SOLAR POWER WATER DISTILLATION UNIT

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Abstract — Clean drinking water is the basic necessity for every human being, but about 1.1 billion people in the world lacked proper drinking water. There are many different types of water purification processes such as filtration, reverse osmosis, ultraviolet radiation, carbon absorption, but the most reliable processes are distillation and boiling. Water purification, such as distillation, is especially important in regions where water resources or tap water is not suitable for ingesting without boiling or chemical treatment. In design project It treats the water by combining different methods such as Filtration, Distillation and a technique called concentrated solar power (CSP). Distillation is literally the method seen in nature, whereby: the sun heats the water on the earth's surface, the water is turned into a vapor (evaporation) and rises, leaving contaminants behind, to form clouds. As the upper atmosphere drops in temperature the vapors cool and convert back to water to form water. In this project distillation is achieved by using a parabolic mirror which boils water at high temperature. Filtration is done by sand filter and carbon filter. First sand filter catches the sand particles and the carbon filter which has granules of active carbon is used to remove odor dissolved gases from water. This is the Pre-treatment of water. The filtered water is then collected in a water container at a focus of parabolic mirror where distillation process is done. Another important feature of the designed project is the solar tracking of a parabolic mirror which increases the efficiency of a parabolic mirror [1],[2].

Index Terms— Water purification processes, Filtration, Reverse osmosis, Ultraviolet radiation, Carbon absorption, Distillation and concentrated solar power (CSP).

I. INTRODUCTION

The atmosphere of the earth absorbs some of the energy and the more air the sun’s rays have to travel through to get to the earth’s surface, the weaker they become. We can harness the sun’s energy to distil water. If there is a full sun, we can safely assume about 100 watts of solar rays per square foot. The key is developing technologies that efficiently convert solar power into usable energy in a cost-effective manner. One way to achieve this is by making a parabolic mirror. The purpose of the parabolic mirror is to collect the sun’s energy over as wide an area as possible and focus it onto a smaller area. [2]. Solar powered water purification unit uses the process of distillation to purify the tap as well as contaminated water. Heat by the parabolic mirror at the focus evaporates the water and thus various salts and microorganism will remain left. Then the steam is passes through the condenser which converts the steam into water which is actually called the distilled water. The parabolic mirror is based on a motor which follows the rotation of a sun. The mirror rotation/movement is controlled by a sun tracker circuit. Which follows the sun movement from East to west and slightly north to South because there is a slightly variation in the direction of sun from North to South [4].

A portable distillation unit which can be setup anywhere in remote areas. Solar tracking System’s unit which is cost effective. Reduces demand for fuel or firewood. All the material can be obtained from local market. Its main application is in remote areas where pure water is not
available for drinking. It is used in various industries and chemical and biological laboratories where highly purified water is essential [1].

II. DESIGN METHODOLOGY

A. Purpose of Designing
The water treatment system which is cost effective and consume less energy to purify water, keeping this in mind we decide to utilize solar energy for treatment system. We use solar panel to fulfill the power requirements for the circuits and gear motors. It is a common observation that sun position changes throughout the day for this purpose solar tracker circuit designed which follows the direction of the sun and utilize the solar energy as maximum as possible. Figure 1.1 shown the complete flow of the design project.

![Figure 1.1 System flow chart](image)

B. Material used
In project we used different materials for achieving our desire goals. Which consisted of gear motors which provide torque and low RPM? One gear motor is used for east-west movement and other is use for north-south movement. The project structure made up of iron which provides strength to the structure. Backup Battery is also used which provides power requirement for the solar tracker circuit. Concave mirrors used which reflect inward to one focal point, therefore they are used to concentrate sun rays on a focus point and raise the temperature above 600ºC. Condenser is used which allow the steam to convert into purified water.

C. Techniques
In this project we use two major techniques one is concentrated solar power (CSP) and other is solar tracking. Concentrated Solar Power (CSP) is a technology which produces high temperature by concentrating solar energy in a single focal point. This concentrated energy is then used to heat up water or other fluids to produce steam. The focusing of the sun rays can be achieved through different designs such as parabolic trough, parabolic dish. Concave mirror or power tower systems. The steam produces by CSP can be used to drive turbine to produce electricity for desalination plants or it can be directly converted in purified water by passing it through the condenser [5]. Simple and non-polluting CSP technology can be deployed relatively quickly anywhere and can contribute substantially to reducing carbon dioxide emissions. The desert areas with frequent sunshine are ideal places for the deployment of CSP technology. [6].

The basic lay out of solar tracking system is shown in figure 1.2.

![Figure 1.2.Solar Tracking](image)
D. Project phase.

In 1st designing phase we made a sand filter by using a PVC pipe of 4 inches diameter and 3 feet in length. In sand filter phase we bought a concave mirror from scrap market which was in two pieces so we join these two pieces to make a single concave mirror of 2 feet’s by using fiber cloth and resin. In last phase we design mechanical structure of a project and modifying the structure from time to time. On the other hand we were also designing the circuit for solar tracking.

III. HARDWARE DESCRIPTION.

A. Charge Controller Circuit.

Charge controller is design to control how much ampere is flowing towards the battery. It is also to prevent overvoltage. Figure 1.3 is shown the complete schematic of charge controller circuit.

A. Solar Tracker Circuit & its description.

It is a circuit which synchronizes the movement of concave mirror and solar panel with the sun. The circuit uses LDR (Light dependent resistance) as a light sensor. One pair of LDR control NORTH-SOUTH movement and other pair control the EAST-WEST movement. Figure 1.4 is shown the complete schematic circuit of solar tracker. With the photocells mounted on the solar collector and in bright sunlight and correctly aimed at the sun each photocell should produce about 3000 ohms of resistance. This value can be obtained by placing different pieces of translucent plastic over the cells; this is not a critical value. The plastic will also protect the cells from the weather. With both photocells seeing the same amount of light trim pot VR1 is adjusted to drive the output of voltage comparator IC1 a low this is indicated by
LED 2 turning off. As long as both cells see the same amount of light the circuit will not respond, even if a cloud has the nerve to pass between your solar collector and the sun.

Now as the sun moves and the vertical barrier causes a shadow to be cast on the west photocell IC1a senses this change and its output will go high, turning on LED 2, and begins the slow charging of C3 through R5. After C3 has charged to the value determined by voltage divider R6 & R7, IC1b’s output goes high this turns on transistor Q1 that in turn energizes relay RL1 causing the drive motor to start. The motor then runs turning the collector until the west cell again sees the full light of the sun, this returns the circuit to its initial state and the motor stops. The circuit then waits for the sun to move again and the whole process repeats.

The purpose of the time delay provided by R5, C3 & D1 (D1 is used to discharge C3 at end of cycle).

So now at the end of the day after the sun has been turned off, the west photocell has one more duty to perform. It sends a voltage to IC1c and when compared with the voltage set by trim pot VR2 its output will go high turning on LED 1 and to transistor Q2 that energizes relay RL2 causing the motor to run in reverse, driving the collector back to the east for the start of the next day. Also the output of IC1c goes to IC1d, this turns on the output of IC1d that in turn prevents the possibility of transistor Q1 from being turned on. This then keeps relay RL1 from being energized and prevents lots of smoke and fire that would occur if both relays were allowed to be energized at the same time. Finally there are two switches SW1 & 2. These are limit switches mounted on the collector to control the maximum amount of rotation in the east and west directions.

Figure 1.4. Solar tracking circuit
Conclusion

We observe that concave mirror/reflectors use in our project rise the temperature up to 600 – 800 c. which is enough to convert the water into steam and increase the speed of the process. The water obtain from this system is highly purified whose conductivity is in micro Siemens which has many applications in biomedical sciences. The important features are the solar tracking which is a key factor in increasing the efficiency of a system throughout the day. This system is highly cost effective results are obtained at minimum cost, no fuel/line electric supply (220VAC). The only power source is solar. Power requirement is fulfilled by solar panel and battery. Solar panel charging the battery via charge control circuit. This project can be easily installed at any remote area where purified water is not available easily.

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