

SOLAR STILL WATER DISTILLATION FRESNEL LENS, SOLAR TRACKER AND PCM

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ABSTRACT

Solar energy is one of the cheapest and easily available source of energy and we can use it in so many ways. One of the application is water purification.

The motivation for this project is the limited availability of clean water resources and the abundance of impure water available for potential conversion into potable water, in addition, there are many coastal locations where seawater is abundant but potable water is not available. Our project goal is to efficiently produce clean drinkable water from solar energy conversion.

Our project goal is to efficiently produce clean drinkable water from solar energy conversion. Increasing shortage in fossil fuel supply and the growing need for fresh water have motivated further development of water distillation and purification by renewable energies. The use of solar thermal energy will cured the problem of getting fresh water in rural area. The simplest and direct applications of energy are the convergence of solar radiation into heat.

Many type of solar stills are designed. Here in this project we designed a single basin single slope solar still. With Fresnel lens for concentrating sun light in to the solar still. Then we track sun light for this a solar tracker is used. Then we added a paraffin wax as a thermal energy storage material. Using latent heat storage materials which is paraffin wax can helps to store the solar energy during its availability and repack during off sunshine hours. A temperature measure device also used.

Solar distillation is a simple technology and non requirement of highly skilled labour for maintenance and low energy consumption.

Keywords: solar still, Fresnel lens, solar tracker, paraffin wax.

1.INTRODUCTION

The availability of fresh water resources and their quality is essential for developing countries. Simple technological innovations can improve the availability therefore contribute to a rapid enhancement of the rural areas. Fresh water resources are rivers, lakes and underground water reservoirs. About 71% of the planet is covered in water, yet of all of that 96.5% of the planet's water is found in oceans, 1.7% in groundwater, 1.7% in glaciers and the ice caps and 0.001% in the air as vapor and clouds, Only 2.5% of the Earth's water is freshwater and 98.8% of that water is in ice and groundwater. Less than 1% of all freshwater is in rivers, lakes and the atmosphere. According to the World Health Organization (WHO) 20 liters of water per capita per day are the minimum requirements to assure the basic needs.

The use of solar thermal energy will cured the problem of getting fresh water. The simplest and direct applications of energy are the convergence of solar radiation into heat. A problem in a solar energy is the availability is only during day time, during off sunset hours there was a lack, then to overcome the problem the use of thermal energy storage balance the demerit by storing the solar energy during sunshine hours and release it in sunset hours. Using latent heat storage materials which is paraffin wax can helps to store the solar energy

during its availability and repack during off sunshine hours. Solar water distillation is a simple and effective technology used to provide Potable water in remote areas of developing countries. The solar stills can improve both the availability and quality of water also minimizes the evaporation losses. The collected water from solar still has been purified during the process and can be used as drinking water.

2.LITERATURE SURVEY

The water is one of the natural resource and very much needed for sustaining life on the earth. But in the present era due to the various anthropogenic pressure the availability of the safe water for the is decreasing dramatically. Pathak et. al. (2014) given the brief about the total water available, utilized for various purposes, cause of pollution in water, how a water efficiency can be increased and effect of climate change on water in India. This decrease in water availability is very much dependent on its utilization. Therefore can be vary region to region. The different anthropogenic deeds needs different amount of water such as industries pharmaceutical's, sugar, distillery, paper, mining, manufacturing of different modern equipment and gadgets along with the daily human needs such drinking, cooking, irrigation and sanitation. Therefore, in the present era there is a huge pressure of the natural water and various techniques are used for purification/decontamination of the water for enhancement of the reusability of the polluted water. The effluent treatment plant is one of the method used by the industries to decrease the pollution load from the discharged water but the reused efficiency is very much low due to its high impurity.

Szulmayer and Nelson both presented and investigated a solar concentrator based on linear Fresnel lens, which could reach temperatures between 60 and 143 0C for water heating, steam production, desiccants (silica gel) regeneration, as well as thermoelectric power generation (Szulmayer et. al.1973,1980). A 0.457 m diameter Fresnel lens focused sunlight onto the hot end of a 0.0254 m diameter reticulated vitreous carbon prime mover stack, heating it to 475 0C, (Adeff et. al. 2000).

3.NEEDS OF SOLAR STILL

Solar distillation is a cost effective means of providing clean water for direct and indirect human consumption.

- It is improving health standards by removing impurities from water supplies.
- It shall help complement the existing fresh water in locations where the quality/quality of supply is deteriorating.
- Where sea water is available, it can reduce the dependence on rain fall.
- Solar stills, operating on sea or brackish water, shall ensure supplies of water during atime of drought

4.SOLAR ENERGY

The sun radiates the energy uniformly in all direction in the form of electromagnetic waves. When absorbed by body, it increases its temperature. It is a clean, inexhaustible, abundantly and universally available renewable energy. Solar energy has the greatest potential of all the sources of renewable energy and if only a small amount of this form of energy could be used, it will be one of the most important supplies of energy, especially when other sources in the country have depleted. This solution is solar water distillation. It is not a new process, but it has not received the attention that it deserves. Perhaps this is because it is such a low-tech and flexible solution to water problems. Nearly anyone is capable of building a still and providing themselves with completely pure water from very questionable sources. 3.8×10^{24} joules of solar radiation is absorbed by earth and atmosphere per year. Solar power where sun hits atmosphere is 1017 watts and the total demand is 1013 watts. Therefore, the sun gives us 1000 times more power than we need. If we can use 5% of this energy, it will be 50 times what the world will require. The energy radiated by the sun on a bright sunny day is 4 to 7 KWh per m.

5.METHODOLOGY

The design methodology of the project involves designing an asymmetrical solar still as per the output requirements. An asymmetrical design is chosen as it has higher output efficiency . The solar still is designed for an estimated output of around 3 to 5 liters, which is the average requirement for our application. In addition to it, an Fresnel lens and paraffin wax has been fabricated to increase the output efficiency.

6. BASIC REQUIREMENTS OF SOLAR STILL

- Be easily assembled in the field.
- Be constructed with locally available materials.
- Be light weight for ease of handling and transportation.
- Have an effective life of 10 to 20 years.
- No requirement of any external power source.
- Can also serve as a rainfall catchment surface.

7. COMPONENTS OF SOLAR STILL

1. Base

It is the part of the system in which the impure water for purification is stored. It is necessary that the material has high absorptivity or very less reflectivity and completely opaque. Therefore, The mild steel sheet is properly marked with the required dimensions then by using power shear machine & hand shear the sheet is cut into the appropriate shape, three holes are made on the sheet of half inch each for water supply & water collection, holes are made by using the drilling machine, then the sheet is folded at the required markings by using the folding machine. Solar radiation transmitted through transparent cover is absorbed by the black coating of the basin. Black bodies are generally good absorbers. Matte black paint is used as liner in this project. A wooden casing is used to enclose the basin and the transparent glass cover is mounted in the wooden casing. It also acts as a good insulation material and it ensures the whole setup is air-tight.



Fig-1: Solar Still Base

2. Glazing

Transparent glass of 4mm thickness is selected as glazing material and the glazing is set inclined to 11° based on the geographical location of the test centre i.e., Aluva ($11^\circ 1'N$ $76^\circ 58'E$). The use of glass is because of its inherent property of producing greenhouse effect inside the still. Glass transmits over 90% of incident radiation in the visible range.

3. Condensate channel

The condensed water in the glazing trickles to the condensate channel. Pipe of required dimension is first cut out to one fourth of its diameter, and then it is placed inside the still in a such a manner that the inclination is 3° . The inclination is kept for the quick flow of condensed water into the collecting jar.

4. Fresnel Lens

A **Fresnel lens** is a type of composite compact lens originally developed by French physicist Augustin-Jean Fresnel (1788–1827) for lighthouses. It has been called "the invention that saved a million ships."

The design allows the construction of lenses of large aperture and short focal length without the mass and volume of material that would be required by a lens of conventional design. A Fresnel lens can be made much thinner than a comparable conventional lens, in some cases taking the form of a flat sheet. A Fresnel lens

can capture more oblique light from a light source, thus allowing the light from a lighthouse equipped with one to be visible over greater distances.

Fresnel lens is a succession of concentric rings ,each consisting of an elements of a simple lens ,assembled in proper relationship on a flat surface to provide a short focal length.The Fresnel lens is used particularly in lights to concentrate the light into a relatively narrow beam.The basic idea behind a Fresnel lens is simple. Imagine taking a plastic magnifying glass lens and slicing it into a hundred concentric rings.Each ring is slightly thinner than the next and focuses the light towards the centre.

5. Solar Tracker

The aim of this project is to utilize the maximum solar energy through solar Fresnel lens Concentrating solar thermal devices using solar tracking mechanism. For this an automatic sun tracking system is proposed. This project will help the solar power generating equipment/concentrating solar thermal devices to get the maximum sunlight automatically thereby increasing the efficiency of the system. The solar Fresnel lens, tracks the sun from east to west automatically for maximum intensity of light, making the system hassle free.

Sun tracking, simply put, is the process whereby the solar radiation of the sun is sensed and being followed from sunrise to sunset. This can be achieved in two ways; manually and by means of an automated device. The Sun moves relative to the Earth’s surface at the rate of 15° per hour east to west and by approximately 46° per annum north to south.

A Sun Tracking mechanism is a device incorporated into a solar still which follows the movement of the sun across the sky with the aim of ensuring that maximum solar irradiance is transmitted through the glass cover of the still into the basin and is absorbed by the brine from sunrise to sunset, throughout the day.

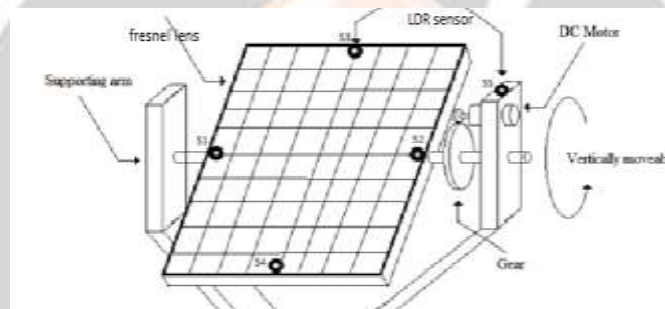


Fig-2:Solar Tracker

Rack and pinion gears, a slowly spinning gear wheel (the dc motor pinion) meshes with a flat ridged bar (the rack). If the rack is fixed in place, the gear wheel is forced to move along it (as in a railroad). If the gear is fixed, the pinion shifts instead. That's what happens in car steering: we turn the steering wheel (connected to a pinion) and it makes a rack shift from side to side to swivel the car's front wheels to the left or the right. In simple weighing scales, when you load a weight on the pan at the top, it pushes a rack straight downward, causing a pinion to rotate.

LDR Structure and Working The basic structure of an LDR is shown below.

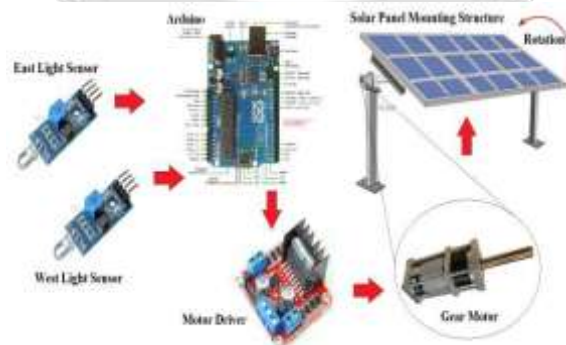


Fig-3: Arduino Solar Tracker unit

6.Paraffin Wax

A phase change material (PCM) is a substance with a high heat of fusion which, melting and solidifying at a certain temperature, is capable of storing and releasing large amounts of energy. Heat is absorbed or released when the material changes from solid to liquid and vice versa; thus, PCMs are classified as latent heat storage (LHS) units. The phase change material should possess melting temperature in the desired operating temperature range. High latent heat of fusion per unit volume. Non-corrosiveness, non-toxic, non-flammable and non-explosive materials. Low cost and Large-scale availabilities.

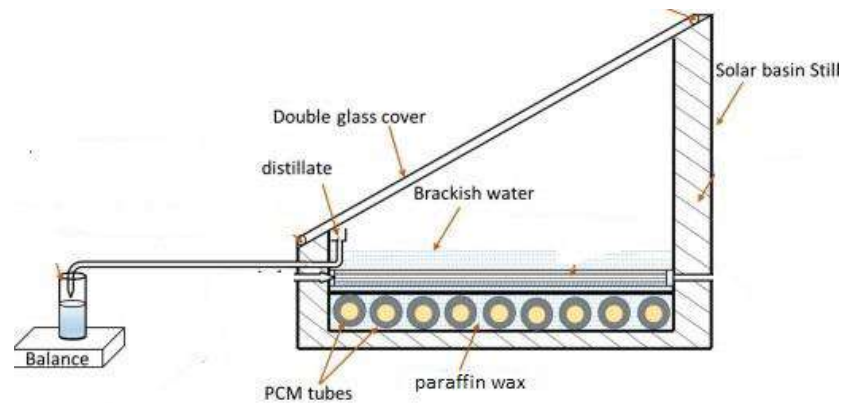


Fig-4: solar still with PCM

In this project 3kl paraffin wax is used .for that an aluminum pipe placed inside the still base. And the paraffin wax is filled. when temperature risee the phase changer material paraffin wax is absorb heat energy. And it liquifies, then the pcm is liquid state inside the aluminum pipe. then the temperature false the stored heat is released. This is the working of paraffin wax in solar still.

8.SOLAR STILL OPERATION

The solar distillation consists mild steel frame, paraffin wax and Fresnel lens,Tracking system. When the solar still is placed outside where the sun rays falls on the Fresnel. The Fresnel is adjusted along an axis to focus the sun light rays on the glass which the object to be heated is placed on the mild steel frame. At below of the frame, the paraffin wax is stored on the square tube separately, which the square tube containing wax is placed just below the object. The paraffin wax absorbs the rays from the sun and melts with the boiling point of 80 degree Celsius. With this process the desalination process is carried out and another advantage of this is, after the absence of sun light process can be carried out with the remaining heat present in the paraffin wax.

Fresnel lens is combined with the heating tank, so as to concentrate more amount of solar radiation onto the glass cover. The bottom of the tank is coated black to absorb maximum energy. During the day time, solar radiation is trapped inside the tank by greenhouse effect and is utilized for heating process. All measurements were taken during the period of 9:00 AM to 4:00 PM. Maximum efficiency test is carried out to estimate the optimum load to give the maximum distillation yield. Fresnel lens offers a simpler and cheaper method for concentrating solar energy that can be used for pre-heating water. The experimental observations of the behavior of Fresnel lens concentrator alone as pre-heating device can improve the performance of distillation system.

Solar tracker is used for tracking the sun light when movement of sun east to west. that is improve the concentration of solar energy.the LDR sensors are helping to detect the sun light.the sensors are convert the signals to the servo motor then the servo motor is roated for the required direction.The paraffin wax are used as a phase changer material.this system act as a themal storage devise.

9.RESULT

The solar still was designed and fabricated and the test results were presented. The maximum temperatures of water and glass are around times of higher maximum solar intensity. It can also be observed that when a Fresnel lens was used, both the water temperature and glass temperature are much higher when compared to ordinary solar still. The maximum T_w and T_g observed with Fresnel lens case, they are 87.6 °c and 79.4 °c, respectively. The total productivity in the case of Fresnel lens is around 6.38 times higher than the productivity achieved in case of ordinary solar still. The total productivity of still with phase change material is

slightly higher than the still without phase change material. Preliminary tests on the distilled water proved that the distilled water is suitable for domestic usages.

10.CONCLUSION

A strong multidiscipline team with a good engineering base is necessary for the Development and refinement of advanced computer programming, editing techniques, diagnostic Software, algorithms for the dynamic exchange of informational different levels of hierarchy.

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. We are proud that we have completed the work with the limited time successfully. The “SOLAR STILL WATER DISTILLATION FRESNEL LENS SOLAR TRACKER AND PCM” is working with satisfactory conditions. We are able to understand the difficulties in maintaining the tolerances and also quality.

We have done to our ability and skill making maximum use of available facilities. In conclusion remarks of our project work. Thus we have developed a “SOLAR STILL WATER DISTILLATION FRESNEL LENS SOLAR TRACKER AND PCM” By using more techniques, they can be modified and developed according to the applications. In the experimental study the pH value of distilled water is in the range of $5 \leq \text{pH} \leq 6$.

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