International Journal of Scientific Research and Engineering Development-– Volume 3 Issue 3, May – June 2020

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RESEARCH ARTICLE OPEN ACCESS

A REVIEW ON DESIGN AND FABRICATION OF WATER ELECTROLYZER

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Abstract:

Nowadays pollution is increasing in huge amount and fossil fuels are the major reason of causing pollution, also they are in the verge of extinction. So the present research aims for an alternative source such as hydrogen powered IC engine in making pollution free environment and providing cheaper fuel. Hydrogen is the most efficient energy carrier. Hydrogen can be obtained from different sources of raw materials including water. Among many hydrogen production methods, eco-friendly and high purity of hydrogen can be obtained by water electrolysis.Various experiments were conducted by hydrogen based internal combustion engine equipped with a kit consist of electrolytic cell as it produces fresh pollution free HHO gas (Brown gas) from water. Hydrogen is the most efficient carrier of energy. It can be obtained by simple technique known as electrolysis process. Among many hydrogen gas production methods, eco-friendly and high purity of hydrogen can be obtained by this process.Here in this project Stainless Steel plates are used because of its mechanical properties as it generates HHO gas from water effectively, the setup for this project is like they are placed one above the other where there must be no connectivity between them and an external DC power supply source is given. The output of this process produces HHO gas and when required quantity of the gas is generated then it is possible to start an IC engine in an ideal condition.Further improvements and advancement must be done in this project to run two wheeler vehicles with higher efficiency and complete safety because hydrogen is one of the dangerous gases as it is highly flammable and it can explode easily if it is stored.

Keywords: Water Electrolysis, HHO gas production, Renewable energy, IC engine.

I. INTRODUCTION:

Nowadays global warming is the one of the major issue that entire world is facing due to pollution that comes from vehicles and respective industries .There are some fuels that is use to run the vehicles and industries but those all completely polluting ambient and it brought about to global warming .The Hydrogen gas is one of the highly flammable gas that we have in water .It consist of almost same flammable properties that we have in petrol, diesel and methane gas .Extracting the Hydrogen and Oxygen gas from the water will aid to do combustion process in the vehicles and Industrial application .

However the obtainability of fossil fuel will get stop in upcoming years , so Hydrogen gas can replace the fossil fuel needs without polluting the atmosphere . Hydrogen is the one of the most promising clean and sustainable energy carries and emits only water as a byproduct without any carbon emissions.

Here we are using the electrolysis process to Extract the Hydrogen and Oxygen gas from water .The electrolysis process consists of two or more plates in stainless steel material by name of Anode and Cathode and both the plates are individually

connected on positive and negative terminal to the battery to get the Electrolysis process to happen. Hydrogen can produce either when water started to get decomposed or the colour of a water gets to change from colourless to pale yellow ,so we can recognize the Hydrogen gas when it emits the bubbles from the water .

Electrolyzers use electricity to break water into hydrogen and oxygen. The electrolysis of water occurs through an electrochemical reaction that does not require external components or moving parts. It is very reliable and can produce ultra-pure hydrogen (> 99.999%) in a non-polluting manner .

Water is fully oxidized hydrogen. Hydrogen itself is a high-energy, flammable substance, but its useful energy is released when water is formed. Water will not burn. The process of electrolysis can split water into hydrogen and oxygen, but it takes as much energy to take apart a water molecule as was released when the hydrogen was oxidized to form water. In fact, some energy would be lost in converting water to hydrogen and then burning the hydrogen because some waste heat would always be produced in the conversions. Releasing chemical energy from water, in excess or in equal proportion to the energy required to facilitate such production, the electrical source is renewable energy.

The hydrogen car, although it often incorporates some of the same elements. To fuel a hydrogen car from water, electricity is used to generate hydrogen by electrolysis. The resulting hydrogen is an energy carrier that can power a car by reacting with oxygen from the air to create water, either through burning in a combustion engine or catalyzed to produce electricity in a fuel cell.

Hydrogen fuel enhancement, where a mixture of hydrogen and conventional hydrocarbon fuel is burned in an internal combustion engine, usually in an attempt to improve fuel economy or reduce emissions.

According to the currently accepted laws of physics, there is no way to extract chemical energy from water alone. Water itself is highly stable—it was one of the classical elements and contains very strong chemical bonds. Its enthalpy of formation is negative (-68.3 kcal/mol or -285.8 kJ/mol), meaning that energy is required to break those stable bonds, to separate water into its elements, and there are no other compounds of hydrogen and oxygen with more negative enthalpies of formation, meaning that no energy can be released in this manner either.The electroysis process is one of the effortless method to extract hydrogen and oxygen from the water .The hydrogen gas that comes from water is flawless and spotless gas .

2.Different types of materials for electrolytic cell: It is learnt that which material is apt for electrolysis process. There are few material that has the tendency to do electrolysis process such as copper, brass, stainless steel among these the stainless steel has more tendency to do electrolysis process, so by aid of this journal it helps to identify the suitable material with better properties[4]

The HHO gas that is formed by electrolysis process is clean and eco-friendly where the formation of the gas is from renewable energy source. The combustion of HHO gas is three times more than the gasoline. For efficient means of gas production based on electrolysis process the main importance given is the size of electrode and also they must be kept at short distance in order to reduce the resistance. Here platinum and gold materials are considered for usage of electrodes,even the cost is more the efficiency of the process is high. The efficiency of the water electrolyzer decreased because of the electrical resistance of electrolytic cell increases with increase in volume fraction of gas bubbles on the surface of electrodes. The volume of hydrogen produced twice that of the oxygen. The process was carried out at ambient temperature and pressure.
By variation of voltage applied is increased,the rate of production of HHO gas also increased. It is same as when current is also increased. Based on varying the current and voltage, production rate of gas can be either increased or decreased[7].

The electrolysis process of electrode materials, production of hydrogen used in sodium chloride electrolysis based on method with ion-exchange

membrane. Proposed electrode has conducting base and layer of coat formed on it and made from composition obtained by thermal decomposition in presence of organic acid of mixture containing at least one salt of platinum group metals[14]

3.Future development for Hydrogen fuel:

A hydrogen on demand vehicle uses a chemical reaction to produce hydrogen from water , In addition to claims of cars that run exclusively on water ,there have also been claims that burning hydrogen or oxyhydrogen together with petrol or diesel increases mileage and efficiency[5]

For better future without any pollution and environmental issues,an alternate source of fuel is found which is known as hydrogen energy source. Thus in order to replace gasoline to hydrogen energy source the gas must be produced in a safest mode and also effectively. The produced gas can be used in internal combustion engines and thus it helps in controlling pollution. Hydrogen source a highly need of hour is because of rising CO2 levels from vehicles output have directly contributed to the global warming,but only exhaust of hydrogen gas in IC engine is water vapour. The best and safest method for production of hydrogen gas is by electrolysis process. The only problem is that the transportation and storage of hydrogen gas is extremely dangerous and also it is highly expensive process. When compared it with PEM fuel cells,the efficiency is comparatively low. Hydrogen gas, although it does not exist freely in nature,it can be produced by various process. The only issue is about storage and transportation. Thus inorder to bring hydrogen gas into full existence,more research and developments must be done. However the process is feasible only in low operated areas where damages can be reduced if any malfunction occurs[10]

One of the most well established technology is the water electrolysis process. The usage of other energy sources such as gasoline and traditional fossil fuels give carbon emissions, which change the climate. So an alternative source of energy must be used where the carbon emission is neutral. The renewable energy source such as wind energy, solar energy are also contributing to the betterment of saving the environment,but only few percentage when compared with the other nonrenewable resources. While the water electrolysis process is cost effective and efficient[16]

In recent years for low carbon emission and safety of the environment various study and interest are rising in the idea for the best renewable energy resource through water electrolysis process. There are different types of electrolysis process such as Alkaline electrolysis cell,Proton exchange membrane electrolysis cell. Various developments and research are done for better usage of these resources for the benefit of the modern society[17]

4.Usage of different electrolytes and addition of catalyst:

They have used salt, baking soda, and vinegar for electrolysis process. They were able to produce hydrogen and oxygen gas by through two cables powered by a 9 volt battery. Professor Hongjie Dai's experiment taught me that baking soda or (NaHCO3) isn't an electrolyte by itself, but salt or (NaCl) however, a good additive to produce electrolytes. He concluded that (NaCl) was better at carrying the electrical charges than the (NaHCO3) which means the salt would produce more hydrogen and oxygen gas. A group of scientist that work with education.com conducted the experiment too. These scientist taught me the setup and how to test it. In their experiment they tested baking soda, salt, vinegar, and lemon water, and they concluded that the salt solution is the best conductor of electrolytes. From these scientist I have learned how to safely conduct the experiment, and also gained much knowledge about the science that causes the reaction and why it happens[3]

Though hydrogen can be produced in different process. The output is ineffective mostly in water electrolysis process. So by adding catalyst such as NaCl in distilled water,it helps to increase the

hydrogen production. For enhancing the hydrogen production various steps or usage such as graphite rode as electrodes,varying the light source in the electrolysis chamber and varying the voltage applied. Thus by increasing the voltage the amount of hydrogen gas produced is also increased. This effectiveness is also increased by illuminating laser lights into the electrolysis chamber. The laser consists of different wavelengths such as 485nm,532nm,635nm. Here in the electrolysis chamber supplementary element such as ethanol was added. So the above parameters increased the production of hydrogen gas through electrolysis process[8]

The present invention discloses an electrolyzer for electrolyzing water into a gaseous mixture comprising hydrogen gas and oxygen gas. The electrolyzer is adapted to deliver this gaseous mixture to the fuel system of an internal combustion engine. The electrolyzer of the present invention comprises one or more supplemental electrode at least partially immersed in an aqueous electrolyte solution interposed between two principle electrodes. The gaseous mixture is generated by applying an electrical potential between the two principal electrodes. The electrolyzer further includes a gas reservoir region for collecting the generated gaseous mixture. The present invention further discloses a method of utilizing the electrolyzer in conjunction with the fuel system of an internal combustion engine to improve the efficiency of said internal combustion engine[13]

A hydrogen fuel system for an internal combustion engine includes an electrolyzer for generating hydrogen and oxygen gases. The engine exhaust may be recycled through the electrolyzer where it is converted to hydrogen and oxygen. A water reservoir in fluid communication with the electrolyzer maintains the water level in the electrolyzer. The hydrogen and oxygen generated by the electrolyzer may be routed to the internal combustion engine and provide the fuel for the engine. Hydrogen and oxygen not consumed by operation of the engine is stored in separate pressurized storage tanks. Expanders lower the pressure of pressurized hydrogen and oxygen for use to power the engine and provide electric power to the electrolyzer[15]

5.For effectiveness and efficiency: HHO cell was designed, fabricated and optimized for maximum HHO gas productivity per input power. The parameter includes distance between the plates so the effectiveness will be high when an external supply is given to the cell. The output of this experiment showed that it increases the efficiency at different engine speeds. It is noted that HHO gas enhances the combustion process through increasing engine thermal efficiency and reducing the specific fuel consumption. It is extremely efficient in terms of fuel chemical structure. The reaction rate and flame speed are increased[1]

The performance of an SI engine powered with both gasoline and HHO as supplement fuel was studied and then compared with pure gasoline-fueled engine.The performance of it was found by measuring the engine torque, the brake power, the brake specific fuel consumption and the thermal efficiency, The maximum gain of torque and power was about 12.6% at 1350rpm and the minimum was about 1% at 2250rpm. When HHO gas supply is increased the engine torque and power also increased because of fuel's heating value with HHO gas addition and thus it yields to better combustion process[2]

There have been a lot of studies of the impact of what is called hydrogen fumigation in both diesel and petrol cycle engines .The impact of hydrogen fumigation appears to be fairly straightforward .A small amount of hydrogen will causes a disproportionate increase in the population of reactive free radicals during the combustion process .These free radicals are predominantly OH and HHO as well as some O. These free radicals more uniformly distributed in the cylinder than the fuel become the hydrogen is fairly well distributes in the incoming air .it helps to burn more fuel completely

.With more complete burning ,more power is generated from the power stroke[6]

For improving the efficiency of water electrolysis process various research and development are being carried out because hydrogen is considered as the best renewable energy source that has a great impact on environment. The hydrogen gas is produced at a certain voltage which can be named as critical voltage in the negatively charged electrode. The advanced technology such as usage of alkaline electrolytes (Potassium hydroxide), elevates the pressure usually at electrolyte temperature approximately at 80 degree Celsius,cell voltage 2V and produces 99.8% of pure hydrogen gas. There are different types of electrolysis process for hydrogen production but water electrolysis has a part of only 4% in the hydrogen production in all over the world.

Though hydrogen gas is the easiest and effective means of energy source,the dangerous part must also be considered. So these technology is still in the research and development stage process[9]

Hydrogen fuelled IC spark ignition engine considerably differs from conventional gasoline fuelled engines .The flame speed of hydrogen ,while the progression of the flame front is very similar to that of gasoline ,dramatically affects the ignition timing maps must be produced and tuned during actual engine operation. The physical characteristic of hydrogen can have a disadvantage when using hydrogen as a fuel. Equivalence ratio can have a dramatic effects on pre – ignition .Despite hydrogen is high equivalent octane rating its wide flammability limits cause many problems with premature ignition[11]

A simple electrolyzer system, that can be easily installed in most motor vehicles, including boats, generates a gaseous mixture including hydrogen as auxiliary motive fuel to provide increased performance and mileage. The electrolyzer system is powered electrically from the vehicle battery and consumes only water. In a preferred embodiment, a pair of similar electrolyzer cells, mounted in the engine compartment of the vehicle, generate a gaseous mixture of hydrogen and oxygen that is delivered independently to corresponding input ports at two strategically selected domains in the vehicle's air intake system: one at the intake manifold and the other at the main air intake duct leading to the intake manifold. A check-valve disconnect coupling in each gas delivery hose serves as a flash-back arrester for safety, and facilitates maintenance[12]

6.Conclusion :

The water electrolyser project is predominantly employed to drive the IC engines, making use of hydrogen gas, which has been procured using electrolyser process, and the fuel is most likely not to pollute or adulterate the environment. Following the combustion process, which transpires inside the engine, the burnt gas transforms into water and the same will be discharged via the exhaust pipeline so the water will be an exhaust liquid in the entire process.

The year is 2020, and the availability of fossil fuel is getting diminished gradually. The world is up and ready to welcome the battery-driven vehicles, popularly known as E-vehicles, into its folds. But, if only the E-vehicles did not cost a fortune for buyers. Keeping in the mind the cost, the efficiency, and the eco-friendly factors, our ‘water electrolyser’ concept promises to bring around a positive change in the realm of automobile as this concept is based on running an IC engine without being dependent on fossil fuels.

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