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Synthetic Solar Hydrogen & Oxygen Production Structure

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ABSTRACT-

In this paper, we introduced the Synthetic Solar Hydrogen & Oxygen Production Structure which generates oxygen, hydrogen and electric energy. As we know, the reduction in oxygen level is being felt all over world. This would prove harmful **to all or any folks**. Artificial oxygen tree can generate and release pure oxygen in the atmosphere using renewable resource. This Solar Technology converts the Solar Energy collected by solar panels in electricity, which is used for electrolysis process. Then the electrolysis is carried out by using electric energy stored in battery. The Hydrogen are going to be stored during a tank and may be used as a fuel and oxygen to be let loose within the air for breathing. Light emitting diode (LED), driven from the generated electricity are used to radiate light during night. This will attract peoples and create awareness among them about importance of trees.

Keywords- Solar, Electrolysis, Oxygen, Hydrogen, LED.

1 Introduction

Plants are the largest source of oxygen on Earth, which convert carbon dioxide into oxygen, an element that is necessary for survival of almost all living organisms on Earth. However, in this age, man has cut down those trees for many of the reasons. The number of trees is declining day by day due to increasing population and industrialization as well. As a result, the amount of oxygen in the atmosphere is declining and harmful CO2 is increasing dramatically, causing air pollution.

All these problems necessitate us to design & develop a solution to either overcome them or reduce their effects on human & other species. Hence our technology has given a birth to, An Artificial Oxygen Tree.

Fig. 1 Synthetic Solar Hydrogen & Oxygen Production Tree

A solar tree may be a structure incorporating solar power technology on one pillar, sort of a trunk .Our project model is capable of releasing pure oxygen in atmosphere by using sunlight. There is no doubt that solar energy is one of the best renewable power sources on earth that we have been using for many years for various applications. The artificial leaves means photovoltaic cells which combine energy through solar panels and convert it into electric energy without leaving any residual elements that can pollute the environment. Using electric charge, water decomposition will be done in electrolysis vessel to extract the oxygen and hydrogen gases from water. The hydrogen produced by the model can be used as fuel and oxygen is released into the air for breathing, which helps to reduce the rapidly increasing air and water pollution. LED lights looks much more attractive while night & attracts the people towards it.

2 Literature Survey

In today's world, many research labs are doing research on oxygen production and making ecofriendly model designs, which will not affect environment. Royal College of Art's graduate Julian Melchiorri has created the primary man-made, biologically functional leaf that takes in CO_2 , water, and lightweight and releases oxygen. K.S. Lackner's work includes demonstrations and improved methods to reduce rising carbon dioxide in the atmosphere. While designing we must have the ability to combine innovative design with modern technology and environmental sensitivity. [1][2]

For our model we gathered basic knowledge for this project from previous models and developed a new prototype from which you have the ability to meet oxygen and light requirements [1]. Our designed and implemented "artificial trees" use wastewater and seawater to produce hydrogen that can be used as fuel and oxygen for breathing, the LEDs in it act as attractive thing at night.

Reviews-

A. ***Centre for Renewable Energy Sources (CRES), Greece, "A review on water electrolysis"-*** *Waste Water is used to decompose the hydrogen and oxygen, by passing a current (with renewable/non-renewable energy through it within the presence of suitable substances, called electrolytes. Electric current causes charged hydrogen ions to migrate to the charged cathode, where a discount takes place so as to make hydrogen atoms. On the other hand, oxygen is formed at the other electrode (the positively charged anode). [5]*

B. ***Prof. V.V. Jadhav "Artificial Solar Oxygen Tree", E&TC Engineering, India*** *- The conversion of solar energy from solar tree for generation of Hydrogen, Oxygen and light various machines are used in market. Very small space requires for solar tree than conventional solar array system. The solar panels on solar tree convert radiation into electricity, which is employed for decomposition of water into oxygen and hydrogen. Oxygen is released within the air to breathe and hydrogen is stored as fuel. A tracker known as Arduino AT mega 328 which is programmed to detect the sunlight with the help of LDRs attracts or moves the position of solar panel in such a way so that it gets the maximum sunlight [3]*

C. ***Kirti Vibhute & Ramakant Shukla, "Economic Electrification Using Solar tree", International Journal of Science, India-*** *Solar technology that imitates how trees convert sunlight into energy. Shrubs, plants and trees use an inbuilt structural design to representation their leaves, height dense to sunlight for photosynthesis. They do this finds out their survival. Recently with the rising population and energy demands, we should always get an option of renewable energy source and also confine the mind that energy shouldn't cause pollution and other natural hazards. For this condition the solar energy is the best alternative for us, so the solar tree could be the best source of energy for us.[4]*

D. ***Miss. Nutan Rajan Kashid, Miss. Priyanka Tanaji Yadav, "Artificial Solar Tree", Jaywant College of Engineering, Sangli, INDIA*** *- In today's life, Artificial tree which gives electrical energy, oxygen and hydrogen. This tree provides hydrogen as fuel and oxygen to be emitted in the air for breathing. The leaves means solar panels are used for collecting sunlight and convert into light energy with the assistance of PV cell. The decomposition of hydrogen and oxygen called as Electrolysis of water. The hydrogen appears at charged electrode and oxygen at charged electrode. The pure water as well as waste water can be used for electrolysis process.[6]*

E. ***Silvano Tosti & Alfonso Pozio, Article on "Hydrogen and Oxygen Production via Water Splitting in a Solar powered Membrane Reactor- A conceptual study", Italy-*** *A conceptual study", Italy- Among the processes for producing hydrogen and oxygen from water via the utilization of solar power , water splitting has the advantage of being administered in one step. According to thermodynamics, this process exhibits conversions of practical interest at very high temperatures and wishes efficient separation systems so as to separate the reaction products, hydrogen and oxygen. The design of such a membrane device could also be feasible when considering special reactor configurations. [7]*

3. Construction Diagram

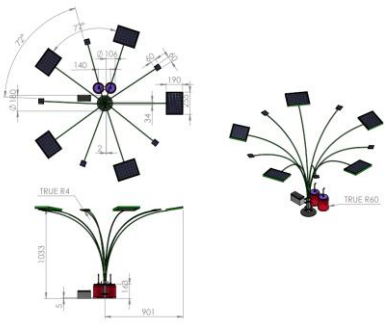

Fig. 2 Artificial Solar Oxygen Tree- Solid Works Diagram

4. Components

A. **Solar Panels-**

Solar cells collect light from the sun and switch it into electricity. The direct conversion of solar power is administered into electricity by conversion of sunshine or other electromagnetic wave into electricity. At solar panels, energy from the sun falls on a thin slice of a silicon-based material. This causes the silicon material to have gather more energy & the electrons in the silicon material moves faster. These Moving electrons create electricity & heat within them. The heat energy makes the electric current flow from the silicon material. As we get the greater intensity of the sunlight at solar panels, the greater the amount of electricity is produced. The output from a solar cell is at its highest level when the light hits the cell at right angles. In this way, solar panels play a most important role in process.

Specifications-

Make- Waaree
Size- 260 x190mm -5 nos.
60x60mm- 5nos.

Fig. 3 Solar Panel

B. **Battery-**

The battery is an electrochemical converter that converts chemical energy into electrical energy. Here we are using the lead acid battery in or process. The main purpose of the battery is to provide a supply of current for operating the cranking electrical units. When a battery is supplying electrical power, its positive terminal acts as cathode and its negative terminal acts as anode. The terminal marked negative is that the source of electrons. We use the lead acid battery which can be demonstrated using sheet lead plates for the two electrodes.

Specifications-

Make- Copro
Voltage- 12v
Current- 7.2

C. **Electrode-**

An electrode is a solid electric conductor of electricity when it is in metallic form. A steel electrode is used in our model for better performance. In electrolysis, the ionic substance must be dissolved in water or melted in order that the ions are liberal to move. Ions with a positive charge, like metal ions have lost electrons. Ions with a charge have gained electrons. In electrolysis, electrodes are wont to pass a current through a substance. Direct current (DC) is employed for electrolysis, because the "cathode" and "anode" are constantly switching places.

Specification-

Size- 6mm dia., 150mm long.
Material- Steel

Fig. 4 Electrode

D. **LED-**

A LED may be a semiconductor light that emits light when current flows through it. Electrons within the semiconductor recombine with electron holes, releasing energy within the type of photons. It works on the principle electroluminescence.

LED light used in model has ultra-bright 5050 SMD LED with long life span >50,000 hours. It gives excellent luminous efficiency, low temperature & low power consumption as well but the mail purpose of the LED is to make the model attractive and decorative by using excessive energy.

Specifications-

LED type- SMD 5050 Light
Colour- Green
Length- 5000x10x3mm
LED quantity- 60 LEDs/m
Luminous Flux- 3-4m per LED
Working current & voltage- 5A & 12v
Waterproof Rating: IP65
Viewing Angle: 120°
Working Temperature: -20 C to 50 C

E. **Frame-**

The frame is formed from low-carbon steel. It is strong enough to face up to all kinds of loads in working condition. All other parts are fitted to the frame, like solar panel bracket, base plate, LED strips etc. Frame shows the good aesthetic loop. Here we require a good frame design. Our whole project assembly is mounted on the frame. All the tree branches are fabricated by using round rod. Here we are using a 10 branched frame to fix the solar panels.

Specifications-

Material- Mild Steel
Round rods- 4 feet, 5mm dia. - 10nos.

Fig.5 Frame

F. **Air Supply Lines-**

Air supply lines are used to pull out the oxygen and hydrogen from the electrolysis vessel. Flexible hoses are utilized in conjunction with rigid piping of the compressed air or by itself in smaller workshops. They are also used for temporary or mobile air supply. Because flexibility, ease of installation, and durability are important in applications for the project.

G. **Electrolysis Vessel-**

An electrolysis vessel is a tank used for the electrolysis process. Electrodes are attached on the top surface/cover of the electrolysis tank. Here we are using the transparent plastic/acrylic tank for the process.

Fig. 6 Electrolysis Vessel

5 Electrolysis of Water

Chemical decomposition produced by passing an electrical current through a liquid or solution containing ions. [8] During electrolysis, positively charged ions move to the negative electrode and negatively charged ions move to the positive electrode. Then charged ions receive electrons and charged ions lose electrons. Both the products of the dissociation get collected at the electrodes.

- ✓ Electrolysis of water is the decomposition of water (H_2O) into oxygen (O_2) and hydrogen gas (H_2) with the help of an electric current being passed through the water. [8]
- ✓ Water molecule is decomposed in to H+ and OH- ions, when electric current is passed through it. These ions move to oppositely charged electrodes and liberated as gases at different electrodes. [8]
- ✓ Here we are using the wastewater as an electrolytic solution. We can also use the salt for better conduction of electricity. It results in, the water near the cathode becomes basic while the water near the anode becomes acidic.
- ✓ An electrical power source is connected to two electrodes, or two plates (typically made from some inert metal such as platinum or stainless steel) which are placed in the water. In a properly designed cell, hydrogen will appear at the cathode (the negatively `charged electrode, where electrons enter the water), and oxygen will appear at the anode (the charged electrode). Assuming ideal faradaic efficiency, the quantity of hydrogen generated is twice the amount of moles of oxygen, and both are proportional to the entire electrical charge conducted by the answer. However, in many cells competing side reactions dominate, resulting in different products and fewer than ideal faradaic efficiency.[8]
- ✓ The positive hydronium ions that approach the cathode mostly combine with negative hydroxide ions to form water. Relatively few hydroniums/hydroxide ions reach the cathode/anode. This can cause a degree overpotential at both electrodes.
- ✓ Electrolysis of pure water requires excess energy in the form of over potential to overcome various activation barriers. Without the surplus energy the electrolysis of pure water occurs very slowly or not in the least. This is partially thanks to the limited self-ionization of water. Pure water has an electrical conductivity about one millionth that of seawater. Many electrolytic cells can also lack the requisite electrocatalysts. The efficacy of electrolysis is increased through the addition of an electrolyte (such as a salt, an acid or a base) and therefore the use of electrocatalysts.
- ✓ electrolysis requires a minimum potential difference of 1.23 volts
- ✓ The electrolysis of water can be very beneficial to the Earth because the hydrogen produced from a full-scale model would be an ideal fuel for powering vehicles. The electricity produced could help power homes and save lots of money. [9]

Currently the electrolytic process is rarely used in industrial applications since hydrogen can currently be produced more affordably from fossil fuels. [10]

6 Electrolysis Reactions

In the water at charged cathode, a reduction reaction takes place, with electrons (e^-) from the cathode being given to hydrogen cations to form hydrogen gas (the half reaction balanced with acid:

Reduction at cathode: $2\ H^+(aq) + 2e^- \rightarrow H_2(g)$

At the charged anode, an oxidation reaction occurs, generating oxygen gas and giving electrons to the anode to finish the circuit:

Anode (oxidation): $2\ H_2O(l) \rightarrow O_2(g) + 4\ H^+(aq) + 4e^-$

The same half reactions also can be balanced with base as listed below. Not all half reactions must be balanced with acid or base. To add half reactions, they must both be balanced with either acid or base.

Cathode (reduction): $2\ H_2O(l) + 2e^- \rightarrow H_2(g) + 2\ OH^-(aq)$ Anode (oxidation): $4\ OH^-(aq) \rightarrow O_2(g) + 2\ H_2O(l) + 4\ e^-$

Combining either half reaction pair yields an equivalent overall decomposition of water into oxygen and hydrogen:

Overall reaction: $2\ H_2O(l) \rightarrow 2\ H_2(g) + O_2(g)$

The number of hydrogen molecules produced is thus twice the amount of oxygen molecules. Assuming equal temperature and pressure for both gases, the produced hydrogen gas has volume twice the volume of the produced oxygen gas. The number of electrons pushed through the water is twice the amount of generated hydrogen molecules and 4 times the amount of generated oxygen molecules.

7. Working Process

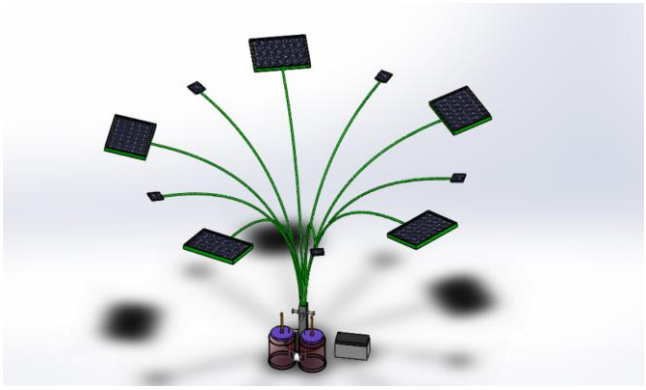

Fig. 7 SolidWorks Diagram of solar tree

Solar panel will absorb the sunlight and convert it into electrical energy which will be stored in battery. Dost old battery will be used to produce oxygen by doing electrolysis process endearing light the stored energy in battery will be used for or LED lights. In electrolysis two electrodes are used one for cathode and other for Anode two electrodes are kept in two different vessels which are connected with each other buy small pipe in between. The cathode is positive electrode and anode is negative electrode when the power is switched on, positive electrode oxygen is produced and negative electrode hydrogen is produced both the produced gases are initially filled in its own vessel which is provided with push connector and supply lines.
The gases will be released in environment because hydrogen is highly flammable and oxygen helps for burning. 10 supply lines are given for storing this very less quantity of gas if required for demonstration purposes.

Result

1. 1 liter of water weights 1 kilo and when electrolyzed will produce hydrogen and oxygen as described by the following equation

2. $2\ H_2O\ (l) \rightarrow 2\ H_2\ (g) + O_2\ (g)$

3. In atomic weight terms 36.0012kg of water with give 4.0032kg of oxygen and 31.998kg of hydrogen.
4. So, a single kilo you will get 4.0032/36.0012 or 111.19gm of oxygen and 31.998/36.0012 or 888.81gm of hydrogen.
5. There are five large solar panels of 3 watts and five small solar panels of 0.4 watts, so total 17-watt energy panels are used. The 17-watt energy solar panel will produce 105 voltages and 0.5 ampere hour (Ah) will charge the battery. The Battery Used here is 12 v and 7.5 ah total 90 watt. So, panel will charge the battery fully from zero in 5 hours 18 minutes.

Advantages

- ✓ Low Cost: Running and maintenance costs of this device are very low.
- ✓ Eco-friendly: The device is eco-friendly, as it uses solar energy as basic source of energy.
- ✓ Easy Installation: The lack of wiring minimizes disruption caused to roads or nearby locations during installation. Solar street models can be erected at almost all locations.
- ✓ Self-Sufficient: Power outages have no impact on street lighting.

Applications

- ✓ Oxygen Generation: The actual model will produce breathable oxygen gas from wastewater and seawater which is very useful and necessary in cities or areas with a smaller number of trees or no trees. It will increase the levels of oxygen in the atmosphere & it can be stored for further uses.
- ✓ Hydrogen Generation: The model will produce hydrogen gas which can be stored during electrolysis and used later as a fuel for vehicles or other purposes.
- ✓ Street Lights: With the help of LED lights this Project model will also acts as a decorative & attractive thing in the streets as well as it can useful to create awareness about tree plantation. The LED lights in the night will light up the sky and provide a beautiful spectacle.
- ✓ Gadget Charger: The actual model can be used to charge the gadgets like mobile phones and laptops by using the power from batteries.
- ✓ Advertisements: Advertisements will be displayed in between or near to the LED strips; it will attract the sponsors.

Future Scope

- Solar tracking system (solar panels axis moves automatically according to direction of Sun rays) can be installed in future for increasing the power output.
- CIGS solar cell (copper indium gallium selenide solar cell) panels will be used in future because it has more efficiency than poly crystalline panels, so it will collect more energy.
- Micro controllers which is useful for automation will be used for automatic operation controls for light and oxygen production.
- If we can extract a large amount of oxygen in less time, we can store it and use it for various application

Conclusion

Our designed and implemented "artificial tree" produces oxygen as well as hydrogen, but without the need for planting, soiling or watering. Such a design is are often implemented usefully in cities, where there are insufficient trees and therefore the concentration of CO_2 gas in air is alarmingly high while levels of oxygen gas are low. In addition, our model also fulfils street lighting requirements of cities. As discussed in Results, the solar panels can successfully produce 15 W of electricity which is stored in battery and used to light up LEDs and carry out electrolysis.

The model is environment-friendly, saves money, is cheap to use and can be installed anywhere. Although the initial installation would require planning and resources, we believe the long-term benefits would be totally worthwhile.

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