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DESIGN, FABRICATION AND ANALYSIS OF HHO GENERATOR FOR TWO WHEELERS

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***Abstract*—Electrolysis utilization, is the process in which separation of water as Oxygen and Hydrogen of two molecules of each is the basic step in the project. The process which is electrochemical, began for the separation of water molecules, as a result of introduction of electrical voltage to the solution, which is the combination of the catalyst with distilled water. If the HHO generator efficiency is increased to 100 % the engine's thermal losses would be still outweigh for the economic gain from on board HHO addition.**
Keywords—HHO generator, Electric wires, One-way air valve, Glue, Clamp, Air connector.

Introduction

HHO (Oxyhydrogen) is the mixture of Oxygen and Hydrogen of two molecules of each. This mixture of gas is used for refractory materials processing, as torches and for the first time this mixture of gas used for welding. For avoiding an oxidizing flame, a Hydrogen: Oxygen ratio of 4:1 or 5:1 is required in practice. Hydrogen gets composted when it is brought to its auto ignition level. To assist the combustion and to reduce the fuel consumption HHO generator can be implemented in the internal combustion engines. Auto ignition occurs at about 570 ^{0}C (1065 ^{0}F) for a stoichiometric mixture at normal atmospheric pressure. The minimum energy of 20 micro joules is required to ignite such kind of mixture of gasses. When the volume is of range between 4% and 95% hydrogen HHO can burn.

A number of factors affect the fuel consumption of an ordinary vehicle, for example driving behaviors such as acceleration, speed, traffic and road conditions, vehicle conditions, etc. Concerning the above factors, fuel price and environmental pollution the performances of an ordinary Internal Combustion Engine (ICE) have to be improved. In practice, ICEs used in vehicles are divided into three categories, i.e. Spark Ignition Engine, Diesel Engine and Gas Turbine Engines. Spark Ignition Systems are widely used in automobiles. Here, petrol (gasoline) and diesel are highly used as the preliminary source of fuel [1-2]. Throughout this research, we have only focused on the spark ignition systems which use gasoline as the preliminary source of fuel. In spark ignition systems an amount of vaporized fuel is mixed with an appropriate amount of air and these engines are designed to ignite the air-fuel mixture at the optimum instant. The flammability range of Gasoline is 1.4% to 7.6% of the volume. Hence, every pound of air should mix with 0.224g to 1.216g of vaporized gasoline in order to have a better combustion. If more vaporized gas is fed into the system, it may leave some unburned/partially burned fuel in the piston chamber. This unburned/partially burned fuel is one of the main pollutants that originate from conventional. Hydrocarbon fuel, Carbon Monoxide (CO), Oxides of Nitrogen (NOX) and smoke are the main pollutants produced by this process.

The unburned/partially burned fuel causes in increasing the exhaust emission of an engine which results in reducing the efficiency of the engine [3-4]. In order to decrease the amount of exhaust emission it is necessary to increase the thermal efficiency of the engine. As the result of the ignition, the mixture of gas releases energy and converts into water vapour, which can sustain the reaction: 241.8 KJ of energy (LHV) for every molecule of H_2 burned. The released heat energy is independent of the combustion mode, but the flame temperature varies.

There is a misconception about the Hydrogen gas on the demand is burning hybrid hydrogen or HHO gas or Brown's gas along with gasoline or diesel and due to this reason there should be increasing in the MPG (Miles per Gallon). But it is different it says that, HHO gas is a supplement or as added to the conventional engine fuel system, it helps in combustion of the conventional engine fuels more efficiently & effectively. HHO gas is also called as Brown's gas or Oxy-hydrogen gas, it is water break into two parts by the help of the

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electrolysis process of water, and hence it is two moles of hydrogen & one mole of oxygen.

There is a device called a Hydrogen generator that uses a process known as electrolysis to separate and extract both hydrogen and oxygen out of water. Earlier developments for hydrogen generators were designed to extract HHO or sometimes referred to as Browns Gas. They were originally designed for welding and cutting purposes, but HHO can be used as a supplemental fuel for internal combustion engines, even diesel motors. One company has developed a patented pending design that is compact and can fit into almost any vehicle's motor compartment.

Methodology

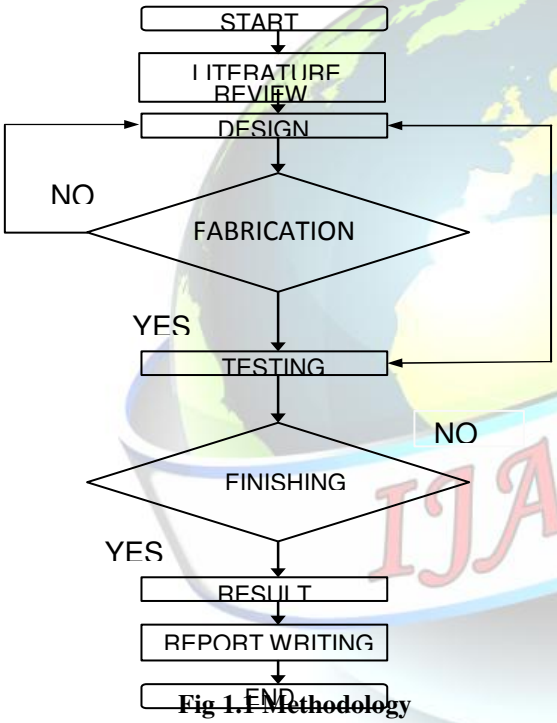

Fig 1.1 Methodology

INTRODUCTION

This chapter includes about all the process to fabricate the fuel saving device from the beginning to the end of the project. There are three dimensional drawing using Solid Work and fabrication process.

OVERALL RESEACH METHODOLOGY

Overall, this project is following the flow chart from taking the title from the supervisor, then the second task of taking the title is finding the related literature review for the project given. Then, sketch some design of the fuel saving device to be choosing the best design using concept screening method. After that, draw the final design selected using Solid Work. After the fabrication is finished, the device is tested for the motorcycle engine to get best result. Finally, report documentation is writing do describe all the process from the beginning to the end of the project.

DESIGN

The design of the device must be compliance with several aspects. The design consideration must be done carefully so the design can be fabricated and functioned well. The aspect that must to be considered in designing the device are:

Ergonomic factors

The fuel saving device must be user friendly as easy to use and convenient.

Safety

The fuel saving device must the characteristic of electrical insulator since it is generated by the electricity source.

DRAWING

The drawing divides two categories which are:

Sketching:

All the ideas for the device fabrication are sketched first so that the idea selection can be made.

Solid modelling:

The selected design or concept sketch are transfer to solid modelling by Solidwork software.

Outline of the project

Hydroxy gas (HHO) was produced by the electrolysis process of different electrolytes (KOH (aq), NaOH (aq), NaCl (aq)) with various electrode designs in a leak proof plexiglass reactor (hydrogen generator). Hydroxy gas was used as a supplementary fuel in a four cylinder, four stroke, spark ignition (SI) engine without any modification and without the need for storage tanks. Its effects on exhaust emissions and engine performance characteristics were investigated. Experiments showed that the constant HHO flow rate at low engine speeds (under the critical speed of 2800 rpm for this experimental study), turned advantages of the HHO system into disadvantages for engine torque, carbon monoxide (CO), hydrocarbon (HC) emissions and specific fuel consumption (SFC). Investigations

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demonstrated that the HHO flow rate had to be diminished in relation to engine speed below 2800 rpm due to the long opening time of intake manifolds at low speeds. This caused excessive volume occupation of hydroxy in cylinders which prevented correct air to be taken into the combustion chambers and consequently, decreased volumetric efficiency was inevitable.

Decreased volumetric efficiency, influenced the combustion efficiency, which had negative effects on engine torque and exhaust emissions. Therefore, a hydroxy electronic control unit (HECU) was designed and manufactured to decrease HHO flow rate by decreasing voltage and current automatically by programming the data logger to compensate disadvantages of HHO gas on SFC, engine torque and exhaust emissions under engine speed of 2800 rpm. The flow rate of HHO gas was measured by using various amounts of KOH, NaOH, NaC1 (catalysts). These catalysts were added into the water to diminish hydrogen and oxygen bonds and NaOH was specified as the most appropriate catalyst. It was observed that if the morality of NaOH in solution exceeded 1% by mass, electrical current supplied from the battery increased dramatically due to the too much reduction of electrical resistance.

HHO system in addition to the engine without any modification resulted in increasing engine torque output by an average of 19.1 %, reducing CO emissions by an average of 13.5 %, HC emissions by an average of 5 % and SFC by an average of 14 %. Faced with the ever increasing cost of conventional fossil fuels, researches worldwide is working overtime to cost effectively improve internal combustion engine (ICE) fuel economy and emission characteristics. In recent years, many researchers have focused on the study of alternative fuels, which benefit enhancing the engine economy and emissions. Hydrogen is seen as one of energy vectors of the next century. Hydrogen, as a renewable energy source provides a potential for sustainable development particularly in transportation sectors.

The Hydrogen driven engine reduces both local as well as global emission. Increases in thermal efficiency are more dominant than the energy loss incurred in generating hydrogen. This is specifically with regard to use of a hydrogen reformer.

Overall computational analysis has marked the possibility of operating with a high air overabundance (lean or ultra-lean mixtures) without a substantial performance decrease but with great advantages on pollution emissions and fuel consumption. Today, people often think that there are several different designs of HHO cells Although there are some variations of the original design, all of them still operate on the same basic principle. Today, HHO cell consists of a water reservoir, electrolysis parts, tubing and wiring. Besides that, there is not much more when it comes to building your own HHO cell.

As you may have heard by now, you can easily build a device that essentially turns water into powerful, clean burning fuel. Installing this HHO generator on your vehicle can provide you with several benefits. Increased horsepower and torque Smoother engine operation - Government refunds for alternative fuel conversion - Above all - improved fuel economy A HHO Generator is a device that uses electrolysis to convert water into two moles Hydrogen and one mole Oxygen (HHO). This gas, also known as Brown's Gas, is a very clean burning, powerful fuel. Efficient HHO Generators are capable of using Distilled Water only, but the most HHO Generator uses an electrolyte, or catalyst in addition to the distilled water. The most popular is regular old baking soda.

That's right folks. Distilled water + Baking soda + Electricity = cheap, clean fuel. One important use of electrolysis of water is to produce hydrogen.

$$2H_20(l) = 2H_2\,(g) + 0_2\,(g);\ E_o = +1.229\ V$$

Hydrogen can be used as a fuel for powering internal combustion engines by combustion or electric motors via hydrogen fuel cells. The energy efficiency of water electrolysis varies widely. The efficiency is a measure of what fraction of electrical energy used is actually contained within the hydrogen. Some of the electrical energy is converted Experimental Investigation Of Hydrogen Port Fuel As A Part Of Supplement On 4-Stroke Si Engine (IJSRD/Vol.2/Issue 03/2014/243) All rights reserved by www.ijsrd.com 923 to heat, a useless by product. Some reports quote efficiencies between 50 % and 70 %. This efficiency is based on the Lower Heating Value of Hydrogen.

The Lower Heating Value of Hydrogen is total thermal energy released when hydrogen is combusted minus the latent heat of vaporization of the water. This does not represent the total amount of energy within the hydrogen; hence the efficiency is lower than a stricter definition. Other reports quote the theoretical maximum efficiency of electrolysis as being between 80 % and 94 %. The theoretical maximum considers the total amount of energy absorbed by both the hydrogen and oxygen. These values refer only to the efficiency of converting electrical energy into hydrogen's chemical energy. The energy lost in generating the electricity is not included. For instance, when considering a power plant that converts the heat of nuclear reactions into hydrogen via electrolysis, the total efficiency is more likely to be

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between 25 % and 40 %. Water is a molecule, and a molecule is made up of smaller parts known as atoms.

The water molecule is named H2O because it contains two Hydrogen atoms (H2) and one Oxygen molecule. In a combined form they are the most abundant resource known as water. Through the simple process of running electric current through the water, the atoms 'split' back into their original elemental forms. This process is known as electrolysis. Electrical current runs through the water and all the Hydrogen atoms run toward the negatively charged electrode, and all the oxygen atoms move toward the positive electrode. Any HHO generator simply adds 'free' hydrogen and oxygen in a gaseous state of the combustion process. The mixture of this burns so hot, and so fast, it helps to complete the combustion process of the original gasoline.

Different types of HHO generator

There are twelve types of HHO Generators which are listed below

(i) 8 PLATE HHO DRY CELL
(ii) 21 plates HHO dry cell
(iii) 11 plates HHO dry cell
(iv) Seven series isolated cell HHO generators
(v) High efficiency HHO electrolyser
(vi) The triple cell HHO booster
(vii) Heavy duty HHO booster
(viii) The hot stable booster
(ix) The hot stable power booster
(x) Small engine HHO booster
(xi) Plate smk2 HHO booster
(xii) The zackwest electrolyser

Research Objectives

The rationale behind the research objectives the need to experimentally prove the validity of the claims of hydrogen on demand vendors.

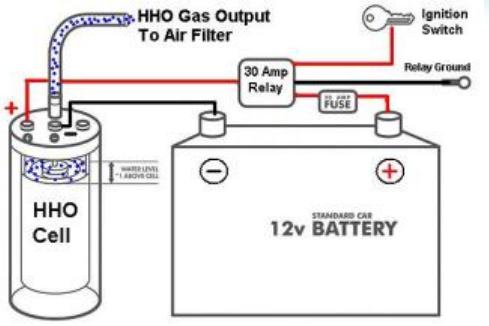

Fig 1.2 HHO fuel enhancer setup

The experimental research objectives of this research include

- Experimentally test the effect on fuel consumption and exhaust emissions of adding 0 L/min to 6 L/min of HHO to a constant speed 28 kW diesel generator under two loading conditions – 30 % and 55 % of the engines rated load.
- 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
- Discuss the financial feasibility of on-board HHO, if HHO proves to reduce diesel consumption

Electrolytes

Use an electrolyte that suits the best to you HHO Gas generator design. The distance between the electrode plates does really matter.

1. For electrodes with little distance between the plates you could use: tap water or distilled rain or demi water with a very little of any of the catalysts such as NaOH or KOH.

2. For electrodes with more space between the plates tap water won't work. So use distilled rain or demi water with a few of the catalysts mentioned below.

3. For electrodes with a lot of space between the plates tap water won't work. Use distilled rain or demi water with a one of the catalysts mentioned below.

1. Tap Water - H2O (containing minerals, salts etc.)

Advantages:

- Available everywhere
- Cheap
- Safe

Disadvantages:

- Water might turn brown with smudges on the electrodes
- Water that contains chlorine should not be used

2. White Vinegar - acetic acid – H3C-COOH

Advantages:

- Stainless electrodes stay clean
- Available everywhere

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- Cheap
- Safe

Disadvantages:

- Smells

3. Baking Soda (Natriumbicarbonate) NaHCO3

Advantages:

- Available everywhere
- Cheap

Disadvantages:

- Electrodes and water might turn brown
- Produces Co_2 (30 %) and Co (4 %).
- For this reason not recommended
  Pure Baking Soda might leave a brown tinted residue.

4. Sodium Hydroxide also called Lye = NaOH

Advantages:

- Electrodes stay clean
- Cheap
- 95 – 100 % pure HHO (oxygen, hydrogen) Gas production with right generator design
- Available in the Grocery store

Disadvantages:

- Limited dangerous to work with
- Too much heat causes corrosion

Pure sodium hydroxide is a white solid; available in pellets, flakes, granules and as a 50 % saturated solution. It is deliquescent and readily absorbs carbon dioxide from the air, so it should be stored in an airtight container. It is very soluble in water with liberation of heat. Use with distilled water.

5. KOH (potassium hydroxide)

Advantages:

- Electrodes stay clean
- 95 – 100 % pure HHO gas production along with the right generator design
- Strong and pure electrolyte

Disadvantages:

- Not available everywhere
- Dangerous to work with
- Recommended as very good electrolyte (recommended by Honda in 2001)

6. K_2CO_3 (Potassium Carbonate)

Advantages:

- Maximum HHO gas production
- Very pure HHO gas production along with the right generator design
- Efficient
- Safe to work

Major components

The main component in a Hydrogen-on-Demand system is the HHO or Hydroxy gas generator. This device can be a simple one-cell unit or have as many cells as needed to produce the quantity of HHO gas desired. Electric current is the driving force that creates electrolysis in such generator. It separates chemically bonded compounds in water by passing an electric current through them. By adding an electrolyte to the water, the electrolysis process can be enhanced. An electrolyte is any substance containing free ions that behaves as an electrically conductive medium. Catalyst, would be the correct term because of the function it performs to speed up the production of HHO gas.

Another important component of regulation is the Amp Meter, this is a tool used to measure the amperage flowing through a wire or other conductive material. It is a very important tool for this project, because the amount of amps sent to the cell determines the amount of HHO gas generated. Moreover, we need to add an EFIE to the car's ECU to make sure the mixture of air, gas, and HHO are well balanced as well as the use of a PWM (pulse width modulator) to adjust the frequency of the current in order to decrease the amount of amperes needed for the water breakdown. The final major component of our design is a vessel that's big and sturdy enough in which to conduct electrolysis in. It has to be able to maintain a high enough pressure of HHO gas to the ability to send it through hoses and into the engine's combustion chamber. Furthermore, some machining is needed for the vessel. Holes are drilled in the bottom of the vessel to allow for screws, which design specifications

- Plates are 2.75-inch x 4.5 inch (70 mm x 115 mm) in size and them two mounting holes need to be drilled out to 5/16 inch (8 mm) diameter in order to take the plastic bolts used to hold the plates together to make as an assembly.
- After a year of constant usage, these plates are shiny and not corroded thanks to proper use of stainless parts.
- Two stainless steel straps that were made are used to attach the plate assembly to the screw cap of the booster.
- 4-inch diameter PVC pipe, 12-inches long 1, this Forms the body of the generator.

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- 4-inch diameter PVC pipe end-cap 1, this Closes the bottom of the generator.
- 4-inch diameter PVC pipe screw cap 1, this makes the top of the Generator.
- 90-degree Quick Connect Outlet fitting 1 3/8" O.D. Tube x 14" NPT from Hardware store.
- Level indicator Nylon barbed tube fitting 2 1/4" Tube x 1/8" NPT from your local hardware store or Home Depot.
- Quarter-inch I.D. Poly sight tube 8" Water-level indicator tubing.
- Stainless steel switch covers 16 these make plate assembly components or stainless steel sheet metal flat pieces from eBay or steel yard.
- Stainless steel straps 12-inches long 2 The electrical connections to the plates or stainless steel utensils like spoons or forks from cooking supply stores or dept. stores will work.
- 3/4" Inside Diameter Clear poly tube 12-inch from your local hardware store or Lowes Home Depot.
- 5/16" stainless steel bolts 1.25" long 2 Electrical strap connected to the top cap.
- 5/16" stainless steel nuts & washers 6 each fitting the steel bolts in the cap top.
- 5/16" diameter nylon threaded rod 8" min. Nylon Threaded Rod.
- 5/16"-18 Thread. 2 needed.
- 5/16" inch nylon washers 1.6 mm thick 1-pack Nylon 6/6 Flat.
- Washer 5/16", pack of 100.
- 5/16"-18 s/s jam nuts (1/4" thick) 20 needed.
- 90-degree Bubbler Fittings 2 1/4" Barbed Tubing 1/2" NPT.
- Check valve 1 1/4" tube, aquarium shop.

The plates are bolted in position by two plastic bolts which run through the mounting holes in the stainless plates. The arrangement is to have a small 1.6 mm gap between each of eight pairs of plates. These gaps are created by putting plastic washers on the plastic bolts between each pair of plates. The spacing is important is must be the 1.6 mm gap between the plates as this spacing has been found to be The best at the electrolysis hydrogen production.

Design specification

Plate design specification

The hydrogen generator plate arrangement is laid out in this way for a good reason. This is mainly because the sets are squeezed inside in this manner to create more hydrogen two identical sets of plates into one PVC generator as shown here:

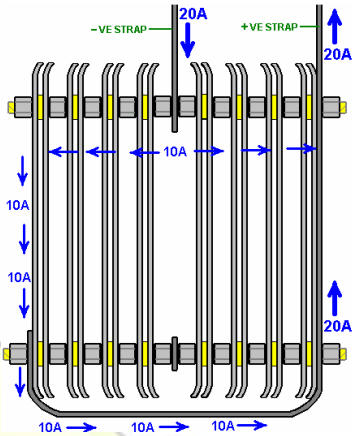

Fig 1.3 Voltage displacement

This arrangement is two identical sets of plates positioned back to - back. Here, you have just the electrical Positive linked to the electrical negative by a set of four pairs of stainless plates in a daisy chain (the technical term is: connected "in series" or "series connected"). Easily the most electrically efficient ways for doing this is to exclude all possible current flow paths through the electrolyte water by sealing off around the edges of all the stainless plates and forcing the current to flow through the plates and only through the plates.

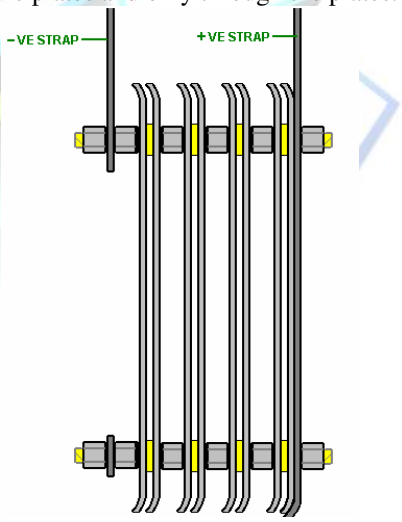

Fig 1.4 Power distribution through plates

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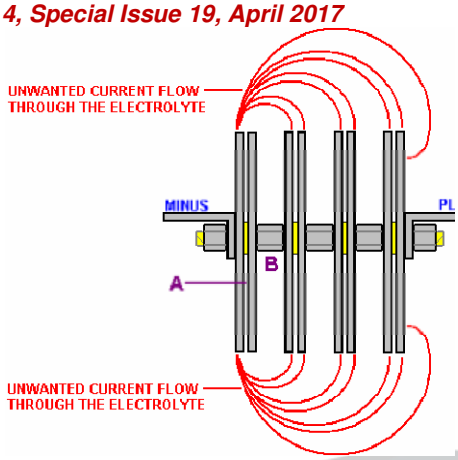

Fig 1.5 Current flow through plates

The picture shows how the plates are connected. The red lines show the paths of unwanted current flow, which produce almost no HHO gas. This lost current flow is opposed by the useful current flow across gap "A" in the diagram. To assist the flow across the 1.6 mm gap "A", the waste flows as long as possible. This is done by the gap "B" being made as large as possible. The voltage applied to the cell (13.8 volts when the engine is running) divides equally across the four plate pairs, so there will be 1/4 of that voltage (3.45 volts) across each stainless plate pair. If you look again at the original diagram, you will see that there are two of these sets of four plate pairs, positioned back-to-back in the generator. Remember that they are connected in pairs in the middle due to the metal-to-metal connection created by the steel nuts between the plates:

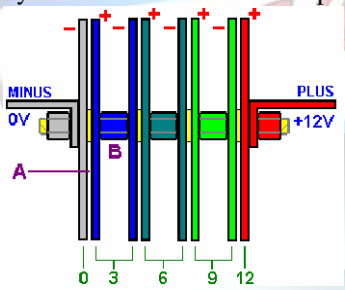

Fig 1.6 Voltage distribution

Engine specification

Engine	TVS Super XL, air cooled
Cubic capacity	69.9 cc
Stroke	2 stroke
Brake power	3.5 Bhp @ 5000 RPM
Number of Cylinders	Single

Table 1.1 Engine specifications

WITHOUT HYDROGEN:

TRIAL NO	AMOUNT GASOLINE CONSUMPTION	DISTANCE COVERED
1	100 ml	4.8 km
2	150 ml	6.7 km

Table 1.2 Without hydrogen test

WITH HYDROGEN:

Trial no	AMOUNT GASOLINE CONSUMPTION	DISTANCE COVERED
1	100 ml	7.2 km
2	150 ml	12 km

Table 1.3 With hydrogen test

Battery specification

Fig 1.7 DC source

A battery converts chemical energy into electrical energy by a chemical reaction. Usually the chemicals are kept inside the battery. It is used in a circuit to power other components. A battery produces direct current (DC) electricity (electricity that flows in one direction, and does not switch back and forth).

Using the electricity from an outlet in a house or building is cheaper and uses less energy, but a battery can provide electricity in areas that do not have electric power distribution. It is also useful for things that move, such as electric vehicles and mobile phones.

The chemical reactions that occur in a battery are exothermic reactions. This type of reaction makes heat. For example, if you leave your laptop on for a long time, and then touch the battery, it will be warm or hot.

Rechargeable batteries are recharged by reversing the chemical reaction that occurs within the battery. But a rechargeable battery can only be recharged a given amount of time (recharge life).

Even i-Pods, with built in batteries, cannot be recharged forever. Moreover, each time a battery is recharged, its ability to hold a charge goes down a bit. Non-

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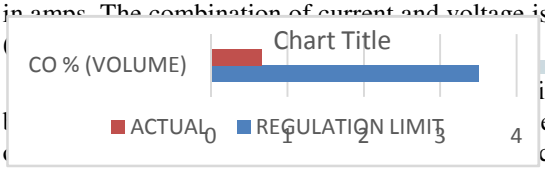
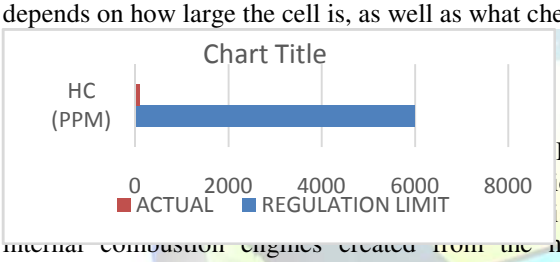
rechargeable batteries should not be charged as various harmful and harmful substances can leak out, such as potassium hydroxide.

The cells can be connected to make a bigger battery. Connecting the positive of one cell to the negative of the next cell is called connecting them in series. The voltage of each battery is added together. Two six volt batteries connected in series will make 12 volts.

Connecting the positive of one cell to the positive with the other, and the negative to the negative is called connecting them in parallel. The voltage stays the same, but the current is added together. Voltage is the pressure pushing the electrons through the wires, it is measured in volts. Current is how many electrons can go at once, it is measured in amps. The combination of current and voltage is the power



ing alkaline
ell depends
can supply
depends on how large the cell is, as well as what chemicals.



HHO and
ons. NOx
ssions of
internal combustion engines created from the high peak temperatures generated during the combustion stroke. NOx gases contribute to smog, greenhouse emissions and acid rain, and react with other chemicals forming toxic compounds dangerous to human and plant life. For these reasons maximum limits on NOx emissions are continually being reduced, and to meet these limits technologies that reduce NOx emissions are continually being developed.

Emission testing on the diesel generator set was performed with the same rates of Oxy hydrogen and water injection as the BSFC tests. The main difference with the emissions test included only running externally powered electrolysis for the HHO production.

The time base for each system state was reduced from 100 g fuel consumption for a 75g fuel consumption period. The gas The time at each load level was around 75 s and 52 s for the 9.91 kW and 19.1 kW load respectively, allowing between 400 and 290 exhaust emission samples. The last half of each set of samples was averaged to yield the results outlined in this section.

HHO and water injection reduced NOx between 1.3 % and 11.8 % due to water and or HHO injection. At 30 % engine load NOx was most affected by HHO injection, when combined with water injection there was a total reduction of 11.8 % NOx emissions.

Computerized emission test result

Emission test without HHO

5V output is obtained while

Volume of CO %

HC (PPM)

Without HHO generator

As we can see the results of emission test without the generator from current Indian standards of emission control, the Hc value is nearly 30 % of the projected maximum value of the government

These hydrocarbon concentrations can increase gradually due to severe weather conditions and due to vehicle maintenance. Also the carbon value is 30 % of the projected maximum value by the government If this is the case, then the pollution would reach its peak along with the increase in the number of vehicles day by day. So with this project we reduce the hydrocarbon and carbon dioxide emission to 8 of the projected maximum values by the government. [3] proposed a system, this fully automatic vehicle is equipped by micro controller, motor driving mechanism and battery. The power stored in the battery is used to drive the DC motor that causes the movement to AGV. The speed of rotation of DC motor i.e., velocity of AGV is controlled by the microprocessor controller.This is an era of automation where it is broadly defined as replacement of manual effort by mechanical power in all degrees of automation. The operation remains an essential part of the system although with changing demands on physical input as the degree of mechanization is increased.

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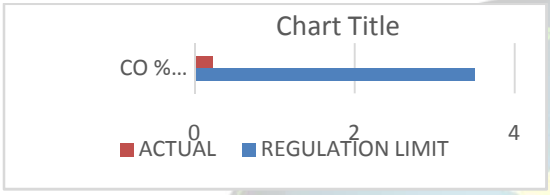
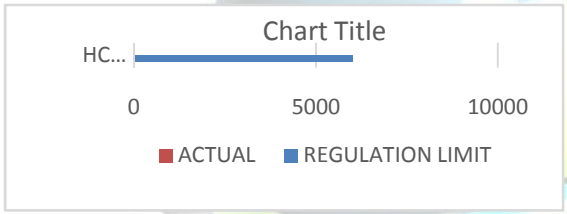
Computerized emission test result

Emission test with HHO gas in air intake



Volume of CO %



HC (PPM)

With HHO generator

As we can see the results of emission test with the generator, shows that from current Indian standards of emission control, the Hc value is nearly reduced to 8% of the projected maximum value by the government.

These hydrocarbon concentrations can increase gradually due to severe weather conditions and due to vehicle maintenance. But with the addition of HHO the vehicle maintenance is reduced to a great amount.

Also the carbon value is reduced to 10 % of the projected maximum value by the government. If this is the case, then the pollution will be controlled comparably by the HHO gas that would prevent the pollution from reaching its peak along with the increase in the number of vehicles day by day. Thus, by the introduction of HHO gas in the air manifold we obtain and achieve the perfect and guided amount of emissions from the internal combustion engines.

CONCLUSION

There is a lot of scepticism about HHO generators for vehicles found online. Our final thesis gives valid evidence that, in fact, they do work. It was determined that in order to supplement fuel consumption with hydrogen gas completely, many modifications need to be made to the fuel system of the car, that were out of our reach. Even if these were accomplished, the amount of energy needed for the car to run as well as to power the generator is not enough without the energy coming from the fuel. The hydrogen cell produced oxygen and hydrogen from water through electrolysis. Minimization of the cost was done by using widely available materials. From the results of the experiment, it can be concluded that having an HHO generator such as this one, will improve gas mileage.

Implementing the hydrogen generator will produce less carbon dioxide to the atmosphere, as well as, less consumption in gas. Therefor it will reduce greenhouse gasses. Hence, less effect on global warming in the long run. Moreover, since implementing a hydrogen generator will provide more fuel efficiency, it will save money for people who will use our product. It is hard to tell if the generator will continue to be as efficient in the long run, because we couldn't take into account alternator wear or battery productivity.

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