, allowing electrolysis to occur. Distilled water and KOH is the preferred electrolyte. An electrolysis device is called an electrolyze cell, the process of using DC supply to the arranged electrodes which are immersed into the electrolysis split water into hydrogen and oxygen. The positive plate emits oxygen and negative plate emits hydrogen. Storing this gas creates explosive effect so directly hosed into the air intake of the engine. Within the engine before firing this HHO gas is automatically mixed with filtered air and then combines with the fuel. By nature HHO supports with gas as well as diesel, another property. While designing the HHO generator the following important points should be taken care:

a) Selection of electrodes
b) Distance between two electrodes
c) Connectivity between electrodes
d) Selection of catalyst, its level
e) Merits and demerits
f) Selection of container
g) Electrical connectivity and pumping with gas tight arrangement
h) Backfire protection

2) *Selection of Catalyst:* The catalysts may be pinch of salt or White Vinegar (H_3C-COOH) or Baking Soda ($NaHCO_3$) or Sodium Hydroxide (NaOH) or Potassium Hydroxide (KOH) or Potassium Carbonate (K_2CO_3). Each catalyst has its own merits and demerits. As per the requirement the requirement the catalyst is chosen; otherwise it gives more heat with more gas but consumes more DC current from the vehicle battery. Density of electrolyte is directly proportional to current consumption

3) *Extraction of HHO from Wate:* 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 out and this combined gas is what we call HHO

4) *Production Of Hh:* A HHO generator uses electrolysis to split water (H_2O) into its base molecules, 2hydrogen and 1oxygen. The HHO in itself is not an alternative to gasoline engines but an additive to boost the efficiency or performance of the engine. An HHO gas is highly flammable much more than so gasoline, so when the engine ignites the hydrogen the explosion ignites the gasoline with much better results (cleaner, less waste and fewer emissions. Some basics of the burn speed of hydrogen is 0.098 to0.197 ft/min (3 to 6 cm/min) compared to gasoline's 0.00656 to 0.0295 ft/min (0.2 to 0.9 cm/min). Instead of just a spark in one end of the combustion cylinder and we would like to do that because the gasoline burns for a short time but not fully burnt in that short amount then it just goes out of the exhaust and is lost. It is also preferable to ignite all of the gasoline when it is under maximum compression in combustion cylinder to get the maximum amount of energy out of it (this is a small time window), once the piston starts going down the energy transfer from the explosion to engine becomes less efficient. The Oxy hydrogen's higher burn temperature and explosive force is such that it cleans the soot that collects in the engine and with a cleaner engine we can get better mileage and fewer oil changes.

III. COMPONENTS

A. HHO-kit

1) *Electrolyzing Chamber:* It is made up of titanium dioxide which is a form of metal oxide .It separates pure gases using and oxygen gases using DC amps. At the top of electrolyzing water feed nozzle is placed .It is used to feed the water into the

electrolyzing chamber .The below fig1(a) shows electrolyzing chamber. The DC current is taken through the wires connected from the pulse dozer which supplies the current. The wires are connected to the cathode and anode securely inside the electrolyzing chamber .It is nearly 10mm diameter opening into the chamber

2) *HHO transfer hose:* It is the used to connect the electrolyzer and moisture filter on one side and to connect another side of moisture filter to the engine of the vehicle.

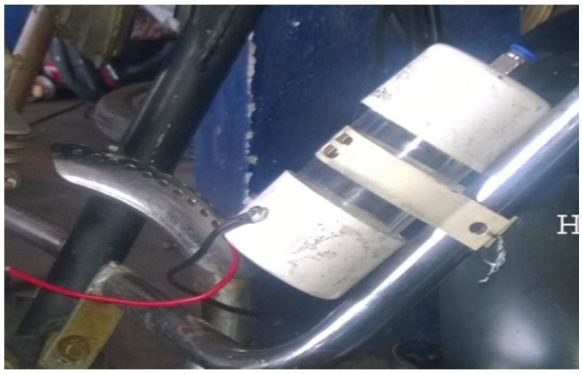


Fig1(a) ELECTROLYZING CHAMBER

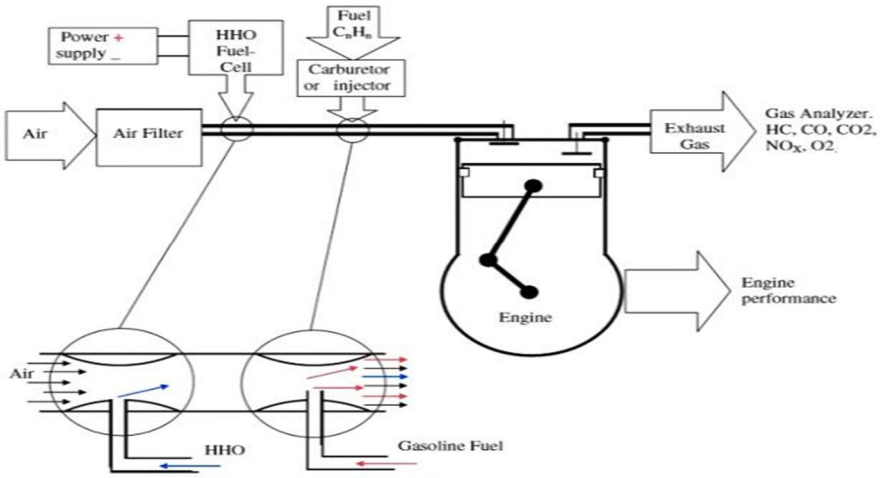
Fig1(b) MOISTURE FILTER

3) *Moisture filter:* Fig1(b) shows moisture filter i.e; used to filter the moisture particles in the hydrogen gas produced in the electrolyze chamber .Its main function is to prevent entering these moisture particles into the engine

IV. WORKING PRINCIPLE

After installing electrolyzing chamber to safety rod of bike the engine is started, then the pulse dozer generates 12V-13V in it. But it supplies only 3V-4V to the electrolyzing chamber. When the current is supplied, the electrolysis process starts in the electrolyzing chamber. The reactions take place between the anode and cathode. This will dissolve H_2O into 2 parts Hydrogen and 1 part Oxygen and combing this two generates oxy hydrogen (HHO) gas inside the electrolyzer. This oxy hydrogen gas is collected at the top of electrolyzer. It is then passed into the connecting hose which is connected to the air filter boot of the vehicle. Here in this air filter boot air and oxy hydrogen mixes and this mixture is passed into engine cylinder. In engine cylinder the combustion takes place with petrol and this mixture and energy is produced. This energy produced is greater than the energy produced when only petrol and air is combusted in the engine cylinder.

The hydrogen contains high density. This property is the main reason for the complete combustion to take place in the engine cylinder. During the supply of petrol intro the engine cylinder a valve is arranged to regulate the flow of fuel. Since the oxy hydrogen gas has more density, little amount of this gas can perform cent percent combustion. Hence to reduce the actual flow of the petrol into the engine cylinder this arrangement is made in the bike. It helps in producing more energy with little amount of fuel. As a result of this the efficiency will also increase



Basic Layout Of Hho

V. TESTING PROCEDURE

In this paper we are going to conduct two types of test to ensure the advantage gained on using this innovative technique.

A. Mileage Testing

Mileage is nothing but the fuel economy of any automobile. It is the total distance travelled by the automobile for specified quantity of fuel. For example BAJAJ CT100 (petrol) bike gives the mileage of 80 kmpl. So our project aims to increase this mileage compared with vehicle running without this equipment.

1) First Step
a) Before installing the equipment run the vehicle with 1 liter fuel either petrol or diesel.
b) Note down the distance (km) travelled by the vehicle in complete 1 liter fuel.
c) Make minimum three trail runs and note the readings.
2) Second Step
a) Now install the equipment to the vehicle and run it with1 liter fuel.
b) Note down the distance (kms) travelled by the vehicle in complete 1 liter fuel.
c) Make minimum three trail runs and note the readings.
3) Third Step
a) Tabulate the readings obtained in the above two steps.
b) Take the difference of these readings and note the resulted value.
c) This would be extra mileage added to the vehicle on using this technique.

B. Emmision Test

Due to the combustion of fuels in the vehicle some gases (exhaust gases) are produced such as hydrocarbons, carbon monoxide (CO), nitrogen oxides (NO_X), sulphur oxide etc. This is called emission of gases in automobile. We know that these gases are one of the reasons for global warming. So our project aims to reduce these harmful emission with the help this new technique.

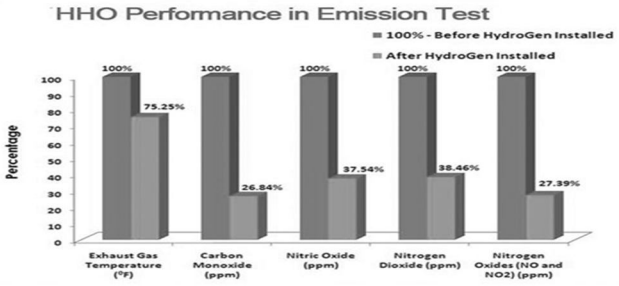
1) First Step
a) Make a trail run with one liter petrol/diesel.
b) Check the emission at mobile pollution check vehicle
c) As the pollution check certificate has validity up to 6 months of period it can be conformed for the next two more trails.
2) Second Step
a) After installing the equipment make a trail run with one liter petrol/diesel
b) Check the emission at mobile pollution check vehicle
c) As the pollution check certificate has validity up to 6 months of period it can be conformed for the next two more trails.
3) Third Step
a) Tabulate the readings obtained in the above two steps
b) Take the difference of these readings and note the resulted value.
c) Next convert the resulted value into percentage and this would be the percentage of reduced emission obtained by using this technique

III. RESULTS AND DISCUSSIONS

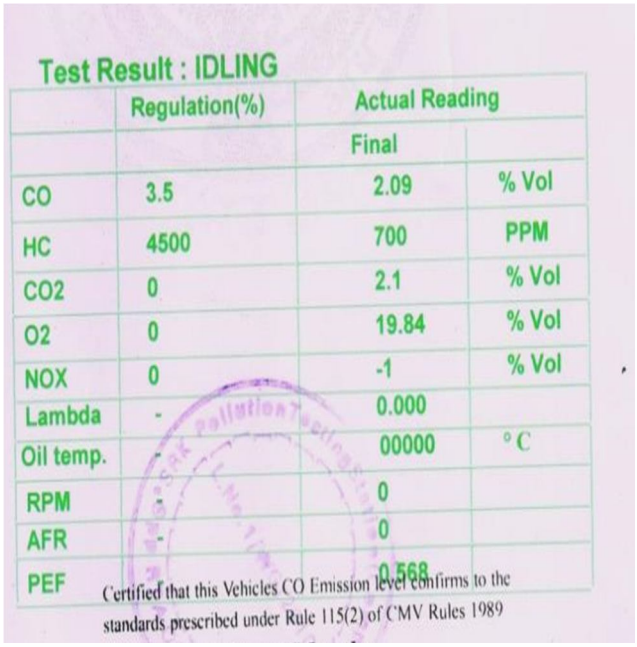
6.1. RESULT OF MILEAGE TEST

SLNO	By using petrol	By using Petrol + HHO
1	80	90.5
2	79	89.5
3	79	91.5

6.2. RESULT OF EMISSION TEST



6.2.1. EMISSION CHECK (PETROL)

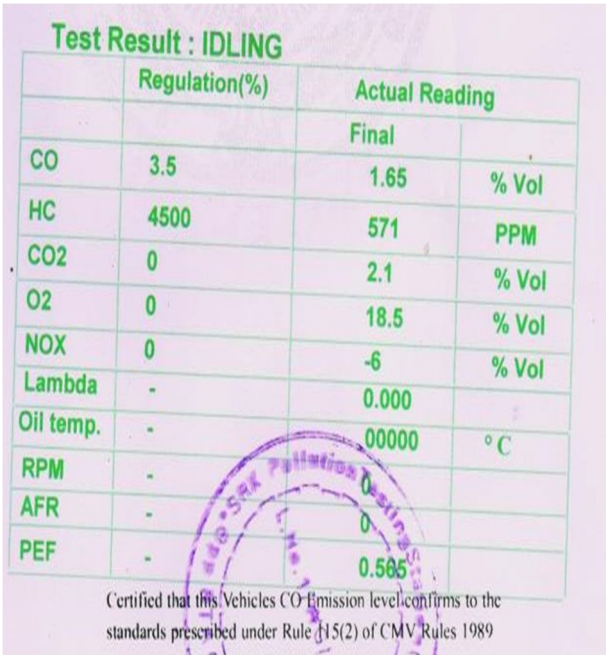


Test Result : IDLING

	Regulation(%)	Actual Reading	
		Final	
CO	3.5	2.09	% Vol
HC	4500	700	PPM
CO2	0	2.1	% Vol
O2	0	19.84	% Vol
NOX	0	-1	% Vol
Lambda	-	0.000	
Oil temp.	-	00000	°C
RPM	-	0	
AFR	-	0	
PEF	-	0.568	

Certified that this Vehicles CO Emission level confirms to the standards prescribed under Rule 115(2) of CMV Rules 1989

6.2.2. EMISSION CHECK (PETROL+HHO)



Test Result : IDLING

	Regulation(%)	Actual Reading	
		Final	
CO	3.5	1.65	% Vol
HC	4500	571	PPM
CO2	0	2.1	% Vol
O2	0	18.5	% Vol
NOX	0	-6	% Vol
Lambda	-	0.000	
Oil temp.	-	00000	°C
RPM	-	0	
AFR	-	0	
PEF	-	0.565	

Certified that this Vehicles CO Emission level confirms to the standards prescribed under Rule 115(2) of CMV Rules 1989

By comparing the above the emission check forms before and after using the petrol +HHO as Fuel there is a predominant decrease in emission from 0.98 to 0.36 i.e 60% of emission is reduced at the same time the mileage increase .Hence this proves that is a tremendous advancement by using petrol+HHO as fuel

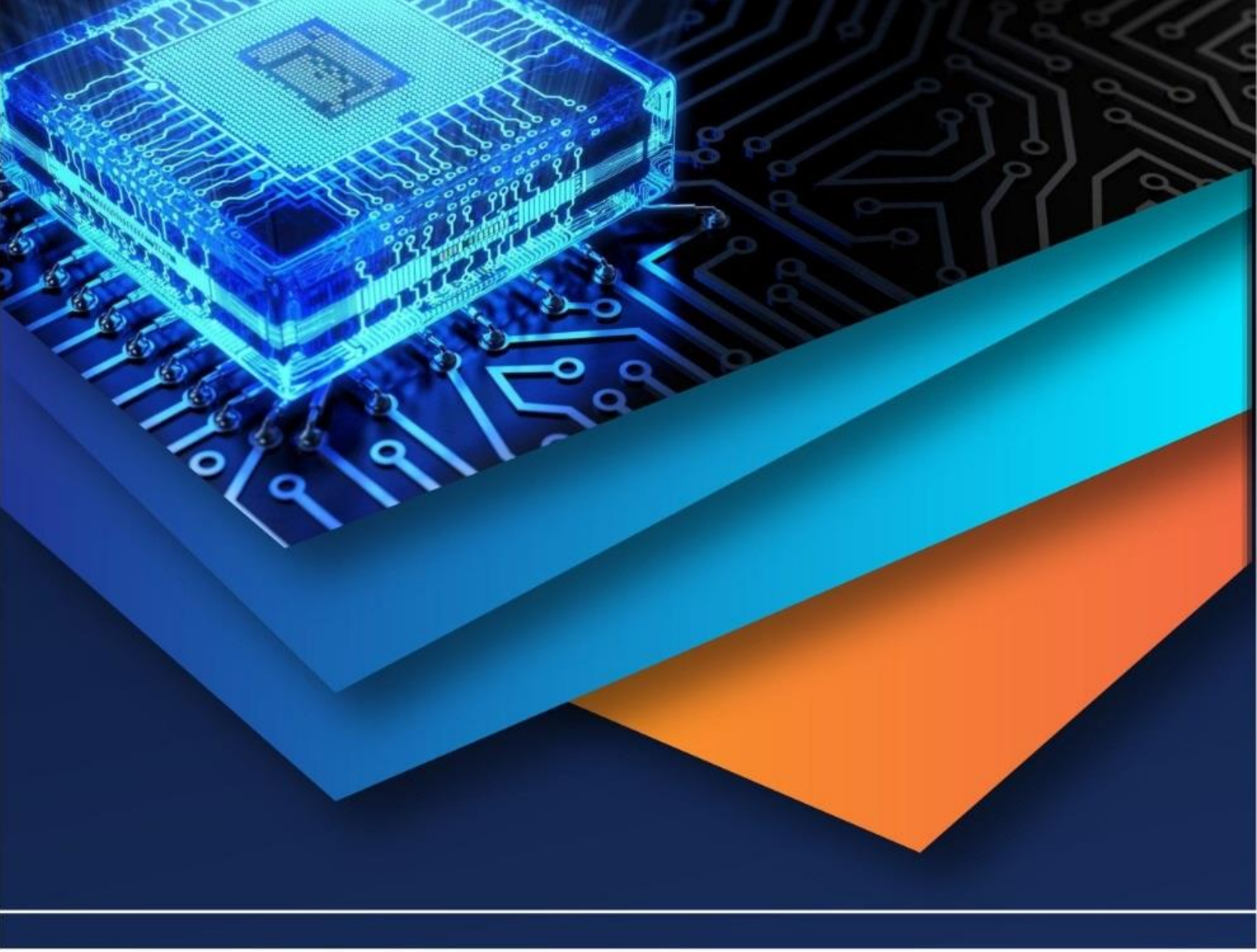
IV. CONCLUSION

Our paper is to obtain advancement in the field of automobile. So we made combustion in vehicles using HHO gas. It resulted in the increase of mileage up to 20% and also reducing the emission of harmful gases up to 60%. This technique acts as a source to makes us a part in the contribution made in reducing the global warming.

Use of HHO in gasoline engine increases the output of the engine around 5.7%. The HHO gas kit can be easily constructed and integrated with existing engines at low cost.

REFERENCES

[1] M.Sunil Raj, A.Ramakrishna, P.Naveenkumar , Modification Of S.I Engine To HHO Engine Using HHO Generator And Its Analysis Vol2, Issue2, March-April 2014, ISSN 2320-6349
[2] N.B.V.S.R. Karthik* Better Performance of Vehicles Using HHO Gas2017, Vol. 5, No. 4, 167-174 DOI:10.12691/ajme-5-4-9
[3] N N Patil1 , C B Chavan1 , A S More1 and P Baskar Generation of oxy-hydrogen gas and its effect on performance of spark ignition engine 263 (2017) 062036 doi:10.1088/1757-899X/263/6/06203
[4] Ghulam Abbas Gohar* and Hassan Raza Comparative Analysis of Performance Characteristics of CI Engine with and without HHO Gas (Brown Gas) 2017, Vol 6(4): 172 DOI: 10.4172/2167-7670.1000172
[5] Mustafa Ozcanli a , Mustafa Atakan Akar a,* , Ahmet Calik b , Hasan Serin Using HHO (Hydroxy) and hydrogen enriched castor oil biodiesel in compression ignition engine 0360-3199/© 2017
[6] Dr. V.V. Prathibha Bharathi1 I. Parameshwara Rao2 V.V.Naga deepthi3 I. Prasanna4 A. Lakshmi Jyothi5 Improving the Efficiency of an I.C. Engine by Using Secondary Fuel (HHO) | Vol. 01 | Issue 04 | July 2015 | 69
[7] TS De Silva, L Senevirathne and TD Warnasooriya HHO Generator – An Approach to Increase Fuel Efficiency in Spark Ignition Engines ISSN: 2394 - 658X
[8] B.Gautham1 , P.Ganeshan2 , E.Manojkumar3 , R.Prasanabalaji4 , S.Suresh kannan5 Hydrogen powered bike ISSN 2394-3777 (Print)
[9] V. Jose Ananth Vino, Vyas Sunil Ramanlal and Yemmina Madhusudhan Performance Analysis of Petrol - HHO Engine ISSN 1990-9233
[10] G .Ajay Kumar Performance Characteristics f Oxy Hydrogen Gas n Two Stroke Petrol Engine ISSN: 2231-5381
[11] Seralathan S, Baskar P, Thangavel S, Satyam Sharma, Norman Clifford Francis I J and Arnold C Performance Enhancement of a Conventional Motorcycle to a Racing Motorcycle without Afffecting the Mileage by Using HHO Generator ISSN 2250-3234 Volume 4, Number 1
[12] A.L.R.Prathyusha1 , Dr. T Nancharaiah2 Improving the fuel economy and reduction of pollutants from Automobiles using HHO gas ISSN (e): 2321-3418



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