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Experimental Study of the Performance Water Distillation Device by Using Solar Energy

Abstract- *Evaluation and an experimental study of the performance of solar water distillation by using collector box with the aperture area of the water distillation of (1*0.6) m. The obtained results are shown that the amount of distilled water increased with increasing the solar radiation temperature. The highest solar water distillation efficiency was found equal to 11.4% for rainy and partially cloudy day between 8am to 10am for 12/4/2016. Also the second higher efficiency was found equal to 5.155 for a sunny day between 10am to 12 pm for 20/4/2016. The results indicated that the distilled water can be obtained on if even the weather condition very bad and the solar radiation very low as well as the higher amount of distilled water can be obtained at higher values of solar radiation intensity. Experimental results showed the higher ambient temperature lower the condensation, which lowering the amount of distilled water.*

Keywords- *Solar water distillation, solar collector box, Evaluation, Performance*

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1. Introduction

The world population is increasing day by day and also the demand for energy is increasing consequently. Oil and coal because the main supply of energy to day is predicted to finish up from the globe throughout the recent century that explores a heavy drawback in providing the humanity with a reasonable and reliable supply of energy. The requirement of the hour is renewable energy resources with low – cost running prices. Solar energy is taken into account jointly of the most energy resources in heat countries [1 – 5]. Solar energy is incredibly giant inexhaustible supply of energy. The ability from the sun hindered by the planet is or so one.8*10^11 MW, that is manifold thousands of times larger than the current consumption rate on the planet of all industrial energy sources. These two parts square measure a collector and a storage unit. The collector merely collects the radiation that falls on that and converts a fraction of it to alternative types of energy (either electricity and heat or heat alone). The storage unit is needed thanks to the non-constant nature of star energy; at sure times solely a really touch of radiation are going to be received [6 – 10]. Solar energy collectors square measure special quite heat exchangers that rework radiation energy to internal energy of the transport medium. There square measure primarily two sorts of star collectors: non concentrating or stationary and, concentrating. A non – concentrating collector has identical space for intercepting and for engrossing radiation, whereas a sun – pursuit concentrating reflector sometimes has dish-shaped reflective surfaces to intercept and focus the sun's beam radiation to a smaller receiving space, thereby increasing the radiation flux. This includes FPC, ETC, and concentrating collectors [11 – 15]. There's a very important want for clean, pure drinkable in several developing countries. Usually water sources area unit briny (i.e. contain dissolved salts) and/or contain harmful microorganism and thus can't be used for drinking. Additionally, there are units several coastal locations wherever brine is plethoric however potable water isn't offered. Pure water is additionally helpful for batteries and in hospitals or faculties [16]. Distillation is one amongst several processes that may be used for water purification. This needs associate in nursing energy input, as heat; radiation will be the supply

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of energy. star distillation may be a straight forward and clean technology that may be accustomed distill brackish/polluted water into drinkable water and can also be used to reduce the fossil fuel dependence that exists with current large scale desalination methods. Being able to predict solar still performance from long – term daily varying solar irradiance, air temperature, wind speed, wind direction, and cloud cover data could allow for the appropriate sizing of solar distillation facilities. This could allow for the determination of the correct level of investment needed to produce the correct amount of potable water to supply individuals or a community. The Florida solar energy Center receives [17] frequent requests for info regarding star distillation for purifying water. Distillation is one in every of several processes on the market for water purification, and daylight is one in every of many styles of heat which will be wont to power that method. Solar distillation systems as shown in figure (1). They're designed either to serve the requirements of one family, manufacturing from 0.5 to 3 gall drink daily on the average; or to supply abundant bigger amounts for a complete neighbor. These solar energy distilling plants square measure comparatively cheap, low – technology systems, particularly helpful wherever the requirement for little plants exists ones of potable every day on the average; or to provide abundant bigger amounts for a complete neighborhood or village. In some components of the globe the inadequacy of water is part overcome by covering shallow salt water basins with shut in greenhouse – like structures.

Figure.(1) Basic Concept of the solar distillation of water [18]

These alternative energy distilling plants square measure comparatively cheap, a fig.(2) low – technology systems, particularly helpful wherever the requirement for little plants exists.[18 – 20] figure (2) show form of solar still.

The aim of this article is the efficiently produce clean drinkable water from solar energy conversion. To achieve this goal, a system was designed for this aim.

Figure.(2) A simple solar still [18].

as well as the restricted convenience of fresh water resources and therefore the abundance of impure water obtainable for potential conversion into potable water. In addition the impact of the of design and construction on the performance of water distillation device by solar energy.

2. Experimental work

Due to the fact that we need to optimize use of solar energy and heat generated, including the use of an important characteristic of the glass and of its ability to allow the entry into force of the sun's rays promise to let her return has been used glass thickness mm, with a focus on work to provide thermal insulation required for our experience using black silicon. Our business started stages including

I.System Design of the Experimental Apparatus

1. The work of the basin Wooden, aquarium wooden wood thickness of 15 mm and a height of 200 mm and a width of 600 mm and a length 1000 mm consists and is securely fastened through the screw and glue to ensure the cohesion of the body with the raised ground level rise 400 mm to ensure that no thermal leakage in any form. The pelvic coating inside the white bleached at the beginning and then it was painted textured black silicone lack of any leakage of water from the aquifer. The work of the circular openings at the front basin for the purpose of installing a plastic tube slotted for the purpose of distilled water at the start of assembly work to gather in an external vessel was carrying his work. The work of the carrier rise higher than

the basin for the purpose of installing water barrels a small container, which will be installed by the barrel. Helicopter was installed to maintain the water level inside the wooden.(Figs 3) reveal some parts of the system design used in the experiments.

2. The work of the glass cover, which will be later part used in the steam rising from the murky water accumulated intensify in the basin wooden, was the work of glass from four glass cutting thickness 6mm cover where consists of a piece Avado 36 × 56 × 103 and 36 × 103 × 100which is a triangle specific angle to ensure the smooth flow of water in a heavy ceiling glass cover, as shown in Figure (4). Will be pasted of temperature and humidity devices at the top of the glass cover with distilled water to ensure that arrived inside the device.

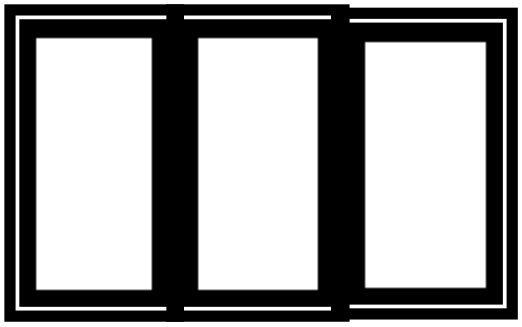


Figure.(3) Shows some parts of the system design

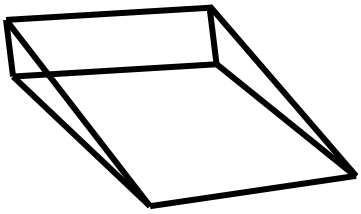


Figure. (4) Shows the glass section

3.After complete the implementation of the practical part of the article and the shape as shown in figure (5).

4.Devices used in the experiments

The special devices used for measuring temperature and humidity to help us determine the temperature inside and outside the system and also humidity inside and outside the machine with a device for measuring the level of TDS different minutes dissolved in the water before and after the assessment process, as shown below:

A. Devices measuring temperature and humidity to help us determine the temperature inside and outside the system with watch timing measurements to install.

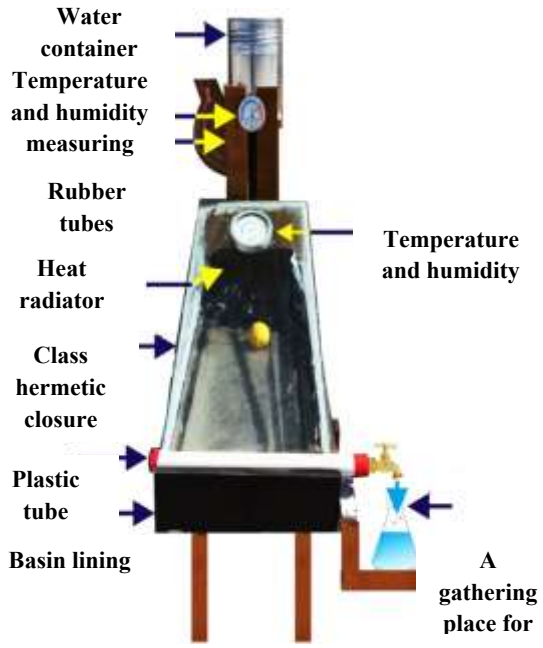


Figure. (5) Shows the experimental apparatus used in the experiments

B. TDS device to measure the level water minutes in the water before and after the distillation process, TDS it Total Dissolved Solids (TDS) square measure the whole quantity of mobile charged ions, together with minerals, salts or metals dissolved during a given volume of water, expressed in units of mg per unit volume of water (mg/L), conjointly mentioned as elements per million (ppm).TDS is directly associated with the purity of water and therefore the quality of water purification systems and affects everything that consumes, lives in, or uses water, whether or not organic or inorganic, whether or not for higher or for worse. This device as shown in figure.(6)

Figure.(6) Shows devices measuring the temperature ,humidity and TDS

C. Electronic device to measure the degree of internal and external temperature and humidity sensor contains a put it within the system.

II.Planner of the experimental apparatus

Water transmission and stages of evaporation by the sun's rays generated from the planned and heat down to condensation and distillation and assembled in a clean container to ensure no contamination. The experimental apparatus depicted in figure.(7).

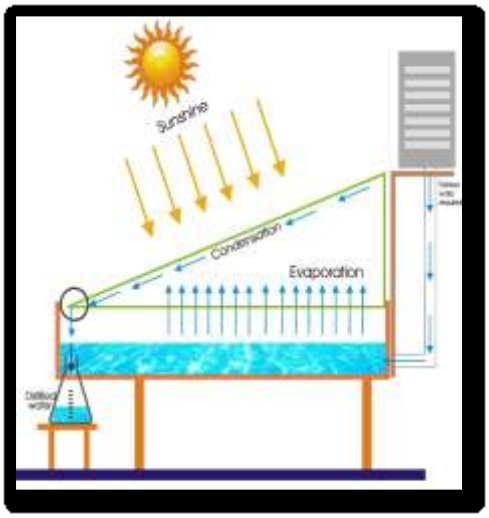


Figure .(7) planned for the conduct of the water distillation process

The highest solar water distillation efficiency was found equal to 11.4% for rainy and partially cloudy day between 8am to 10am for 12/4/2016.Also the second higher efficiency was found equal to 5.155 for a sunny day between 10am to 12 pm for 20/4/2016.

3. Results and discussion

The table (1) indicated reading for rainy and cloudy day for (10/4/2016). The figures (8 to 12) show the inlet water and ambient temperature, solar radiation intensity and volume of distilled water along the day time from 8am to 1pm for different weather conditions. Table (2) indicated reading and efficiency of solar water distillation. Table (3) and figure (9) shows the reading data for very bad weather (rainy and cloudy day).Where the solar radiation intensity was very low and the maximum value was 457w/m^2 at 10 am and reduce to a value 257 w/m^2 at 1pm. The large amount of the distilled water obtained between 10am to 12pm due to the water evaporated and condensed rapidly through this time.

4.Theory and Calculations

Heat of evaporation can be calculated as follows:

$Qw=mh_f$ (1)

Where: h_f =418.68 kJ/kg

Mass of water

$m =V \rho$ (2)

Where: V = volume in [m^3]

ρ =1000 kg/m^3 of water

m = v L/1000

VL must in letter

$$Q_w = \frac{VL}{1000} * h_f \quad (3)$$

$$\dot{Q} = \frac{Q_w}{time} \quad (4)$$

$$Efficiency = \frac{\dot{Q}_w}{A\ I_{av}} * 100\% \quad (5)$$

Time (hr)	Solar Radiation	T c^o (air)	T c^o (water)	Level of water (mlt)
8:00	34.4	27	24.8	0
10:00	457	27	26	50
12:00	283	34	28	200
13:00	257	34	29	240

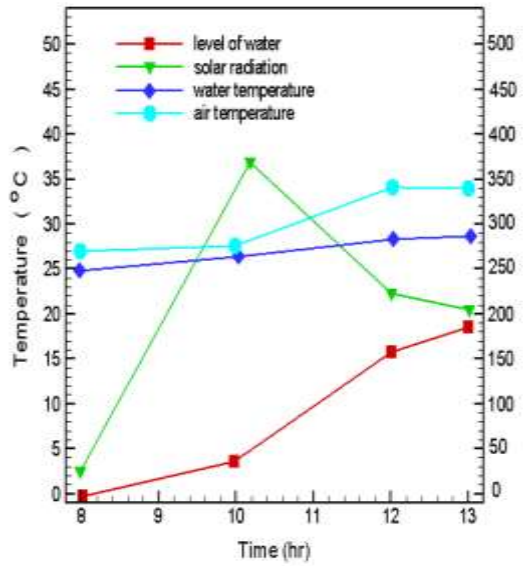
A= L*w (6)

Where: A= Area of basin wooden in [m^2]

L= Length of basin wooden in [m], L = 1[m]W = width of basin wooden in [m], w=0.6[m]

Table:(1) Reading data for rainy and cloudy day for (10/4/2016)

Figure. (8) The temperature, solar radiation



and the volume of distilled water distribution along the rainy and cloudy day for 10/4/2016.

Table (2) Reading and efficiency of solar water distillation
the volume of distilled water distribution along the rainy and partially cloudy day for 12/4/2016

No	Data	Time (hr)	$I_{(average)}$ w/m^2	Qw kJ/kg	$\dot{Q}$ (Watt)	E (%)
1	10/4/2016	8 – 10	245.7	20.934	2.9075	1.97
2	10/4/2016	10–12	370	62.802	8.7225	3.9
3	10/4/2016	12–13	270	16.747	4.652	2.8
4	12/4/2016	8–10	85	41.868	5.815	11.4
5	12/4/2016	10–12	431	62.802	8.7225	3.3
6	12/4/2016	12–13	770	41.868	11.63	2.5
7	18/4/2016	8–10	286.9	41.868	5.815	3.37
8	18/4/2016	10–12	727.5	83.736	11.63	2.66
9	18/4/2016	12–13	874	83.736	23.26	4.435
10	20/4/2016	8–10	377	41.868	5.815	2.57
11	20/4/2016	10–12	564	125.604	17.445	5.155
12	20/4/2016	12–13	720	41.868	11.63	2.692
13	21/4/2016	8–10	624.5	6.2802	0.87225	0.232
14	21/4/2016	10–12	806	77.455	10.75	2.22
15	21/4/2016	12–13	855	83.736	23.26	4.534

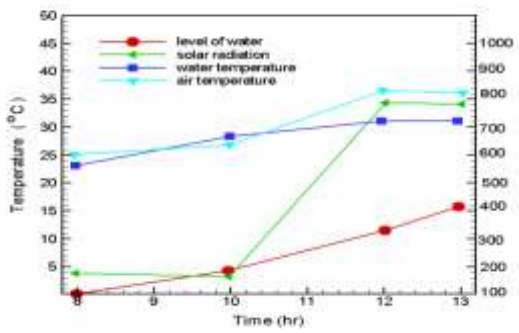
Tables (4 to 6) and figures (10 to 12) show the reading data for the sunny day with different solar radiation intensity. The tables and figures show the largest amount of distilled water occur at the range of highest solar radiation intensity, figure (12) show that the amount of distilled water was lower than that at figures (10 and 11 due to higher ambient temperature which reduced the effect of condensation.

Table (3) and figure (9) show the reading data for rainy and partially cloudy day where the solar radiation intensity was very low at 10am and then increased rapidly to the maximum value of 780w/m^{2}because the sky become sunny due to these conditions the distilled water increased to word the1pm.

Table: (3) Reading data for rainy and partially cloudy day for (12/4/2016)

Table (4) Reading data for the sunny day for (18/4/2016)

Figure. (9) The Temperature, solar radiation and



Time (hr)	Solar radiation	T c^o (air)	T c^o (water)	Level of water (mlt)
8:00	26.8	27	23	0
10:00	547	30	24	100
12:00	908	34	33	300
13:00	840	33	35	500

Table: (5) Reading data for the sunny day for (20/4/2016)

Time (hr)	Solar radiation	T c^o (air)	T c^o (water)	Level of water (mlt)
8:00	780	36	30.9	250
13:00	770	35.7	31	350

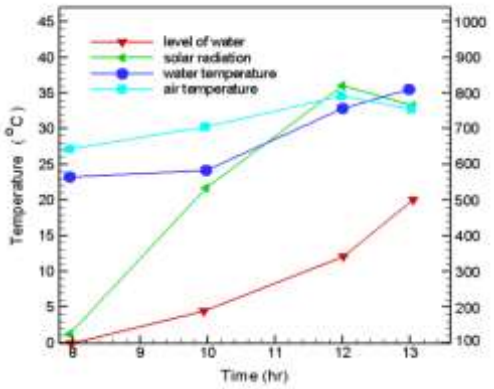


Figure. (10) The Temperature, solar radiation and the volume of distilled water distribution along the sunny day for 18/4/2016

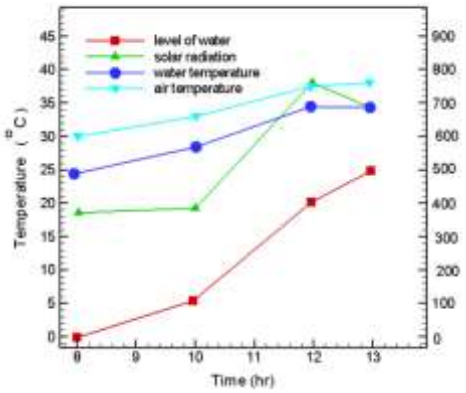
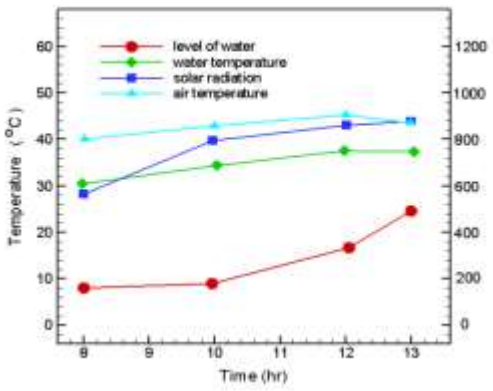


Figure. (11) The Temperature, solar radiation and

Time (hr)	Solar radiation	T c° (air)	T c° (water)	Level of
8:0(				
10:0				
12:0				
13:0				



the volume of distilled water distribution along the sunny day for 20/4/2016

Figure. (12) The Temperature, solar radiation and the volume of distilled water distribution along the sunny day for 21/4/2016

Table (6) Reading data for the sunny day for (21/4/2016)

Time (hr)	Solar Radiation	T c° (air)	T c° (water)	Level of water (mlt)
8:00	489	40	30	0
10:00	760	42	34	15
12:00	852	45	38	200
13:00	858	43	38	400

5.Conclusions

The main conclusions of the present study are:

1. The distilled water can be obtained on if even the weather condition very bad and the solar radiation very low.
2. The higher amount of distilled water can be obtained at higher values of solar radiation intensity.
3. The higher ambient temperature lower the condensation, which lowering the amount of distilled water

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