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Water as A Fuel

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Abstract: *Hydrogen can be a promising vitality vector as time goes by. One of the different procedures of its production, the usage of electrolysis of water gets drawn attention as it's renewable and easy to setup. So, hydrogen signifies an ideal vitality vector to your storage of irregular and non-renewable energies. It intends to offer an insight into the theoretical bases of their principles of distinct kinds of electrolyzers. The development result of hydrogen contains accelerated kinetics, and therefore, the polarization of this cathode isn't vital.*

Key Word*:Hydrogen Generator; HHO gas*

I. Introduction

Fossil fuels, oil, and coal provide Eighty-five percentage of energy globally. Fossil fuels are non-renewable resources, which will become scarce and difficult to research [1]. Fossil fuels are renewable energy resources. The require of fuel and electricity calls for a change to renewable power resources, including solar, wind, biomass, hydropower etc. Due to its particular own correlated issues for example as air pollution, along with the high requirement for Petroleum CNG, generate and our idea is to create a platform to create fuel that is clean and free with carbon monoxide. Hydrogen suggested as a promising fuel for a secondary source of energy in 1973.

Solar can be just a safe solution which may replace fossil fuels such as fuel and coal to its creation of power which produces water, air, and soil pollution. Besides, it is a low maintenance way of generating hydrogen[2]. The use of solar power can expel the dangerous consequences of using conventional fossil fuels. Consuming fossil fuels creates greenhouse gases as well as compounds, inducing air contamination and local climate change. Different petroleum-related products have different levels of toxicity.[3]

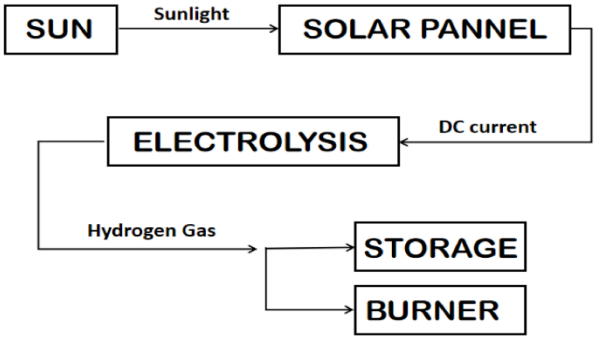


Figure 1: Block diagram

Water electrolysis is just one among the cleanest, rapid, uncomplicated approach to produce hydrogen. In 1820 M.Faraday discovered electrolysis, decomposing water to its inherent parts H^+ and $OH^-$by passing electric current. To generate hydrogen using water electrolysis has been analyzed for quite a long time. Electrolysis can be a vast field to studies for researchers all around the whole world.Some data imply that man has used hydrogen as an alternate gas supply in different heights of areas like industrial industries, military, and commercial.

II. Literature Review

This research paper presents the study of electrolyzer cell design, cell material, electrolyte, and renewable energy sources for HHO gas production. To produce hydrogen gas electrolysis requires DC power supply. Therefore, it is essential to explore which cell design, material, and the energy source is efficient and cheapest.

There are many factors linked with hydrogen fuel production that required necessitates analysis. These elements include the amount ampere draw each unit production of hydrogen, ampere losses, the increasing temperature during production, and also the efficacy of cell ofhydrogen production[4].

Exploration of this detail will alleviate the procedure for creating a compact design of their absolute best suitable approach to suit anywhere. This emerging technological innovation is now for lowering hazardous gases gasoline consumption and also, most importantly, capable[3]. Among the vital aspects of this study cells arrangementis one of the important aspect, e.g., measurement of electrodes, size of plates, level of required electrolyte, additional accessories required, and also their capability to create hydrogen gas for a supplement fuel, overall manufacturing expense for very identical capacity units.

III. Methodology

A basic model of water electrolysis content a power supply, an electrolyte, a cathode (negative terminal), and an anode (positive terminal). This research consist use of Solar panel that generates solar energy and replaces the power supply, as illustrated in Fig. 2.

To maintain the electricity harmony direct current is employed. From the negative terminal of power source(which in this situation is solar-energy) electrons start to flow to cathode at which hydrogen ions that is protons consumed electrons to produce hydrogen gas. Hydroxide ions(OH^-) (anions) move through the electrolyte to the anode to preserving the electrical charge in balance, at the hydroxide ions give away electrons which return into the positive terminal of the power source.

Electrolytes are applied to enhance the conductivity of the solution[3] which generally consist of ions with high mobility. Sodium hydroxide is available for used in water electrolysis.

Stainless steel is a low cost electrode material and is popular due to its high activity[7]. During the process plates are in direct contact with electrolyte and water, which can cause corrosion to the plates.

There are two types of systems: a wet system and a dry system. The electrodes are entirely submerged inside the water in wet cells system, whereas, in dry cell system, the water is passed between the electrodes[4]. This research, follow a wet system because the dry system needs an external pump to flow water in between the plates. Solar power is in use to run the electrolysis, so giving energy to an external pump can't be possible.

Calculating the hydrogen production is on the theory of electrolysis given by Micheal Faraday.[6]. Faraday laws state that the amount of chemical change produced by a current at an electrode-electrolyte boundary is proportional to the quantity of electricity used. 1F(Faraday) is equivalent to 9.6485309×104 coulombs of electricity per mol.

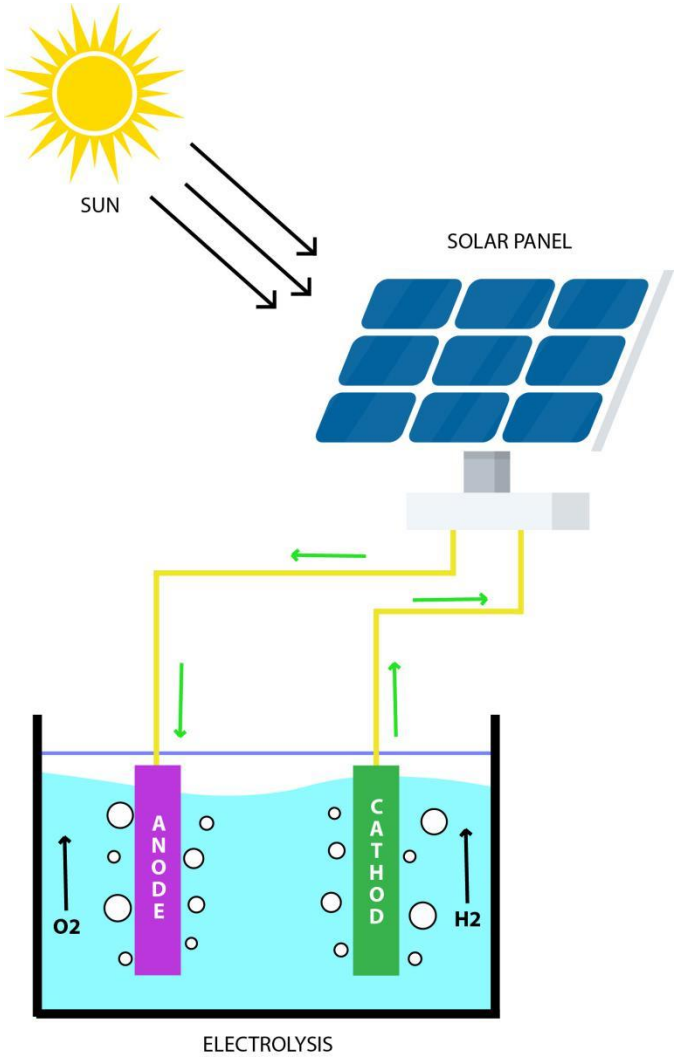


Figure 2: Solar power hydrogen generator

Coulomb of charge are we giving in minutes:

$$Q = I \times T \tag{1}$$

Where: *Q=No. Of Coulomb*

I=Current(in amp)

T=Time(in second)

Molar Volume of Hydrogen Gas = 24dm^3/mol

Equation of Hydrogen Production:

$$2H^{+} + 2e^{-} \rightarrow H_2 \quad (2)$$

This means 2 mol of hydrogen electron gives 1mol of H2, Coulomb carried by one mol(q) 2×96500.

So, volume of H_2 can be calculated as

$$V = \left(\frac{Q}{q}\right) \times v \quad (3)$$

Where: *V=Volume of H_2*

q=Columb carried (in 1 mol)

v=Molar Volume

IV. Analysis of electrolyte

Samuel Pamford Kojo Essuman, Andrew Nyamful, Vincent Agbodemegbe, Seth Kofi Debrah,studies showed a significantresult on the production of hydrogen gas using electrolyte KOH, NaOH, and $NaHCO_3$.

Based on the ionization with conductivity ability[3] the hydrogen gas generated throughout the analysis discovered that KOH is higher followed by NaOH and then NaHCO3.NaOH is less expensive than KOH and produces desire result as depicted in the fig(3), the figure shows that KOH produces slightly greater amount of H_2 gas but it costhigher than NaOH.

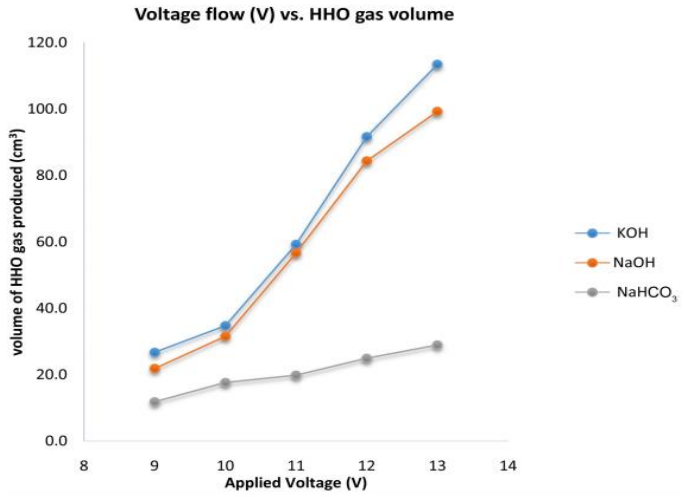


Figure 3: Voltage Flow effect on different catalyst

V. Arrangement of Neutral Plate

The use of "neutral" plates in an electrolysis cell, divides the cell, that looks like a stack of several cells connected in series.Starting with the trivial case (n=0) of an electrolysis cell with 2 "wired" plates, and 0 "neutral" plates, this cell looks like 1 cell.

Next case (n=1): 2 wired plates with 1 neutral plate. This arrangement looks like 2 cells, wired in series.

Next case(n=2): 2 wired plates with 2 neutral plates. This arrangement looks like 3 cells, wired in series.

And so on, and so forth, until n=N, an arrangement with 2 wired plates and N neutral plates, that looks like N+1 cells, wired in series. To transform the general arrangement of metal plates and water into an equivalent electrical circuit made of lumped components, specifically cells, resistors, and wire.

Three rules:

(1) The inside of a metal plate is made of metal. We can draw the insides of plates as short wires. Conduction inside metal is entirely a flow of electrons (e-).

(2) A length of water, also called electrolye, looks like a resistor. Conduction inside water is entirely a flow of ions, e.g. hydroxide (OH^-) , whatever is in my water besides water (H_2O). In the equivalent circuit diagram, we draw the water spaces as resistors.

(3) The only place where electrolysis is actually happening is at the surfaces of the metal plates, because that's where the place where electrons, in the metal, meet the ions, in the water. Technically these surfaces are half-cells, either an anode, or a cathode.

Current flow through the battery, It's making the necessary reaction, at a rate directly proportional to the current

$$I = \frac{dQ}{dt} \qquad (4).$$

Current flow through the resistors is less useful. In those places, the current is making heat, and wasting energy, as

$$\frac{dE}{dt} = I^2 \times R \qquad (5)$$

For this reason, a big, long water space is not useful, because it acts like a high resistance, so we are using a less water space for less resistance.

VI. Working Model

Figure 4display the experimental set-up used to create Hydrogen gas. The system consisted of solar panel, an hydrogen generator, a bubbler, and a burner. The hydrogen generator made upof5rectangular plates of stainless steel sheet containing1 cathode, 1 anode and 3 neutral plates of surface area 12cm×6cm = 72cm^2. To increase bubble, the plate surface is scratch to get more surface area.

The generator is designed in such a way that the voltage between the plates maintained at 3v to 6v. The neutral plates are parallelly placed between anode and cathodeplate.

The plates was positioned parallel and spaced with 3cm, as shownin Figure 4. The entire system is placed inside a beaker, which is popularly known as wet system[1].

On the cap of the beaker two holes are made for gas inlet and outlet, In addition, 2 holes are made for wires to connect with anode and cathode.

The Hydrogen gas produced inside the generator plates was collect on top of the beaker and then channel to a bubbler to filter excess water vapoor.

The role of bubbler is to precipitate the water vapor that was produced with and carried along with the hydrogen gas during the experiment and also used as a safety device. The terminals of the Hydrogen gas generator are connected to solar panel by connecting two insulated copper wires to supply current to the unit.

The current generated by using solar-panel will be further used in electrolysis of water to give H_2 gas.

The plates at the right and left end are cathodic in nature, while the three plates between them are neutral.The power supply of 24v is given from the top of the beaker.

As depicted in the picture, the electrons from negatives plates start moving towards the positive plate when the current is applied to it.This movement of electrons ionises the neutral kept in between. This polarity produces a current in between the plates.The supplied voltage gets divided into four parts making it 6v.

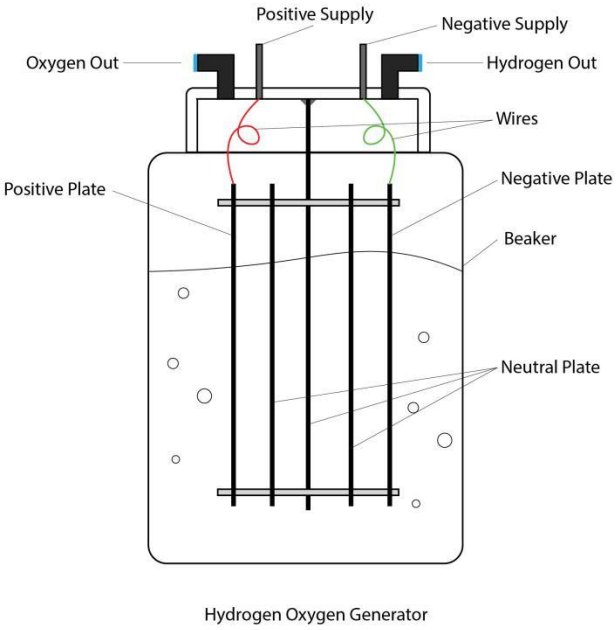


Figure 4: Working model of hydrogen generator

From the reaction process, It is clearly shown that the H_2 and O_2 gas is produced at the negative and positive ends.The bubble formed at the end confirms the presence of hydrogen gas.

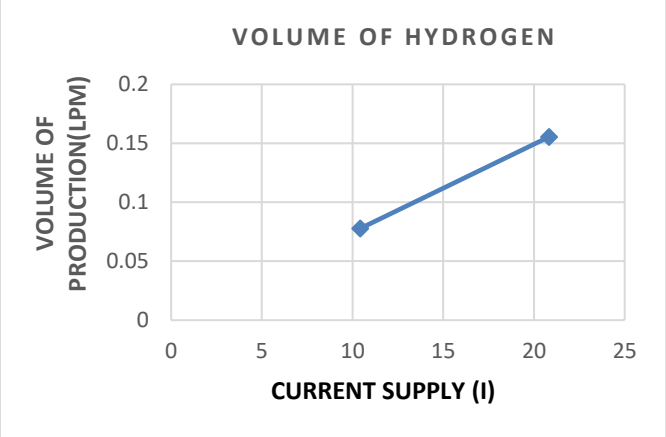
VII. Observation and Result

According to the calculation above we run some few test to find the effective way of producing hydrogen. First test was based on 24v and 250watt that gives current 10.4A. Second test was taken on 12v and 250watt that gives 20A current.

As observe from the observation table, we can say the lesser the voltage and higher the current the production of hydrogen rise. Cheaper Solar Panels of 100watt or higher as 250watt can able to generate a good amount of Hydrogen for small needs.

***Table 1**: Experimental Test based on Calculation*

	Test-01	**Test-02**
Voltage supply(v)	24	12
Current(A)	10.41666667	20.833333
No. of coulomb(A-s)	625	1250
Volume of H2(LPM)	0.077720207	0.15540415



Graph 1: Volume of Hydrogen generator

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