Solar Powered water Purifier

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ABSTRACT

In this paper, we are making a water purifier which works on solar energy. The basic principle behind this project is reverse osmosis. The solar radiations are collected by solar panel. This energy is then stored in a battery. The battery is connected to the purification unit through a electromagnetic relay. The purification unit consists of high pressure motor, reverse osmosis system and the water tank. The high pressure creates the necessary pressure required to carry out reverse osmosis. The microcontroller 8051 keeps a watch to the level of water in the water tank and prevents it from over flow. Through this process we obtain the purified water in the water tank.

I. INTRODUCTION

Photovoltaic solar cells are thin silicon disks that convert sunlight into electricity. These disks act as energy sources for a wide variety of uses, including: calculators and other small devices; telecommunications; rooftop panels on individual houses; and for lighting, pumping, and medical refrigeration for villages in developing countries. Solar cells in the form of large arrays are used to power satellites and, in rare cases, to provide electricity for power plants. When research into electricity began and simple batteries were being made and studied, research into solar electricity followed amazingly quickly. As early as 1839, Antoine-Cesar Becquerel exposed a chemical battery to the sun to see it produce voltage. This first conversion of sunlight to electricity was one percent efficient. That is, one percent of the incoming sunlight was converted into electricity. Willoughby Smith in 1873 discovered that selenium was sensitive to light; in 1877 Adams and Day noted that selenium, when exposed to light, produced an electrical current. Charles Fritts, in the 1880s, also used gold-coated selenium to make the first solar cell, again only one percent efficient. Nevertheless, Fritts considered his cells to be revolutionary. He envisioned free solar energy to be a means of decentralization, predicting that solar cells would replace power plants with individually powered residences.With Albert Einstein's explanation in 1905 of the photoelectric effect—metal absorbs energy from light and will retain that energy until too much light hits it—hope soared anew that solar electricity at higher efficiencies would become feasible. Little progress was made, however, until research into diodes and transistors yielded the knowledge necessary for Bell scientists Gordon Pearson, Darryl Chapin, and Cal Fuller to produce a silicon solar cell of four percent efficiency in 1954. Further work brought the cell's efficiency up to 15 percent. Solar cells were first used in the rural and isolated city of Americus, Georgia as a power source for a telephone relay system, where it was used successfully for many years. A type of solar cell to fully meet domestic energy needs has not as yet been developed, but solar cells have become successful in providing energy for artificial satellites. Fuel systems and regular batteries were too heavy in a program where every ounce mattered. Solar cells provide more energy per ounce of weight than all other conventional energy sources, and they are cost-effective.

II. Block Diagram

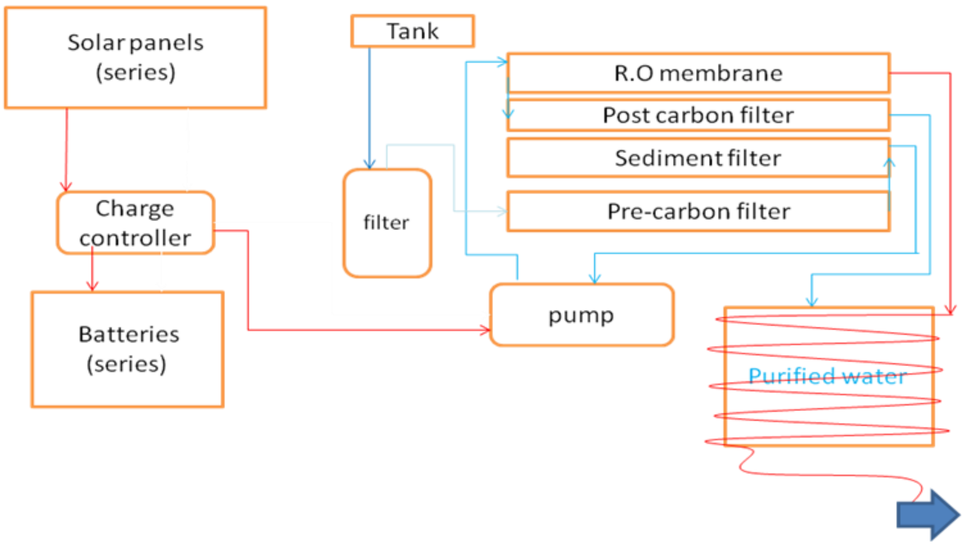

Fig.1 Block Diagram of Purifier unit

Solar (or photovoltaic) cells convert the sun's energy into electricity. Whether they're adorning your calculator or orbiting our planet on satellites, they rely on the photoelectric effect. Silicon is what is known as a semi-conductor, meaning that it shares some of the properties of metals and some of those of an electrical insulator, making it a key ingredient in solar cells. Let's take a closer look at what happens when the sun shines onto solar cells. Sunlight is composed of miniscule particles called photons, which radiate from the sun. As these hit the silicon atoms of the solar cell, they transfer their energy to lose electrons, knocking them clean off the atoms. The photons could be compared to the white ball in a game of pool, which passes on its energy to the colored balls it strikes. Freeing up electrons is however only half the work of a solar cell: it then needs to herd these stray electrons into an electric current. This involves creating an electrical imbalance within the cell, which acts a bit like a slope down which the electrons will flow in the same direction. Creating this imbalance is made possible by the internal organization of silicon. Silicon atoms are arranged together in a tightly bound structure. By squeezing small quantities of other elements into this structure, two different types of silicon are created: n-type, which has spare electrons, and p-type, which is missing electrons, leaving 'holes' in their place. When these two materials are placed side by side inside a solar cell, the n-type silicon's spare electrons jump over to fill the gaps in the p-type silicon. This means that the n-type silicon becomes positively charged, and the p-type silicon is negatively charged, creating an electric field across the cell. Because silicon is a semi-conductor, it can

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act like an. insulator, maintaining this imbalance. As the photons smash the electrons off the silicon atoms, this field drives them along in an orderly manner, providing the electric current. That current is stored into the batteries through charge controller.

A charge controller, charge regulator or battery regulator limits the rate at which electric current is added to or drawn from electric batteries. It prevents overcharging and may protect against overvoltage, which can reduce battery performance or lifespan, and may pose a safety risk. It may also prevent completely draining ("deep discharging") a battery, or perform controlled discharges, depending on the battery technology, to protect battery life. The terms "charge controller" or "charge regulator" may refer to either a stand-alone device, or to control circuitry integrated within a battery pack, battery-powered device, or battery recharger.A series charge controller or series regulator disables further current flow into batteries when they are full. A shunt charge controller or shunt regulator diverts excess electricity to an auxiliary or "shunt" load, such as an electric water heater, when batteries are full.Simple charge controllers stop charging a battery when they exceed a set high voltage level, and re-enable charging when battery voltage drops back below that level. Pulse width modulation (PWM) and maximum power point tracker (MPPT) technologies are more electronically sophisticated, adjusting charging rates depending on the battery's level, to allow charging closer to its maximum capacity. A charge controller with MPPT capability frees the system designer from closely matching available PV voltage to battery voltage. Considerable efficiency gains can be achieved, particularly when the PV array is located at some distance from the battery. By way of example, a 150 volt PV array connected to an MPPT charge controller can be used to charge a 24 or 48 volt battery. Higher array voltage means lower array current, so the savings in wiring costs can more than pay for the controller. Charge controllers may also monitor battery temperature to prevent overheating. Some charge controller systems also display data, transmit data to remote displays, and data logging to track electric flow over time.

III. MANUFACTURING PROCESS OF SOLAR CELLS

1) Purifying the silicon

- 1 The silicon dioxide of either quartzite gravel or crushed quartz is placed into an electric arc furnace. A carbon arc is then applied to release the oxygen. The products are carbon dioxide and molten silicon. This simple process yields silicon with one percent impurity, useful in many industries but not the solar cell industry.
- 2 The 99 percent pure silicon is purified even further using the floating zone technique. A rod of impure silicon is passed through a heated zone several times in the same direction. This procedure "drags" the impurities toward one end with each pass. At a specific point, the silicon is deemed pure, and the impure end is removed.

2) Making single crystal silicon

- 3 Solar cells are made from silicon boules, polycrystalline structures that have the atomic structure of a single crystal. The most commonly used process for creating the boule is called the Czochralski method. In this process, a seed crystal of silicon is dipped into melted polycrystalline silicon. As the seed crystal is withdrawn and rotated, a cylindrical ingot or "boule" of silicon is formed. The ingot withdrawn is unusually pure, because

3) Making silicon wafers

- 4 From the boule, silicon wafers are sliced one at a time using a circular saw whose inner diameter cuts into the rod, or many at once with a multiwire saw. (A diamond saw produces cuts that are as wide as the wafer 5 millimeter thick.) Only about one-half of the silicon is lost from the boule to the finished circular wafer—more if the wafer is then cut to be rectangular or hexagonal. Rectangular or hexagonal wafers are sometimes used in solar cells because they can be fitted together perfectly, thereby utilizing all available space on the front surface of the solar cell. After the initial purification, the silicon is further refined in a floating zone process. In this process, a silicon rod is passed through a heated zone several times, which serves to 'drag" the impurities toward one end of the rod. The impure end can then be removed. Next, a silicon seed crystal is put into a Czochralski growth apparatus, where it is dipped into melted polycrystalline silicon. The seed crystal rotates as it is withdrawn, forming a cylindrical ingot of very pure silicon. Wafers are then sliced out of the ingot.
- 5 The wafers are then polished to remove saw marks. (It has recently been found that rougher cells absorb light more effectively, therefore some manufacturers have chosen not to polish the wafer.)

4) Doping

- 6 The traditional way of doping (adding impurities to) silicon wafers with boron and phosphorous is to introduce a small amount of boron during the Czochralski process in step #3 above. The wafers are then sealed back to back and placed in a furnace to be heated to slightly below the melting point of silicon (2,570 degrees Fahrenheit or 1,410 degrees Celsius) in the presence of phosphorous gas. The phosphorous atoms "burrow" into the silicon, which is more porous because it is close to becoming a liquid. The temperature and time given to the process is carefully controlled to ensure a uniform junction of proper depth.

A more recent way of doping silicon with phosphorous is to use a small particle accelerator to shoot phosphorous ions into the ingot. By controlling the speed of the ions, it is possible to control their penetrating depth. This new process, however, has generally not been accepted by commercial manufacturers.

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5) Placing electrical contacts

- 7 Electrical contacts connect each solar cell to another and to the receiver of produced current. The contacts must be very thin (at least in the front) so as not to block sunlight to the cell. Metals such as palladium/silver, nickel, or copper are vacuum-evaporated.
- This illustration shows the makeup of a typical solar cell. The cells are encapsulated in ethylene vinyl acetate and placed in a metal frame that has a mylar back sheet and glass cover. through a photoresist, silkscreened, or merely deposited on the exposed portion of cells that have been partially covered with wax. All three methods involve a system in which the part of the cell on which a contact is not desired is protected, while the rest of the cell is exposed to the metal.
- 8 After the contacts are in place, thin strips ("fingers") are placed between cells. The most commonly used strips are tin-coated copper.

6) The anti-reflective coating

- 9 Because pure silicon is shiny, it can reflect up to 35 percent of the sunlight. To reduce the amount of sunlight lost, an anti-reflective coating is put on the silicon wafer. The most commonly used coatings are titanium dioxide and silicon oxide, though others are used. The material used for coating is either heated until its molecules boil off and travel to the silicon and condense, or the material undergoes sputtering. In this process, a high voltage knocks molecules off the material and deposits them onto the silicon at the opposite electrode. Yet another method is to allow the silicon itself to react with oxygen- or nitrogen-containing gases to form silicon dioxide or silicon nitride. Commercial solar cell manufacturers use silicon nitride.

7) Encapsulating the cell

- 10 The finished solar cells are then encapsulated; that is, sealed into silicon rubber or ethylene vinyl acetate. The encapsulated solar cells are then placed into an aluminium frame that has a mylar or tedlar back sheet and a glass or plastic cover. If one looks at the photograph on the left one can see why the other term for Active Carbon is Active Charcoal. The term "Active" is used to describe carbon's absorbing ability. If the pores become blocked the carbon is no longer active.

If one looks at the Scanning Electron Microscope picture on the right, the internal surface area of active carbon is generally greater than 400 square meters. It is on this large available surface area that pollutants like Chlorine, pesticides etc. adhere to the carbon. The longer the contact time between water and Carbon, the better the removal of water contaminants. One of the draw backs of Active Carbon is it often becomes a breeding colony for various **bacteria** over time. One should ensure that there is post-sterilization, of drinking water if bacteria is a problem in water supply. Some people claim that impregnating the Active Carbon with Silver prevents Bacteria from passing through the filter. This claim is based on Silver's anti-bacterial properties.

IV. UV STERILIZATION

UV Sterilization works on the principle that DNA and Proteins absorb UV radiation (typically around 254 nm), this causes the bacterial DNA to denature and renders them inactive.

Fig.2. UV unit

UV supplies a relatively cheap source of Microbial contamination in water, Care must be taken with water that fouls Quartz Sleeve, with deposits, this prevents UV radiation from reaching water. Regular checking of Quartz sleeve and UV lamp is recommended. Where high levels of Iron and Manganese are present in water, longer exposure to UV is suggested. UV filters/sterilizers for drinking water should have a minimum radiation dose of 30mJ/cm^2 at the furthermost point from lamp to ensure bacterial Inactivation. Secondly ensure lamp has quartz sleeve, if UV lamp is in direct contact with water, and for some reason had to break, not only would you be exposed to broken glass, but also to Mercury which is typically present in UV discharge lamps. SMI is one of many Labs worldwide that are researching various Nano-Sized Catalytic Inner coatings to enhance the effect of UV filtration, by the creation of Hydroxyl Radicals, on the Housings inner-surface. Hydroxyl radicals are more re-active than chlorine, and there breakdown products are water and carbon dioxide, both of which are harmless. Pesticides and other organic hazardous chemicals are broken down by Hydroxyl radicals.

V. REVERSED OSMOSIS PROCESS TO PURIFY WATER

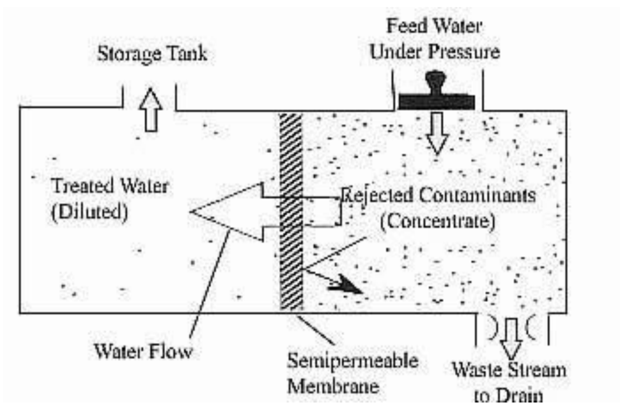

Fig4. RO Filtration

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Reverse Osmosis is typically the most effective of your household units if used as a multi-filtration system combining particle filtration and Active Carbon. If your problems are with dissolved elemental salts in water, RO is the pre preferred option.RO units are not normally required with municipal water systems, as bacterial contamination is most often the problem worldwide, and although RO units will "reject" bacteria, because of small pore size of membranes, tears and faults as well as manufacturing defects can allow some contaminants to pass through. No RO unit will provide "pure" water on a typical municipal water supply. This indicates that some "contamination" does indeed pass through membranes. And final water polishing stages would be required to ensure "pure" water. Points to consider that costly membrane can get easily clogged beneficial minerals as well as "possible" water contaminants are removed. RO units are normally only for one drinking tap and do not cover household water. RO unit waste a lot of water have a look at flow to drain from RO unit. Membrane blocking causing diminished flow into storage tank Bacteria on membrane.

VI. ION EXCHANGE RESINS

These are either mixed bed or consist of separate anion and cation columns. Usually after RO unit or other water filter to polish water to a fairly pure quality. Some separate column units can be re-generated hundreds of times with an acid and alkaline wash. They don't produce waste water, but will need regeneration regularly if water contains high total dissolved salts (TDS). Ceramic water filters if correctly manufactured, have a pore size 0.22 nm or smaller. This prevents bacteria from passing through filter. Some can be cleaned and might provide the cheapest answer for bacterial free water. However if feed water has suspended particles present they tend to clog up leading to a diminished water flow. The typical gravity fed system supplies only a few liters per day. They are often combined with Active Carbon in Filter to provide a improved water filtration system.

VII. CONCLUSION

Finally as we used solar energy overall cost of the operation decreases, as solar energy is renewable energy no depleting problems in nature. These devices can also be used at the remote places where there is no electric power supply. Other purifier systems for small household purpose there is no cooling system for purified water due to cost limit. But we made this happen by making it with low cost and natural cooling with required temperature for drinking water. In this there is no problem of load shedding and supply problem as we are using solar energy harvest over the roof top of home.

Usually during summer season there are more load shedding problems. At that time i.e. summer season temperature of water leads to production of microorganisms which causes diseases. So we need to purify water before we used to drink. But as electric power makes problem to run purifies by load shedding problem. This thing made us to implement solar energy to purifier system.

As we know generation of electricity by hydraulic energy and thermal energy (by using coal or nuclear fission material) is pretty quite more costlier and high maintenance required with skilled operators. Also like in nuclear reactors, it is highly hazardous to environment and living beings if any leakage problems occur in plant and in coal utilizing plants, smoke coming out of plant is also hazardous to living beings health and also causes global warming. By considering all above things, solar energy utilization is pretty good to harvest as it has no side effects on health and environment. No emissions. No transportation cost, less maintenance and eco-friendly nature it is more favor than other systems. The main purposes to use this system are as follows

- Ultimately it reduces the cost of operation by using solar energy as source.
- In cloudy season and rainy season, we make use of storage battery.
- It directly and indirectly reduces human health problems as no emissions.
- It can also be used for multiple operations like to charge mobiles and glowing the low voltage bulbs (CFL Bulbs) and to run FM Radio too.

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