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Solar Distillation Using Nano-Material

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Abstract— ***Fresh water is the basic necessity for sustenance of life and most valuable renewable resource on earth. Due to water pollution the surface and underground water reservoirs are being highly contaminated. The demand of fresh water is increasing along with growth of human population. To meet this demand of fresh water potable water researchers and scientists developed various technologies. These water purification methods require high energy and high cost.***

For water purification one of the most opted methods is distillation, which has its own drawbacks regarding economic and environmental concerns due to its dependence on conventional sources of energy. Therefore a desalination method is required to use renewable energy at low input cost and lesser efforts for the production of potable water. To overcome the scarcity of fresh water the availability of abundant solar energy is the boon for the application of solar distillation technology.

A distillation method using solar energy can be economical and environment friendly. Solar still is widely used in solar desalination. It has relatively low productivity but competitive to the other desalination methods for production of water due to its relatively low cost, simplicity in design and operation.

By making necessary modifications to improve rate of heat transfer we can fetch maximum output from solar desalination. Many attempts have been made using variety of materials such as usage of Lauric acid, Potassium dichromate, $NaNO_3$ etc and also energy absorbing materials such as charcoal, gravels, sponges to serve as heat absorption mediums.

Various materials are being used to improve the productivity and still research is going on for using better materials. After considering various materials we came up with a novice idea of using Titanium oxide (nano-material) as the heat absorbing material to enhance the rate of heat transfer. Because of extensive thermal properties nano-materials possess, they are worthy enough to be tested for increased desalination productivity and output despite their cost.

Nano-materials have proved their success in various fields such as mathematics, engineering and technology and they also played a crucial role in enhancement of various physical ,chemical properties of materials in these fields.

This work is mainly focused on use of Titanium oxide is a nano-material in solar distillation for improving the productivity and efficiency of solar still.

Keywords—Water distillation, solar energy, ferrous oxide, productivity, efficiency.

I. Introduction

Water crisis is one of the major problem on this earth. As the world population increases continually, water shortage is become more severe in the future. Even though water represents 70% of the earth. In the next decades, increased potable water consumption and fresh water resources depletion will cause a worldwide water scarcity problem. Nearly one third of the world population will suffer from a problem of water scarcity. Rare faction of potable water has become a major concern in many countries and therefore new techniques are required to produce fresh water. To take advantage of natural resources, attention has been focused on desalination of sea water or brackish water/saline water. At the same time, the gradual depletion of non renewable fuels and the related climate change consequences should lead to key changes in energy supply and use of energy.

To overcome from this problem, there are various methods to produce fresh water from sea water, saline water or brackish water. Desalination processes have received great attention as an alternative solution for fresh water production. Desalination is one of the method which is suitable for potable water and lesser cost effective. The demand for reliable and autonomously operating desalination systems is increasing continuously. These systems are meant for a basic need of drinking water and fresh water supply.

Solar distillation seems to be a promising method and alternative way for supplying fresh water. Several solar still design have been proposed and many of them have found significant applications throughout the world. Solar desalination systems have low operating and maintenance costs and require large installation areas and high initial investments. There are two different types of solar still, those are; active solar still and passive solar still. Figure 1 indicates active type solar still; which contains the mechanical components like pump, valve etc. Figure 2 shows the passive type solar still; which don't require any mechanical components. Among active and passive solar stills passive solar still get more attractive comparing with active solar still. Because passive type solar still don't have moving elements, so no need of power consumption and no wear and tear problems. So in this present work focused on passive solar still.

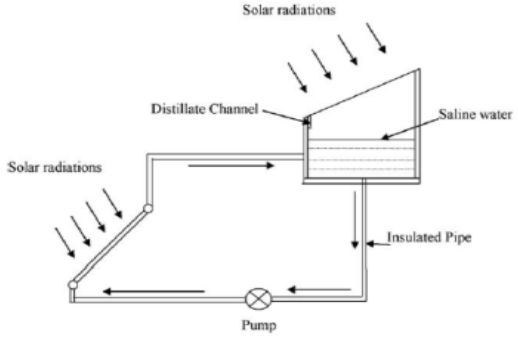

Fig 1: Active type solar still

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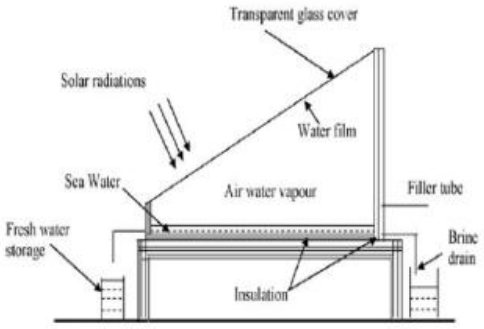

Fig 2: Passive type solar still

II. **Material and Methodology**

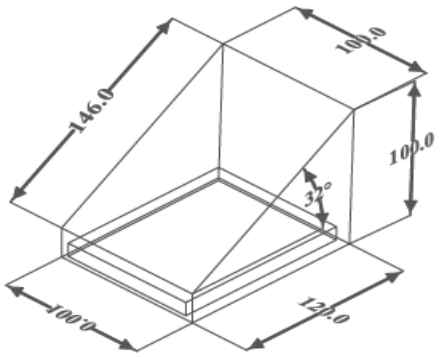

Fig 3: Single slope solar still

Figure 3 presents a schematic diagram of the solar still used in the present experimental study. It consists of a stainless steel basin which has an effective area of $1m^2$. This solar still is made of Stainless steel with all dimensions in cm as shown in figure 3. The stainless steel sheet has a thickness of 0.8mm. It consists of a top cover of transparent glass with a tilt of 32^0 and is coated with
black paint to absorb the maximum possible solar energy. This solar still faces south direction.

The entire assembly is made air tight with the help of rubber gasket and clamps. Water enter in the basin through an inlet valve. To maintain constant water level of 8 cm, a floater is arranged inside the solar still. The distilled water is condensed on the inner surface of glass cover and runs along its lower edge. The distillate water was collected in a bottle and measured by a graduated cylinder. Thermocouples were located at different places of the solar still to measures such as outside glass cover, inside glass cover, basin water temperature, vapour temperature and ambient temperature. In this experiment Titaniun oxide is used as nano material. All experiment work conducted in the month of February in Hyderabad, India.

A basin of solar still has a thin layer of water, a transparent glass cover that covers the basin and channel for collecting the distillate water from solar still. The glass transmits the sun rays through it and saline water in the basin or solar still is heated by solar radiation which passes through the glass cover and absorbed by the bottom of the solar still. In a solar still, the temperature difference between the water and glass cover is the driving force of the pure water yield. It influences the rate of evaporation from the surface of the water within the basin flowing towards condensing cover. Vapour flows upwards from the hot water and condense. This condensate water is collected through a channel.

Measuring Instruments: Pyranometer, Multimeter, Glass beaker, Pt-100 type thermocouples and infrared thermometer. Pyranometer is used to measure the direct solar radiation and diffused radiation. Glass beaker is used to measure the distillate water from the solar still. Pt-100 type thermocouples are used to measure the temperature of water which is in the basin or solar still, inclined glass cover inside and outside temperatures. Infrared thermometer is used for measuring the atmospheric temperature.

Literature Review

Gnanadason et al (2011), was studied of a solar still using nanofluids and they found as using nanofluids in a solar still can increase the productivity of solar still. The effect of adding carbon nanotubes to the water inside a single basin solar still efficiency increases by 50%.

Celeta et al (2011) was studied the erosion and corrosion of metal surfaces using nanofluid flow. They conducted their experiments for TiO_2, Al_2O_3, SiC, ZrO_2 nanoparticles with water as the base fluid where the nanofluids flow in pipes made up of three different materials like aluminum, copper and stainless steel. They concluded that the nanofluids have no effect on the erosion of the stainless steel pipe, while the aluminum pipe has highest erosion and they also found that ZrO_2, TiO_2 nanoparticles lead to highest erosion while SiC nanoparticles is lowest erosion.

III. Results and Tables

Output of a solar distillation depends on the incident solar radiation. Figure 4 represents the variation of solar radiation flux with respect to time. It is observed to increase with time up to 12:00 Noon with maximum flux reaching to 1180 W/m^2 in the presence of Titanium Oxide (nano-material). Thereafter both curves (with and without nano-material) showed a decreasing trend towards evening hours.

Radiation (I) = (154.5* Pyronamometer Reading in mV)-3.2 W/m^2.

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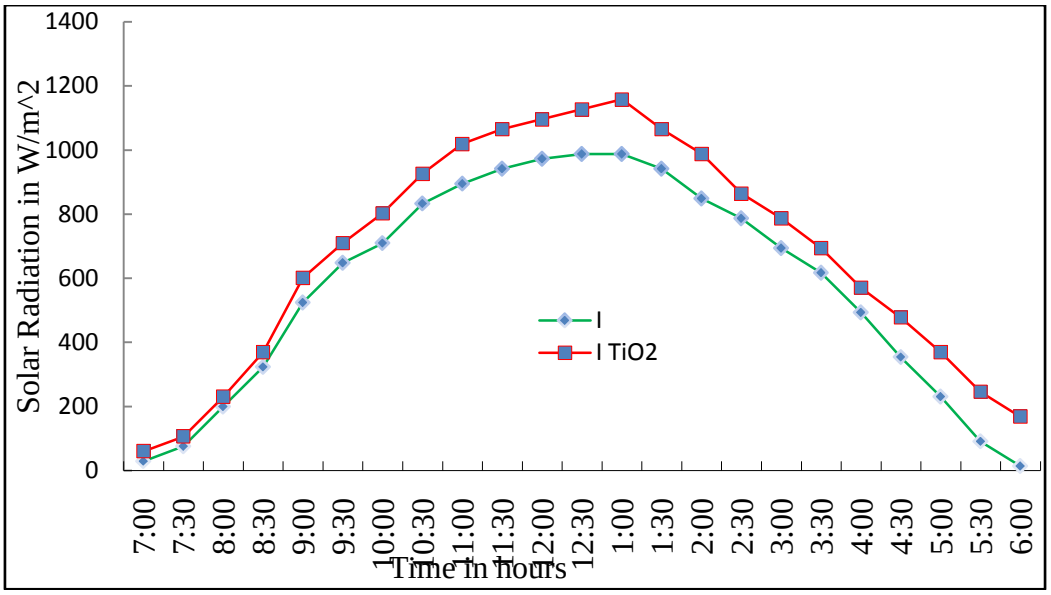

Fig 4: Variation of Solar Radiation with Time

Figure 4 shows the variation of solar radiation along the time in day. It will increasing from morning to afternoon at 1:00 P.M then it is in decreasing order.

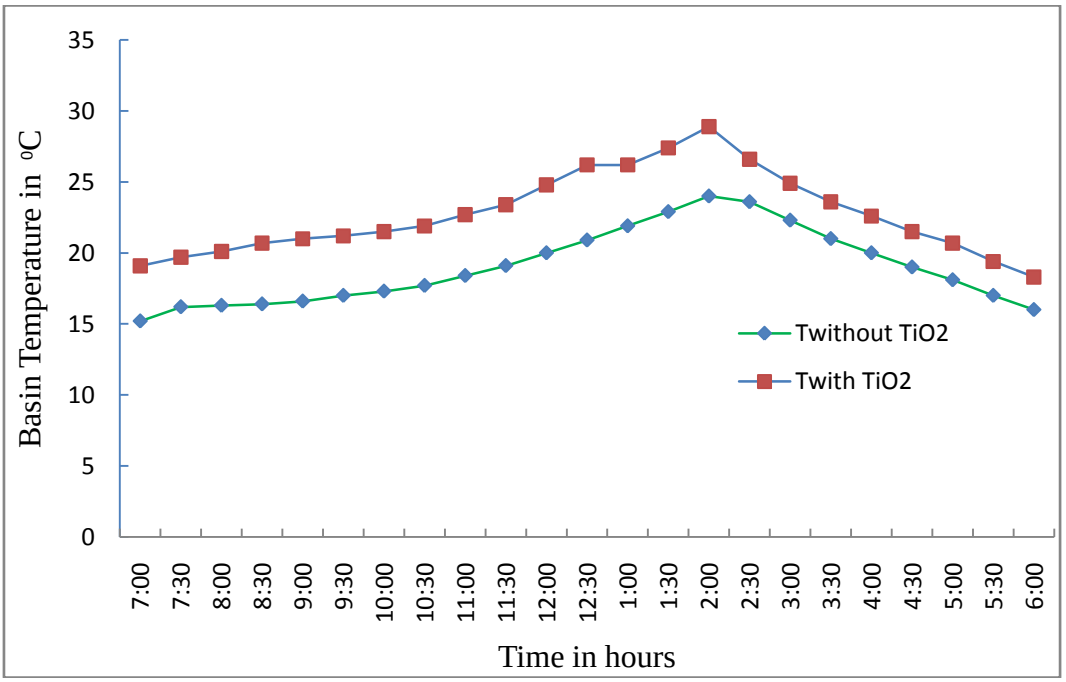

Fig 5: Variation of Basin Temperature with Time

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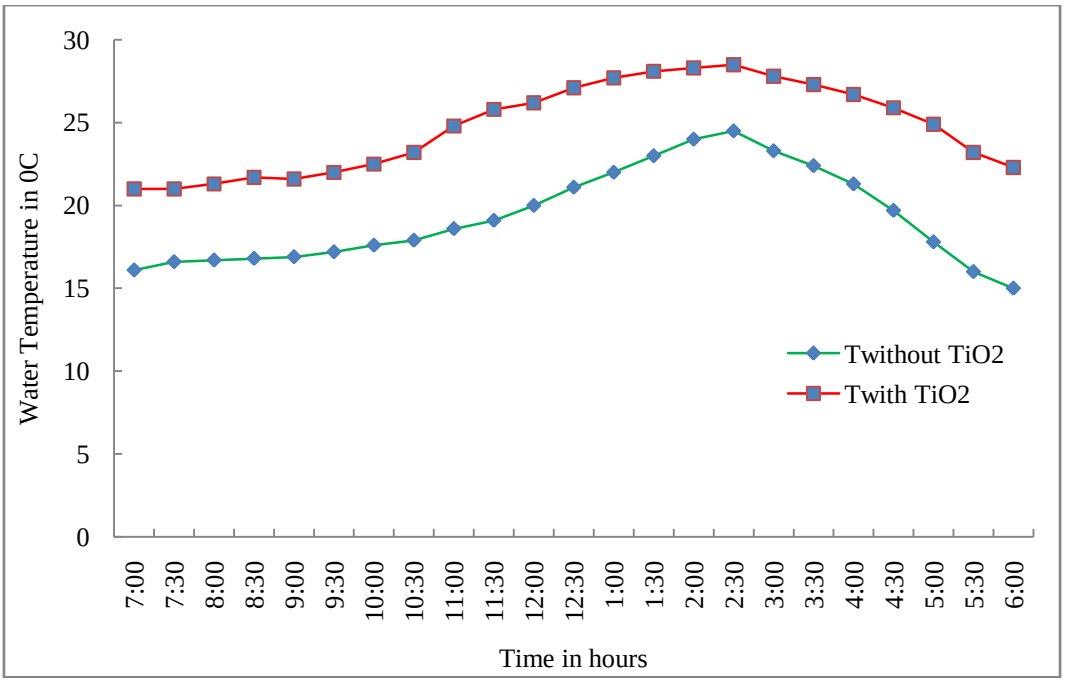

Fig 6: Variation of Water Temperature with Time

Figure 5 and figure 6 indicate the variation of basin temperature and water temperature respectively inside the solar still with respect to time. Both temperatures are observed to increase with maximum temperatures around 30^0C.

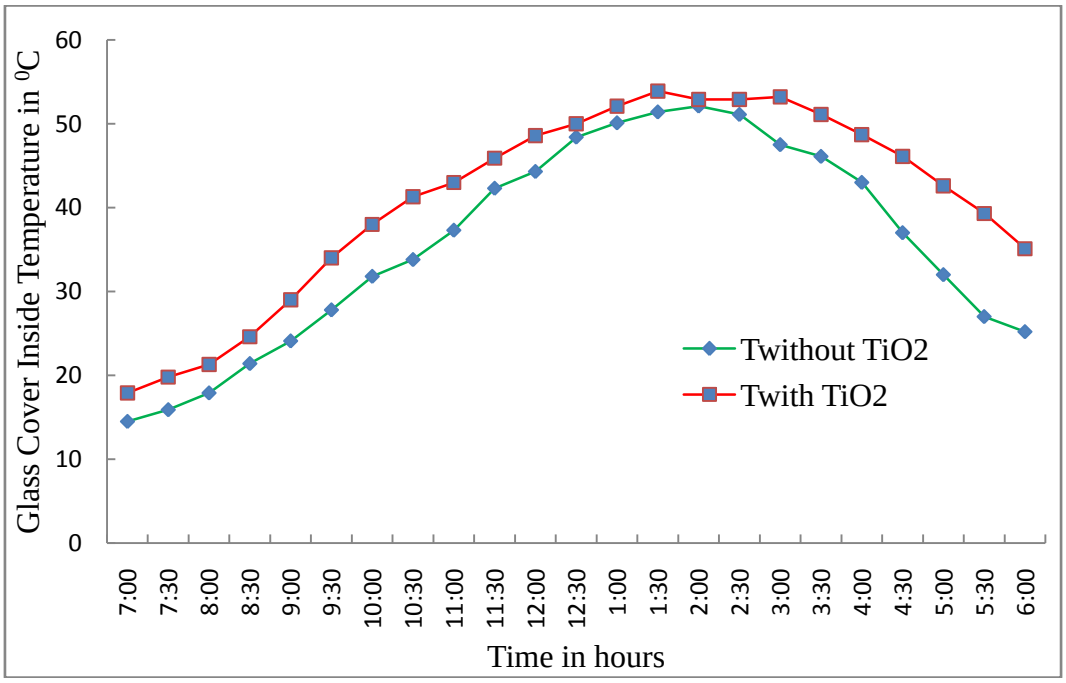

Fig 7: Variation of Vapor Temperature with Time

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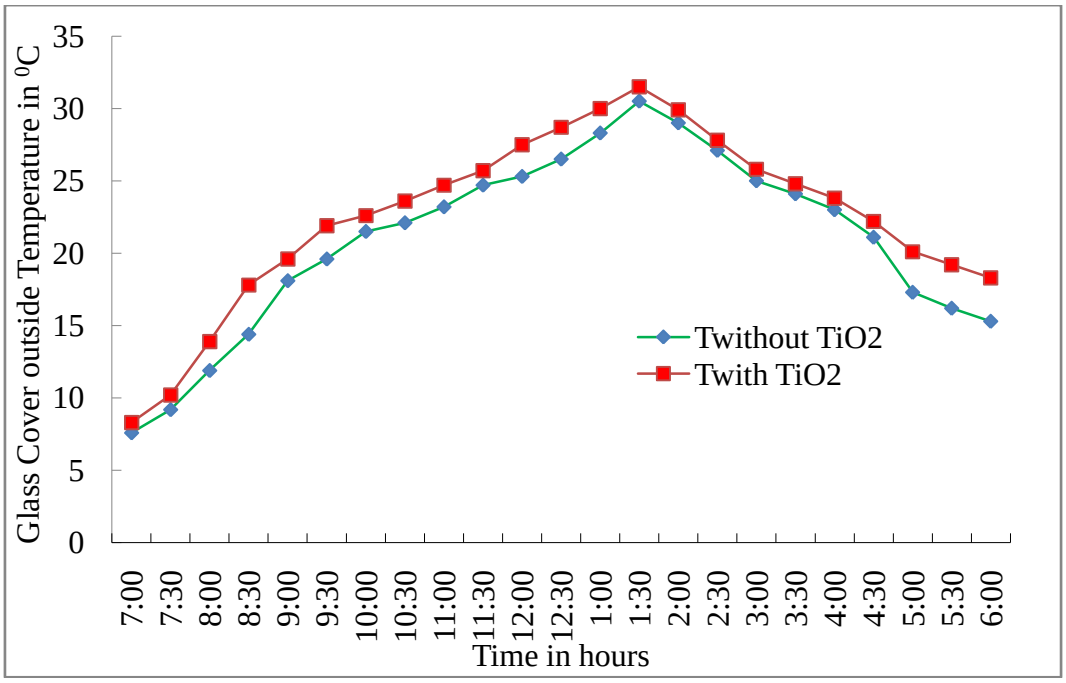

Fig 8: Variation of Glass Cover Outside Temperature with Time

The temperature of condensed vapour is observed to increase with time up to 1:30 P.M as shown in figure 7. Glass cover inside and outside temperatures increased with respective time with maximum temperatures in the Noon with 50^0C and 33^0C respectively in the presence of nano-material as shown in figure 7 and figure 8.

IV. Conclusion

Researchers working on solar energy and energy storage materials need to adopt a approach to ensure no impact on the environment and lesser cost method. Nano-material/ nano-fluids are advanced fluids containing nano sized particles that have emerged during the last two decades. Nano-material/ nano-fluids are used to improve system performance in many thermal engineering systems. The experimental result clearly indicate that the titanium oxide is a promising method and enhancement.

Acknowledgement

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