Artificial Solar Tree using Electrolysis

[1]Mr.Sachin S. Kadam, [2]Mr.Mohite Pandurang T., [3]Mr. Kolhe Ravindra S. [4]Ms. Ujwala K. Patil.
[1]Lecturer, [2]Lecturer, [3]Lecturer, [4]Lecturer
[1,2,3,4]Science Dept.
[1,2,3,4] Bharati Vidyapeeth Institute of Technology, Kharghar, Navi Mumbai

Abstract : — This Paper deals with converting solar energy from artificial solar tree, for generation of Hydrogen, Oxygen and light. The solar panels on solar tree convert light i.e solar radiation into electricity, which is store in battery and used for decomposition of water into oxygen and hydrogen. Oxygen is released in the air to breathe and hydrogen is stored as fuel. Light Emitting Diode (LED) lights, driven from the generated electricity are used to radiate light during night. Artificial solar Tree can be implemented to meet oxygen and Hydrogen fuel requirements and lighting demands of the cities in an eco-friendly manner. We have developed a solar system using a combination of 89C51 and light dependent resistors (LDR's) with the primary aim of improving the power efficiency of the solar panels. The main component of this system is Atmell 89c51 which is programmed to detect the sunlight with the help of LDRs and then switches the electrolysis and lights according to day and night conditions.

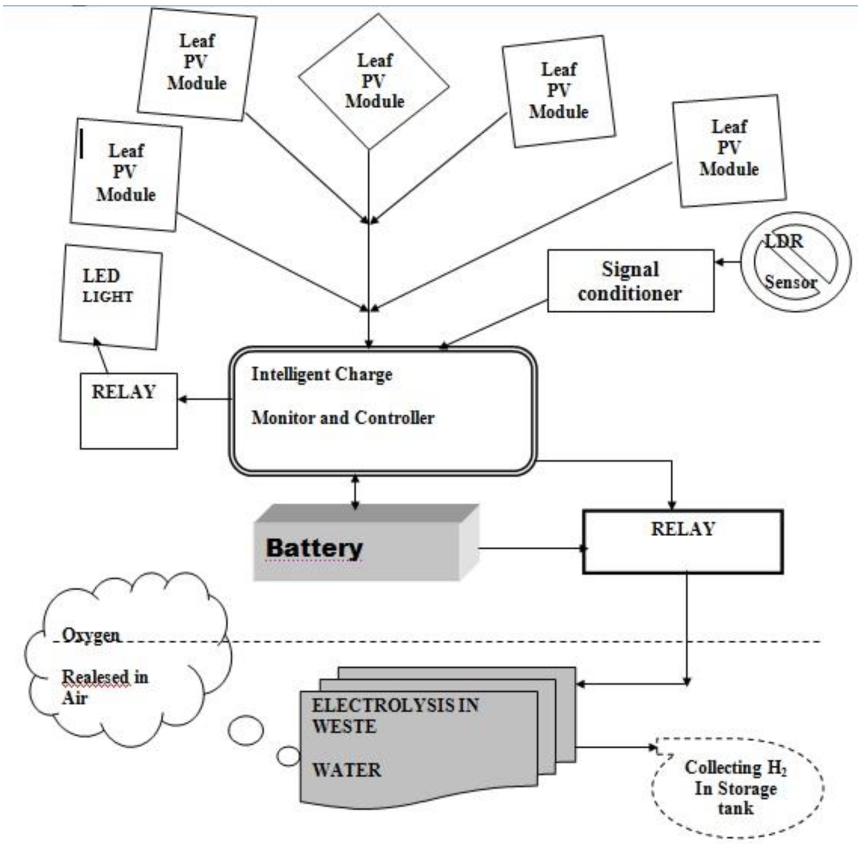
Key words: Solar, Electrolysis, Oxygen, Hydrogen, microcontroller etc

I. INTRODUCTION

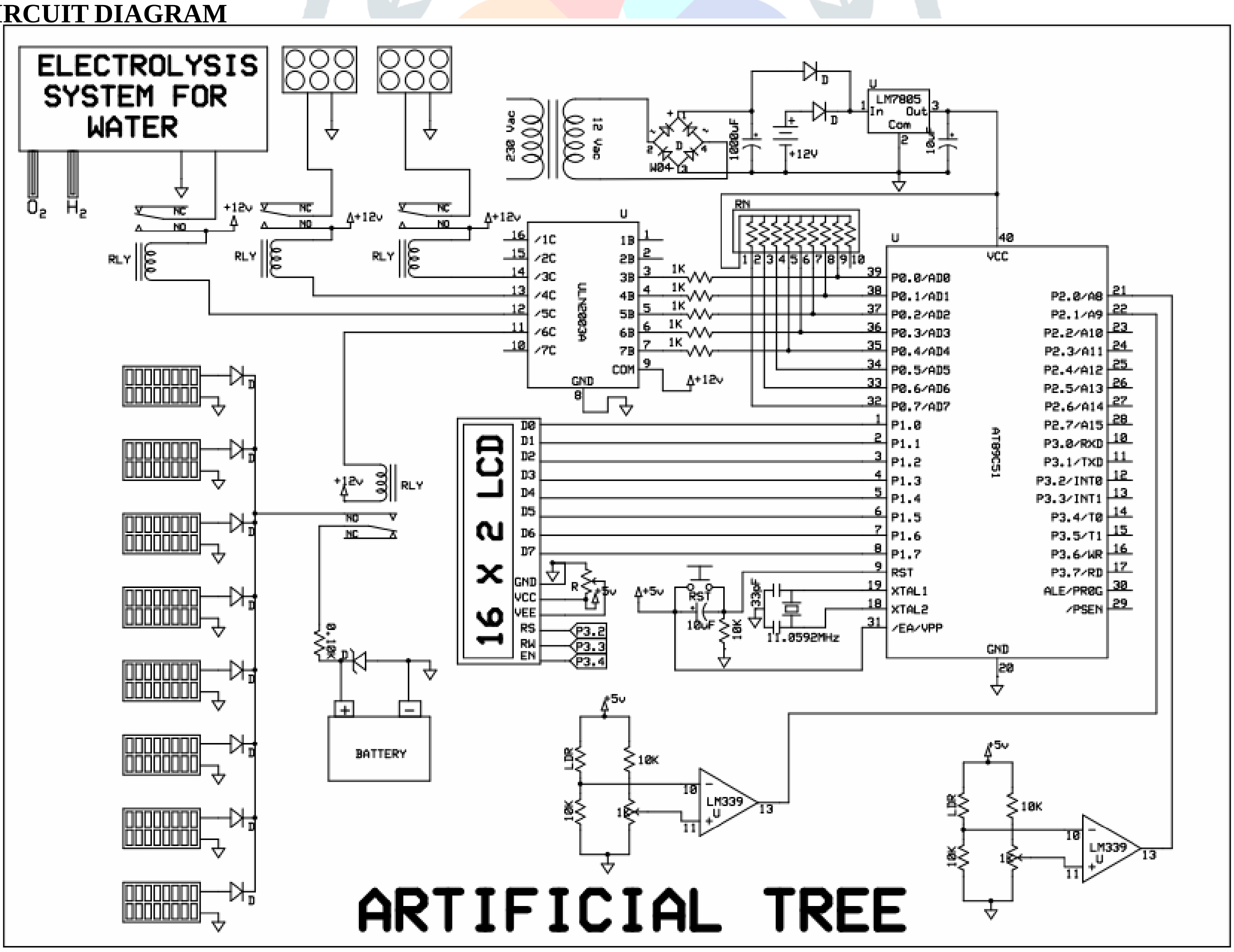
We know that the world`s population is growing day-by-day and the number of trees are decreasing which we call as deforestation. Due to this, many harmful chemicals are emitted in the atmosphere. Emission of such chemicals can cause diseases related to respiratory in humans and animals. The amount of oxygen is decreasing in the atmosphere as the number of trees are decreasing. The major cause of these reducing trees is leading to Global Warming.

Keeping these all situations in mind, we have implemented an project called as Artificial Solar Tree. This tree consists of solar panels which are placed like leaves and a structural body which acts as a branch holds these panels on them. To run our process we use source light from sun which is a natural light. We have used batteries to store this sunlight which are converted into electrical energy. The main feature of our project is to run electrolysis process through which it will produce oxygen and hydrogen. Oxygen can be released into the atmosphere and hydrogen can be collected in a container. The most important feature of this project is that it is portable and can be used anywhere where the sunlight is present. So this process fulfills the main function of a tree, therefore it is named as `Artificial Solar Tree`. This concept will be helpful in reducing global warming and saving electricity

II. BLOCK DIAGRAM



III. CIRCUIT DIAGRAM



IV. SYSTEM DESIGNING

For system designing, we had divided the system designing in three parts.

A. CPU Designing
B. Input Designing
C. Output Designing

A. CPU Board Designing:

In this system we are using 89C51 micro-controller as CPU. 89C51 micro-controller requires some extra supporting hardware like +5 volts regulated power supply, POR (Power ON RESET) as well as manual RESET, Clock generator, pull-up resisters and LED display.

1. Power supply:

For getting +5 volts regulated supply, the +12 volts supply from the rectifier and filter output is taken. And it is given to 7805. The minimum input to 7805 is +7 V dc and Maximum input is +35 V dc. We are giving +9 V dc as input to the 7805. Therefore the output of the 7805 is constant regulated +5 V dc.

2. POR and Manual RESET:

When we switch ON the power supply of the CPU board then micro-controller must be RESET to start the program execution from 0000 H memory location. Therefore POR is must. POR means Power ON RESET. For this purpose we have to use RC differentiator circuit. RC differentiator circuit will provide logic high pulse (+5 V for 1 µsec) to RESET pin of 89C51, when you switch ON the power supply.

Some times we require manual RESET. For this purpose one Push-to-ON tact switch is used. When you press this tact switch then logic high signal is given to the RESET pin of the Microcontroller 89C51.

3. Clock Generator:

The maximum clock frequency of the Microcontroller 89C51 is 24 MHz. Therefore we can use any frequency less then 24 MHz. But if we are using PC interfacing then for selecting the bits per second we have to use particular crystal. For selecting 9600 bits per second we have to use 11.0593 MHz crystal. Now just connecting the crystal is not sufficient to generate the clock, it requires two additional capacitors to generate the starting spike pulse.

4. External Pull-Up resisters:

In microcontroller Port 0 does not have internal pull up resister. Therefore we have to use the external pull up resister at port 0. At other ports external pull-up resistor is optional. But we have connected the external pull-up registers for other ports also.

5. LCD DISPLAY:

In our project to monitor the number of persons in the room, number of persons entered into room and number of persons exit from the room we require LCD display. It is 16 X 2 LCD display. Means 16 character and 2 Lines

B. Input Board Designing:

Input board requires the +5 V supply. This supply is taken from the CPU board. Artificial Solar Tree's operation mainly depends on the light sensing to detect the Light i.e. day or night. So to sense day and night, we have used a Light Dependent Resistor (LDR). The property of this device is that when there is no light falling on it, its resistance increased, reverse happens when there is no light falling on it.

When there is NIGHT there is no light on LDR, therefore LDR resistance gets increased. Due to this current through LDR is reduced. Therefore voltage at inverting terminal of comparator reduces. So Non-inverting input is greater then inverting input terminal therefore output is high and LED is ON.

When there is DAY there is light on LDR, therefore LDR resistance gets reduced. Due to this current through LDR is increased. Therefore voltage at inverting terminal of comparator increases. So Non-inverting input is less then inverting input terminal therefore output is low and LED is OFF.

Other input in our project is output of solar. We are using 6V 250 mA solar cell. We had connected four solar cells in parallel. So overall voltage across the solar cell is 6V, but maximum current is 1Amp. This current is given to battery to charge. This charged battery is further utilized for electrolysis and electricity generation.

C. Output Board Designing:

In output board we have following parameters to design.

1. Power supply.
2. Relay Driver card.

1. Power supply.

In our project output device i.e. light is connected at the relay terminals. Therefore we have to drive the relay. For driving the relay we want +12 Vdc supply.

For getting the +12 Vdc Supply we have converted 230 Vac into 12 - 0 – 12 V ac by using step down transformer. Output of the secondary is given to the bridge W04 for converting it into DC. The output of the bridge is pulsating DC voltage, therefore we have used shunt capacitor filter (1000µF/25 V). The output across the filter is pure DC +12 V, which is used to drive the relay as well as to the microcontroller board.

2. Relay Driving Card.

We have to drive relay. Now we can't connect the relay directly to the micro-controller, because micro-controller board operates on + 5 Vdc supply and relay operates on +12 Vdc supply.

Therefore to drive the relay we have to use switching transistor's IC ULN2308. The relay is connected at the collector terminal of the switching transistor. When we apply logic 0 to the base of the transistor then transistor is OFF and relay is also OFF as it is connected in series with transistor. When we apply logic high (1) to the base of the transistor then transistor is ON and relay is also ON.

Transistors must be protected from the brief high voltage 'spike' produced when the relay coil is switched off. For this purpose freewheeling diode is connected across the relay coil. Note that the diode is connected 'backwards' so that it will normally not conduct. Conduction only occurs when the relay coil is switched OFF, at this moment current tries to continue flowing through the coil and it is harmlessly diverted through the freewheeling diode. Without the diode no current could flow and the coil would produce a damaging high voltage 'spike' in its attempt to keep the current flowing. LED is used to indicate the Relay status i.e. relay is ON or OFF.

V. Electrolysis of Water

In chemistry, electrolysis is a technique that uses a direct electric current (DC) to drive an otherwise non-spontaneous chemical reaction. Electrolysis is commercially important as a stage in the separation of elements from naturally occurring sources such as ores using an electrolytic cell. The voltage that is needed for electrolysis to occur is called the decomposition potential.

Electrolysis is the passing of a direct electric current through an ionic substance that is either molten or dissolved in a suitable solvent, producing chemical reactions at the electrodes and a decomposition of the materials.

The main components required to achieve electrolysis are:

An electrolyte: a substance, frequently an ion-conducting polymer that contains free ions, which carry electric current in the electrolyte. If the ions are not mobile, as in most solid salts, then electrolysis cannot occur.

A direct current (DC) electrical supply: provides the energy necessary to create or discharge the ions in the electrolyte. Electric current is carried by electrons in the external circuit.

Two electrodes: electrical conductors that provide the physical interface between the electrolyte and the electrical circuit that provides the energy.

Electrodes of metal, graphite and semiconductor material are widely used. Choice of suitable electrode depends on chemical reactivity between the electrode and electrolyte and manufacturing cost.

Process of electrolysis :

The key process of electrolysis is the interchange of atoms and ions by the removal or addition of electrons from the external circuit. The desired products of electrolysis are often in a different physical state from the electrolyte and can be removed by some physical processes. For example, in the electrolysis of brine to produce hydrogen and chlorine, the products are gaseous. These gaseous products bubble from the electrolyte and are collected.

$$2\,NaCl + 2\,H_2O \rightarrow 2\,NaOH + H_2 + Cl_2$$

A liquid containing electrolyte is produced by:

Solvation or reaction of an ionic compound with a solvent (such as water) to produce mobile ions An ionic compound is melted by heating An electrical potential is applied across a pair of electrodes immersed in the electrolyte. Each electrode attracts ions that are of the opposite charge. Positively charged ions (cations) move towards the electron-providing (negative) cathode. Negatively charged ions (anions) move towards the electron-extracting (positive) anode.

In this process electrons are either absorbed or released. Neutral atoms gain or lose electrons and become charged ions that then pass into the electrolyte. The formation of uncharged atoms from ions is called discharging. When an ion gains or loses enough electrons to become uncharged (neutral) atoms, the newly formed atoms separate from the electrolyte. Positive metal ions like Cu^{2+}deposit onto the cathode in a layer. The terms for this are electroplating, electrowinning, and electrorefining. When an ion gains or loses electrons without becoming neutral, its electronic charge is altered in the process. In chemistry, the loss of electrons is called oxidation, while electron gain is called reduction.

Electrolysis of water to produces hydrogen.: $2\,H_2O(l) \rightarrow 2\,H_2(g) + O_2(g);\ E^0 = +1.229$ V

The energy efficiency of water electrolysis varies widely. The efficiency of an electrolyser is a measure of the enthalpy contained in the hydrogen (to undergo combustion with oxygen, or some other later reaction), compared with the input electrical energy. Heat/enthalpy values for hydrogen are well published in science and engineering texts, as 144 MJ/kg. Note that fuel cells (not electrolysers) cannot use this full amount of heat/enthalpy, which has led to some confusion when calculating efficiency values for both types of technology. In the reaction, some energy is lost as heat. Some reports quote efficiencies between 50% and 70% for alkaline electrolysers; however, much higher practical efficiencies are available with the use of PEM (Polymer Electrolyte Membrane electrolysis) and catalytic technology, such as 95% efficiency.

VI. APPLICATIONS

1. To generate oxygen for breathing.
2. To generate hydrogen as fuel.
3. To generate electricity.

VII. Conclusion

This prototype will help to generate oxygen for breathing, hydrogen as fuel and also electricity. In this microcontroller plays very important role to switch the system for day and night operation. In day condition electrolysis and charging is ON and lights are OFF. And in night condition the electrolysis and charging is OFF and lights are ON.

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