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Experimental Investigation of Absorber Design on the Performance of a Solar Tracking Distillation System

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ABSTRACT

The problem of water scarcity, especially in North Africa and Libya, has l reviewed. A distillation apparatus has been proposed that uses solar energy source of unlimited energy. It should be noted that most countries in N Africa to a relatively favourable area between 35° north latitude and 37° s latitude. Because of this, they can rely on sunlight as an unwavering sourc fresh water. The setup used in the experiment uses a solar paral concentrator, which collects solar radiation and concentrates it on evaporator.

The parabolic reflector increases the amount of incoming solar radiation an concentration on the evaporator, thereby increasing the heat output production rate of the solar still, thereby increasing the efficiency of the s still. The suggested distillation unit-body consists of a parabolic reflecto evaporator (Tube absorber) which was placed on the focal line of the paral reflector, and a pyramidal glass frame that acts as a condenser. Motors electronics that expose the reflector to the sun's rays throughout the day f sunrise to sunset. The results show that increases in solar intensity, amb temperature, and evaporation area increase specific productivity. Using tracking system as an automatic control unit to make the reflector the sun all over the day from sunrise to sunset.

Keywords: Solar Desalination Unit; tracking system; Test Rig of S Desalination System

I. INTRODUCTION

Water is actually the source of life on Earth. Water in the human body accounts for about 70% of the total mass. Losing as little as 1% of body fluids can make a person feel thirsty while losing about 10% can be fatal. Population growth and economic development, as well as global warming, are creating an imbalance between supply and demand for freshwater worldwide. In fact, providing an adequate supply of fresh water may be the most serious problem facing the world at the beginning of the new century [1]. The biggest problem facing the world at the beginning of the new century [1]. Great efforts have been made to find an appropriate solution to the water crisis. Desalination of seawater is the perfect solution to this scarcity problem. It is estimated that population growth alone will push 17 countries into this water-scarce categories over the next 30 years, with a projected population of 2.1 billion. By 2025, 48 countries with a population of over 2.8 billion (35% of the projected world population in 2025) will be affected by water scarcity or scarcity, as shown in Figure (2.1) (Population Reference Bureau (PRB), 1998). (United Nations (UN) Population Fund, 1997). Nine other countries, including China and Pakistan, are facing water shortages. In addition to the effects of population growth itself, freshwater demand has also increased due to industrial development, increased reliance on irrigated agriculture, large-scale urbanization, and improved living standards [2]. In this century, while the world population has tripled, water withdrawals have increased by over six times (Juma, 1998). The world has withdrawn water every year since the 1940s The average annual growth rate is 2.5% to 3%, while the annual population growth rate is 1.5% to 2% (Dowdeswell, 1996). In developing countries, water withdrawals have increased by 4 to 8 percent per year over the past decade (Marcoux, 1994). [3].

II. SOLUTION OF THE PROBLEM

After this general overview of the impending water scarcity and water scarcity and the abundance of solar energy in the Middle East, the idea of desalination could be the answer to the world's water problems. More specifically, solar desalination is the easiest solution to the problem. Technical Description Desalination is a water treatment process that separates salt from brine to produce water with lower total dissolved solids. Using this method has clear advantages, as it can utilize a wide range of raw water sources, from the ocean itself to brackish water on islands or underground [4].

III.EXPERIMENTAL TEST RIG

A Solar Desalination Unit is designed and constructed specially to study the effect of using concentrators in the desalination field, and to show the difference between actual and theoretical temperatures from the heat transfer point of view. The setup was used to study the effect on freshwater production by distillation using concentrators instead of using conventional stills using only direct sunlight [5]. The design of the unit is compact in dimensions for simplicity electronic circuits were used to adjust the angle of the unit parabolic reflector to face the sun rays all over the day for maximum efficiency. The main target was to make it affordable for all people to have cheap fresh water anywhere. The experimental apparatus arrangement as shown in Figure [1]is prepared to fulfill the operation for domestic uses. These figures illustrate the different components used. [6].

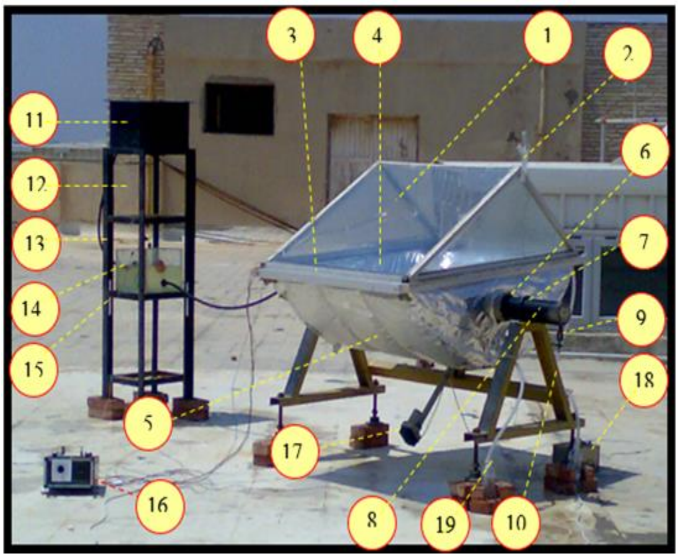

Figure 1. Photograph of Experimental Test Rig of Solar Desalination System.

Item	Description	Item	Description
1	Condenser & Glass cover	10	Stand of the distillation unit
2	Light Dependant Resistor	11	Saline Water Tank
3	Water collecting channels	12	Flexible Hoses
4	Holes	13	Stand of Tanks
5	Parabolic Reflector	14	Level Control Box
6	Bearing	15	Slot
7	U-bolt	16	Selector switch and Digital Temperature
8	Evaporator	17	Electric Motor
9	Drain	18	Tracking System
19	Fresh Water Jar		

IV.TEST PROCEDURE

The system utilizes a 36 liters saline water storage tank which is painted black color. Preliminary heating of the water takes place inside this tank and then saline water flows to the level control box and then to the solar distillation unit; then water evaporated. The vapor of water is condensed on the condenser and collected through channels and then to the receiving fresh water jars. the tracking system is added, by which, solar incident rays will be always facing the reflector all over the day.

The objective is to describe the program, the experimental procedure, and the methodology used to process the primary data for the experiments. The test stand is used to give results for two consecutive days. Each case is used to investigate the effect of the maximum absorbent temperature and the maximum water temperature on the freshwater absorption process and the thermal efficiency of the unit.

V. EXPERIMENTAL CASES

There are some experimental cases here, which will be presented and discussed to show the influence of cases on freshwater production and the thermal efficiency of the unit.

Due to observations of the production of the apparatus, a number of parameters were modified. Increasing the number of holes in the evaporator to 20 holes as well as increasing the hole diameter to 20 mm as shown in figure [2a]and figure [2b]. This modification was taken into account to increase the area of evaporation from which vapor comes out from the evaporator to the condenser.

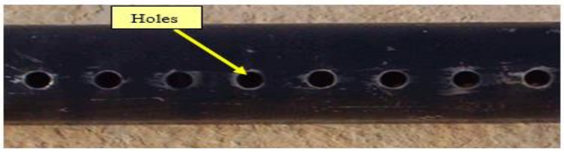

Figure 2a. Schematic diagram of the absorber of 20 holes of 20 mm diameter.

Figure 2b. absorber of 20 holes of 20 mm diameter of the evaporator

The test procedures for this case were as follows:

1. The apparatus was set facing the East /West direction.
2. The water depth in the evaporator is 4.5 cm.
3. Reading out data of temperatures, solar intensity, and wind speed was registered.
4. Repeating the previous steps by using a tracking system with sun different angels in the sky in the E/W direction
5. Repeating step [1] using the tracking system.

VI.DISCUSSION AND RESULTS

The objective of is to present the SDU thermal performance and the main parameters affecting its productivity under different conditions.

The study parameters one used a explain various effects leading to a crease in the SDU thermal performance and total productivity. Experimental data obtained are used to estimate the variation of temperatures and productivity with time.

Since the experiments were carried out in cases that are 20 holes of 20 mm diameter, wet black cloth, and half-cut copper tube, therefore it's preferred to present the discussion of observation readings in the form of graphs. Figures (4), and (7) represent the temperature and time distribution curves of the adsorbent and water on two consecutive days. Curves of effects on water temperature and absorption temperature are also represented. Figure (4) shows the temperature variation of the SDU with the automatic solar tracking system on 01/08/2007 which was hot with a decrease in wind speed, a rise in ambient temperature, and a rotation around the north/south axis so that the collector moves east/west, And the depth of salt water is 4.5 cm. Note that the water temperature increases with increase the absorption temperature.The same trend was observed in Figures [3] to [6], where it was concluded in the case of using the automated tracking mode that the temperatures of absorption and water are higher than those in the case of non-tracking.

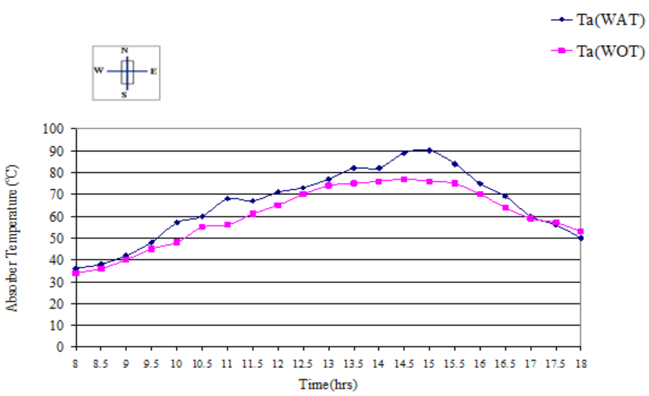

Figure 3. Tracking Effect on Absorber Temperature between Experiments on [7/8/2022].

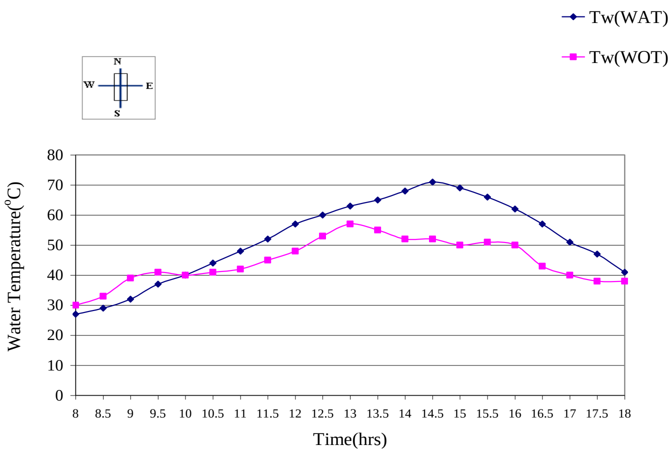

Figure 4. Tracking Effect on Water Temperature between Experiments on [7/8/2022].

Figures [3] and [4] show that the maximum temperature of the absorber and without tracking mode reaches 57 °C while in the case of using automatic tracking mode 71 °C, and show that the maximum temperature of the water and without tracking reaches 77 °C while in case of using tracking mode 90 °C

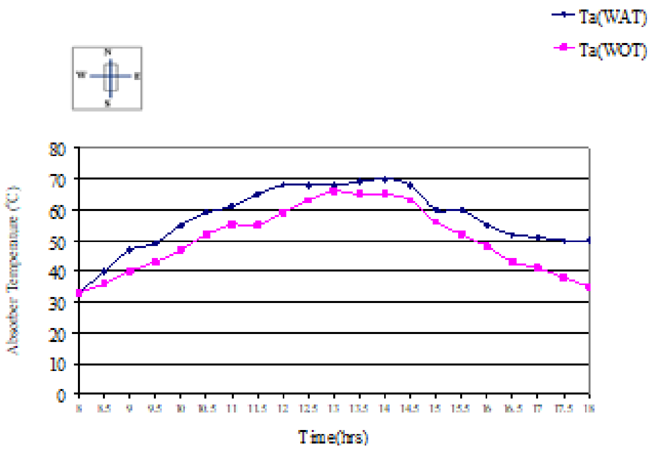

Figure 5. Tracking Effect on Water Temperature between Experiments on [8/8/2022].

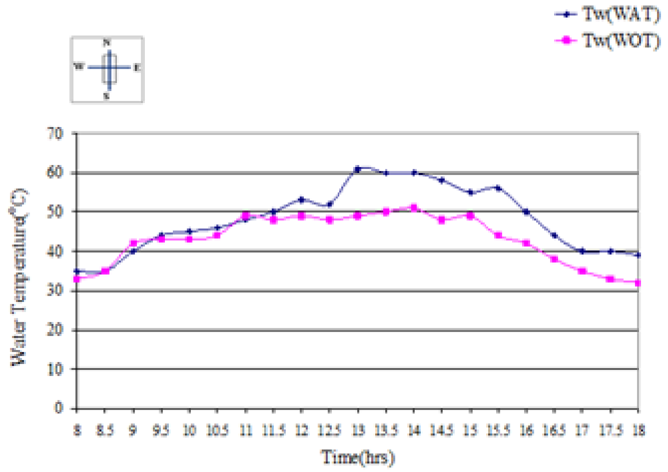

Figure 6. Tracking Effect on Absorber Temperature between Experiments on [8/8/2022].

VII. CONCLUSIONS

For test-rig water distillation nation using a Solar Desalination Unit (SDU) apparatus was tested. From the test results and discussions, the most important conclusions of the present work are:

- The evaporator (absorber) and water temperatures increase as the evaporation area decreases which is noticed from the difference between the evaporator (absorber) and water temperature in the case of 19 holes 19mm diameter of stainless-steel pipe painted black.
- The evaporation area has an important role in Solar Desalination Unit (SDU). So, to increase condensate droplets, the evaporation area must be increased which decreases the temperature of water and evaporator (absorber).
- The aperture area of the reflector has a clear effect on the temperatures of SDU components and water productivity. The increase in aperture area increases water productivity.
- Using a sun tracking system to make the reflector face the sun all over the day for maximum efficiency, when I use a tracking system the freshwater volume is 9-11 liters per day, in the absence of a tracking system the freshwater volume is 3-6 liters per day.
- Using light sensors of sun tracking system but at the same time, the evaporator (absorber) has N/S direction

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NOMENCLATURE

SDU	Solar Desalination Unit
WT	Water Temperature
WOT	Without Tracking
WAT	With Automatic Tracking

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