

## **Improving the Efficiency of an I.C. Engine by Using Secondary Fuel (HHO)**

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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 project these 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 so increased and pollution gets reduced to maintaining the green house effect.

### **INTRODUCTION**

Energy is the primary and most universal measure of all kinds of work by human beings and nature. Everything that happens in the world is the expression of flow of energy in one of its forms. Energy is an important input in all sectors of a country's economy. The standard of living is directly related to per capita energy consumption (Vader and Joshi, 2005). Conventional energy sources based on oil, coal, and natural gas have proven to be highly effective drivers of economic progress, but at the same time damaging to the environment and to human health. Furthermore, they tend to be cyclical in nature, due to the effects of oligopoly in production and distribution. These traditional fossil fuelbased energy sources are facing increasing pressure on a host of environmental fronts, with perhaps the most serious challenge confronting the future use of coal being the Kyoto Protocol greenhouse gas reduction targets (Herzogetal, 2006). Spark ignition (SI) and compression ignition(CI) engines are commonly used for transportation. Fossil fuels used as energy resources for internal combustion engines (ICEs) are known as "automotive fuels" (gasoline, diesel fuel, liquefied petroleum gas (LPG), natural gas). Gasoline is always used in SI engines, with a current maximum compression ratio of eleven. A higher ratios, the mixture in the combustion chamber ignites spontaneously, causing engine knock, which may lead to severe engine damage. Very recently, gasoline has come into consideration as a hydrogen carrier for fuel cell vehicles. Diesel (diesel oil) burns in CI engines. Pure LPG can function only in SI engines a gasoline engine retro fitted for dual fuel use, a dedicated gas engine or a heavy- duty diesel engine retro fitted with a SI system.

### **EXPERIMENTATION ON 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 litre. The HHO requirements also depend upon the level of engine CC and other devices. Approximately 100 CC engine requires 0.05 litre of HHO per minute.

### **BASIC DETAILS FOR HHO:**

As said before, 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.

## EXPERIMENTAL SET UP

### COMPONENTS

The following are the components

- HHO kit, Catalyst (baking soda), Hero Honda passion pro bike, Tools, Distilled water, Petrol testing meter

#### **HHO-KIT:-**

Electrolyzing chamber, Moisture filter, HHO transfer hoses, Injection nozzle, Plastic bottle, Camp

#### **ELECTROLYZING CHAMBER:-**

It is made up of titanium dioxide which is from 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 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



Electrolyzing chamber

#### **MOISTURE FILTER:**

It is used to filter the moisture particles in the hydrogen gas produced in the electrolyze chamber .It is main function is to prevent entering these moisture particles into the engine



Moisturefilter

#### **HHO TRANSFER HOSES:**

It is the used to connected the electrolyze and moisture filter on one side and to connect another side of moisture filter to the engine of the vehicle.



*HHO transferhouse*

**INJECTIONNOZZLE:**

It is like a passage for the hydrogen gas to enter into engine .It is like acylindrical shaped pipe leak proof caps and it is connector one of its sides is connected to theconnecting hose in which the hydrogen gas is passing another end is connected into the air filter bootof thevehicle.



*Injectionnozzl*

**PLASTICBOTTLE:**

It is tube shaped small size bottle narrowed at its top and a cap having along opening. It is used to mix the electrolyte and the distilled water thoroughly .Later top is cutto feed the water into theelectrolyze



*Plasticbottle*

**CLAMP:**

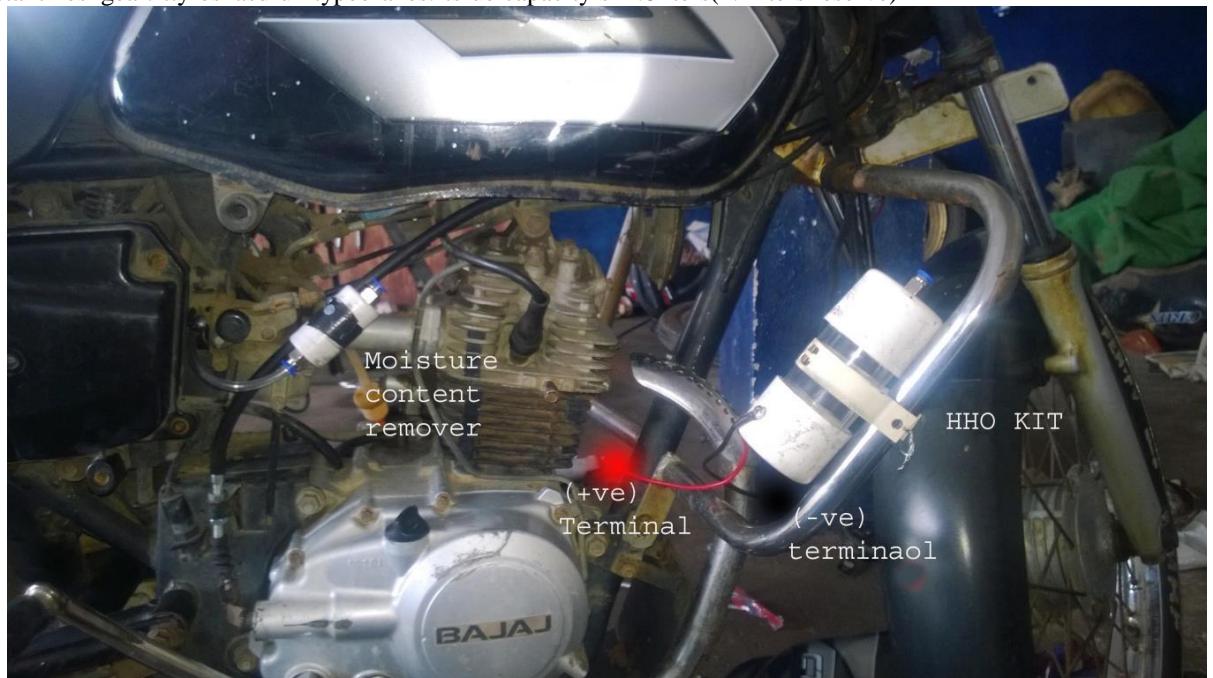
It is used for the purpose of holding the electrolyze to the safety rod of the vehicle very tightly by using bolt and nut .It is made of steel.



*Plastic Clamp*

**BAJAJ CT-100 BIKE:**

The engine is 97.2cc air-cooled, four-strokes single cylinder. The chassis is a tubular double cradle type. Bajaj CT-100 mileage is 85-90 kmph. Its transmission is 4-speed constant mesh gear. It has drum type brakes. Its fuel capacity is 12.8 liters (1.1 liters reserve).



*Assembly of HHO kit Bajaj CT -100BIKE*

**TOOLS:**

The tools used in this project are:

- Cutting pliers, Spanner, Multimeter, Soldering Iron, Cable tie, Screwdriver, Tester, Installation Tape.

**DISTILLEDWATER:**

Distilled water is water that has many of its impurities removed through distillation involves boiling the water and then condensing the steam into a clean container. The distilled water is necessary because if we use generally available water then the impurities will clog up the electrodes of HHO generator and further impede the operations of the HHO celloverall. It is that these impurities accompany known gases which mix with the HHO gas to go onto create unknown chemical reactions which are toxic to the environment .The distilledwater should be changed for periodical interval of every 5000-7000k Therefore only distilledwater should be used in the production of HHO gas from any type of HHOgenerator.



*Fig 5.11: Distilledwater*

**PETROL TESTINGMETER:**

It is the test equipment used to measure the quantity of fuel while conducting the test. It is in the shape of flask having a valve at its bottom. This valve is connected with a hose who seo the rend is connected to the inlet of carburetor. The opening of this valve allows the fuel to enter into the carburetor. This opening can be adjusted to the required rate offlow of fuel into the carburetor. It has readings marked on it. This facilitates in knowingthe quantity of fuel used in performing thetest.



*Petrol testingmeter*

### INSTALLATIONPROCEDURE

**ELECTROLYSERINSTALLATION:**

Firstremovethesafetycoverfromtheelectrolyzer.Connectthefittingclampand adjust the clamp according to the requirement. First position the vehicle in rest conditionby putting it in Centre stand. Fix the electrolyzer to safety rod in vertical position. Whilefixing the clamp fix it tightly by using cutting pliers. Adjust the fitting as per ourrequirement. After adjusting tighten the nut and bold rigidly. While fixing the electrolyzer check the position of the electrolyzer on the safety rod. Make sure that the electrolyzer is not shaking.

**CONTROLLER INSTALLATION:**

Controller has 3 wires input on one side and 2 wires output on other side. The 3 input wires have 3 colors. They are red, black and yellow. The red wire is to be connected to battery. The black is to be connected to earth or neutral. The yellow wire is to be connected to alternator. To safeguard controller connect it in the sitting seat carefully by using cable tie. Connect the black wire to the bolt. The remaining two wires are fixed in the side of 2- wheeler. The yellow wire is connected to the dynamo coil. From dynamo one line is connected to the head light and another line is connected to the lighting circuit connected in socket which can be removed easily.

To disconnect this system unlock the clip towards downwards. The inner side of socket is designed separately to

connect all wires safely. Now start the vehicle to check the lighting circuit. When lighting circuit is disconnected you can see the head light off. By doing this test we can ensure that the connection is correct. Check the voltage in wire using multimeter. Select the alternator selection in multimeter since the dynamo output is alternator supply. Check the voltage available in the socket separately. The wire which has more voltage is taken as correct wire. Here white wire gets more voltage. Hence it is taken as correct wire.

Now the second level of testing starts. When we increase acceleration, the voltage will also increase. While performing this test ensure that the white wire is connected with yellow wire. After ensuring the correct connection the sub socket is to be connected with the main socket. The positive connection is given on the right side cover of the vehicle. Red color wire is to be connected with the brake wire. Switch output is connected within circuit of the socket To check the correctable, disconnect the socket and then check the voltage by using multi meter by selecting the DC option ground to brake line voltage. Brake line supply will work only when you switch on the key. Hence switch on the key and then measure the voltage.

#### **HOSE CONNECTION:**

The hose is the passage for the HHO gas to enter into the air intake of the engine. To filter the gas produced, a filter element is used in between its flow to the engine air intake. The filter element should be connected by facing the electrolyzer and fire arrestor should be facing air filter. The injection of HHO gas into the air intake pipe should be in such a way that it should mix with the oxygen in its way. According to required length the hose is to be connected. Injection nozzle should be connected at the air intake facing towards the air intake carburetor. To connect the injection nozzle make a small hole into the air filter boot by using screw driver. After ensuring the correct connectivity, apply the glue on its neck to prevent the leakage. Now the HHO system is ready to work.

#### **PREPARATION OF ELECTROLYTE:**

The catalyst used to produce oxy hydrogen gas (HHO) is Potassium hydroxide (KOH). Mix this catalyst with the distilled water in the plastic bottle. Shake it properly and check whether it is mixed completely or not. This mixing should be done properly in the plastic bottle. After mixing, cut the top of the bottle and then fill the water and feed it into the electrolyzer through the water feed nozzle. It should not exceed the limit above the electrolyzer

#### **TESTING:**

After filling the water in the electrolyzer start the engine.

After starting, check the voltage and current by using multi meter.

DC amperes can be between 1.2 to 1.3 DC  
voltage can be between 6.2 to 6.5

#### **INSTALLATION COMPLETE:**

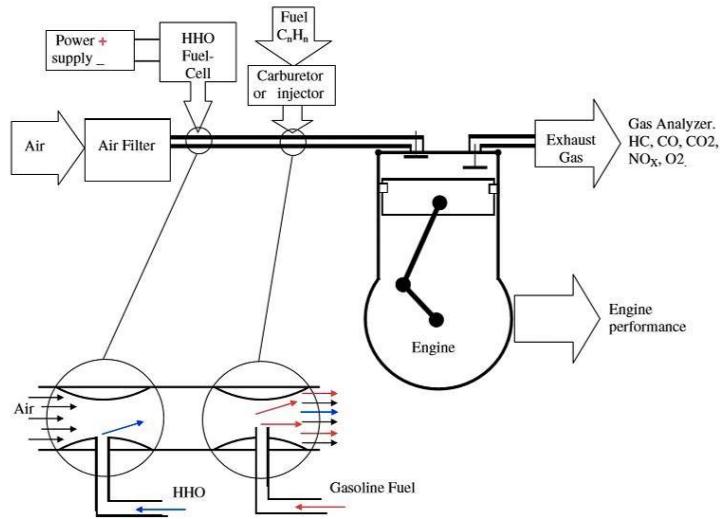
Working of electrolyzer can be sure by seeing the oxy hydrogen bubbles in the electrolyzer. Now the vehicle is ready to drive.

#### **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. There action takes place between the anode and cathode. This will dissolve H<sub>2</sub>O into 2 parts Hydrogen and 1 part Oxygen and combining these 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 produce dis greater than the energy produced when only petrol and air is combusted in the enginecylinder.



*Fig 5.13: Basic layout of HHO*

#### TEST

Here in this project we are going to conduct two types of test to ensure the advantage gained on using this innovative technique.

#### 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 BAJAJCT100 (petrol) bike gives the mileage of 80 kmpl. So our project aims to increase this mileage compared with vehicle running without this equipment.

#### FIRST STEP:

- Before installing the equipment run the vehicle with 1 litre fuel either petrol or diesel.
- Note down the distance (kms) travelled by the vehicle in complete 1 litre fuel.
- Make minimum three trial runs and note thereadings.

**SECONDSTEP:**

- Now install the equipment to the vehicle and run it with 1 litre fuel.
- Note down the distance (kms) travelled by the vehicle in complete 1 litre fuel.
- Make minimum three trail runs and note thereadings.

**THIRDSTEP:**

- Tabulate the readings obtained in the above twosteps.
- Take the difference of these readings and note the resultedvalue.
- This would be extra mileage added to the vehicle on using thistechnique.

**EMMISIONTEST:**

Due to the combustion of fuels in the vehicle some gases (exhaust gases) areproduced such as hydrocarbons, carbon monoxide (CO), nitrogen oxides (NO<sub>x</sub>), 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.

**FIRSTSTEP:**

- Make a trail run with one litre petrol/diesel.
- Check the emission at mobile pollution checkvehicle.
- As the pollution check certificate has validity up to 6 months of period it canbe conformed for the next two moretrails.

**SECONDSTEP:**

- After installing the equipment make a trail run with one litre petrol/diesel.
- Check the emission at mobile pollution check vehicle.
- As the pollution check certificate has validity up to 6 months of period it canbe conformed for the next two moretrails

**THIRDSTEP:**

- Tabulate the readings obtained in the above twosteps.
- Take the difference of these readings and note the resultedvalue.
- Next convert the resulted value into percentage.
- This would be the percentage of reduced emission obtained by usingthis technique

## RESULTS

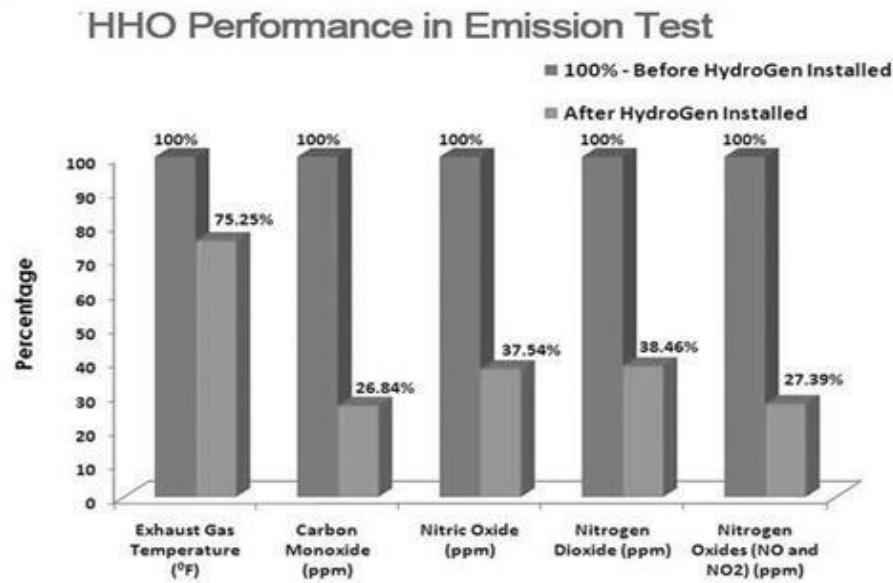
**RESULT OF MILEAGETEST:**

SLNO	By usingpetrol	By usingPetrol+HHO
1	80	90.5
2	79	92.8
3	79	94

*Table 5.2 – Result Of MileageTest*

Increase in mileage of 11km in local area roads. Increase in mileage of 15km on highway roads Overall efficiency is nearly 20-30 percentage

## **RESULT OF EMISSIONTEST:**



*Fig 5.14: HHO Performance in emissiontest*

### **ADVANTAGES:**

- Increases millage up to 20%-40%.
- Reduces Emission.
- Increases Pick-up power.
- Complete combustion of fuel upto 98% Reduces Engine noise & vibration.
- No need of R.T.O approval.
- Easy to install.
- Increases life of engine & battery.

### **DISADVANTAGES:**

- Initial cost is high.
- One of the main limitations of HHO based automobile is that it takes about 5 minutes for the production of HHO gas.
- Another limitation of this type of production of gas is the water used in this type of production should be very pure without any contaminants.
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### **APPLICATIONS**

- It is used in both S.I. Engines and C.I. Engines.
- It is used in both 2-wheelers and 4-wheelers.
- This kit is one of the pollution control device used to control the pollution in automobiles.
- HHO is used instead of traditional fuels like petrol, diesel gasoline...etc.
- It is used in generators and burners

## CONCLUSIONS

Our project is to obtain advancement in the field of automobile. For that reason 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 decrease money towards vehicle fuelling and also it makes us a part in the contribution made in reducing the global warming.

### **THE FOLLOWING CONCLUSIONS ARE OBSERVED AS FOLLOWS**

The use of HHO in gasoline engines combustion efficiencies consequently fuel consumption by 20%.

Use of HHO in gasoline engines leads to emission of harmful pollutants such as monoxide and un burnt hydrocarbons.

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.

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