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Research Article

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Study the effect of the external and internal reflectors with solar radiation concentrates (mirror) on the efficiency solar still in Basra city-Iraq

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Abstract In this research a single slope conventional solar still has been constructed and it's performance has been evaluated under different atmospheric circumstances of Basra city(Iraq) (Latitude 30° 33' 56.55"N, Longitude: 47° 45' 5.86"E).This region is well known of it's plentiful of solar radiation. The still has consists from the basin total area of (625 cm^2). Several additions have been made and examined in order to increase the performance of the single slope solar still . An external and internal reflectors with solar radiation concentrates (mirrors) were used to concentrate the solar rays towards certain region of the solar still (also constructed manually in our laboratory). All our examination were performed under the same atmospheric circumstances. The single slope solar still inclined at an angle of (15^o), the maximum efficiency of the experimental still varies from (42 % - 52 %).

Keywords Desalination, Water, Salt Water, Solar Still, Single slope Solar Still, Fresh water.

1. Introduction

The remote arid warm places in the Middle East and North Africa and other regions in the world are suffering from a sharp shortage of fresh water. These regions are characterized by high salinity of the ground water, lack of rains and a good solar energy. It is an international problem and the best solution, is the use of solar energy for desalination of salt water [1]. Salt water (brackish water) represents very high percentage of the total water on the surface of the earth, (97% - 97.5%), and the rest is fresh water (3% - 2.5%), so the fresh water which is available for use is a very small fraction [2-4]. The salt water desalination is one of the ways of meeting water demand, the high saline for water is the main problem in the world. the desalination of the water resources to remove salt from saline water. The oceans are nearly only constant sources for fresh water. Therefore, it would be attractive to treat the water sharp shortage problem with the desalination of this water [5-6]. The methods of the water desalination require significant quantities of energy to investigation the isolation of salts from saline water [7]. Desalination processes require significant quantities of energy to achieve the separation of salts from seawater [8]. The desalination of salt water needs a large amount of energy, new alternatives which are based on sustainable energy are essential to supplement the required energy of desalination processes. Over the years, solar energy has been used to purify water and numerous solar desalination devices have been developed [9]. In oil rich countries about 95% of all freshwater is already supplied by desalination technologies using fossil fuels (oil or gas). In view of future oil shortages, desalination must, however, be driven with renewable energy [10].

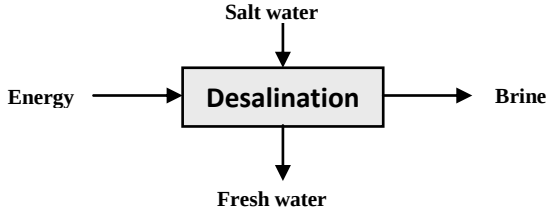

Figure 1: Diagram of desalination process [10]

The Solar distillation is one of many processes that can be used to produce fresh water by using the heat of the sun directly in a simple equipment to purify water. The equipment is commonly called a solar still [11].

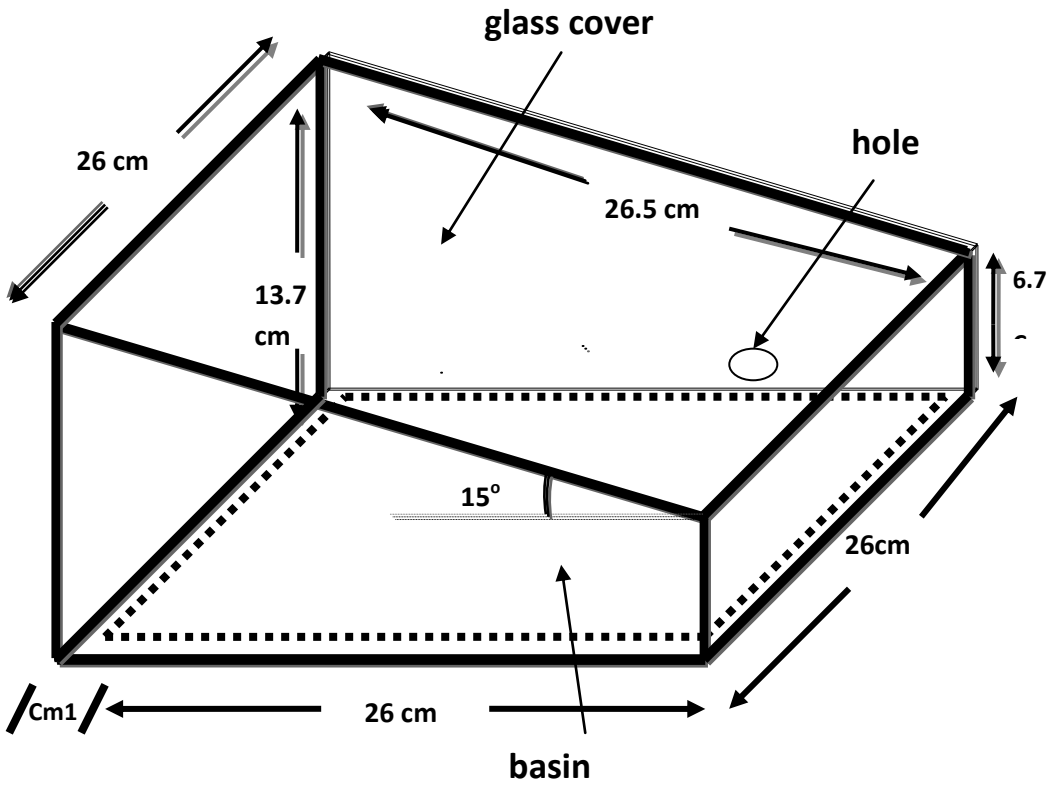

Figure 2a: Schematic diagram of the Single slope solar still

Figure 2b: A photographic picture of the Single Slope Solar Still (glass one face reflector)

Ahmed, et al , study a design of Hemispherical solar still with the Aluminum absorber and get a maximum efficiency of the experimental still varies from (19% -23%) [12]. Huda, et al, presented the results of outdoor experiments of the pyramidal solar still coupled with the flat plate reflector at Basra, Iraq. The maximum production is one at the first and the end day hours arrived to (1280 ml/m^2/h) of pyramidal solar still with external reflector and a maximum solar radiation is one at the first and the end day hours arrived to (1836 w/m^2/h)during the day of 29 May 2014 [13]. Ahmed and Aqeel, Thy have studied designed vertical solar still.

The experimental study that the efficiency without any improvement is (17.6 %) and increases to (38.2 %) by using external reflector [14]. The aim of this work is to study the effect of the external and internal reflectors with solar radiation concentrates (mirror) on the efficiency solar still in Basra city.

2. Experimentation:

A single slope solar still has been constructed and it's performance has been evaluated under different atmospheric circumstances of Basra city (Iraq) (Latitude 30° 33' 56.55"N, Longitude 47° 45' 5.86"E).

The single slope solar still has been built of transparent glass and glass one face reflector with a thickness (4 mm) and has the same dimensions of absorber plate which contains the Saline water, an absorber plate and glass cover that creates a cavity. The cavity length, width and height for the single slope solar still are (0.25 m), (0.25 m) and (0.14 m). This plate in still is made of aluminum with surface area (0.0625 m^2), the surface was coated with black paint to absorb the maximum amount of solar radiation incident on them. The brackish water is fed to the still through the hole screw (double ended screw pipe) of (8mm) diameter on the cover glass and join with rubber tube to the tank of saline water with capacity (20 liter). The condensed channel in still lies between the absorber plate and the glass cover with width (1cm) and height (2cm). The absorber receives solar radiation from both sides. Flowing water gets heated and evaporation starts from absorber plate. The evaporated water was condensed on condensed channel, it has been developed by putting hole screw (ended screw pipe) of (8mm) diameter on the channel to get distilled water linking transparent rubber tube in this screw, goes to the distilled water collecting flask, diameter of the plastic tube (0.5cm).

The base of the still is insulated with pieces of wood (wood block) of (1cm) thickness to avoid the thermal losses to the external ambient, proven the basin on the base by silicon rubber. Figure (1) shows the schematic diagram of the still. Figure (2) shows a photograph picture of the still. An external reflector (mirror) was used to reflect and concentrate sunlight onto the basin. Figure (3) shows a photograph picture of the still with external reflector (mirror). The single slope solar still directed to the south geographic, the direction geographical advantage from solar radiation and to be the first side towards the sunrise and the other side heading towards the sunset. The experiments on the still was carried out during some days of (August 2018 and September 2018) to study their performance under different field conditions. In each experiment, the hourly amount of distilled water and the insulation are monitored for the still. The total daily amount of distillate water was recorded.

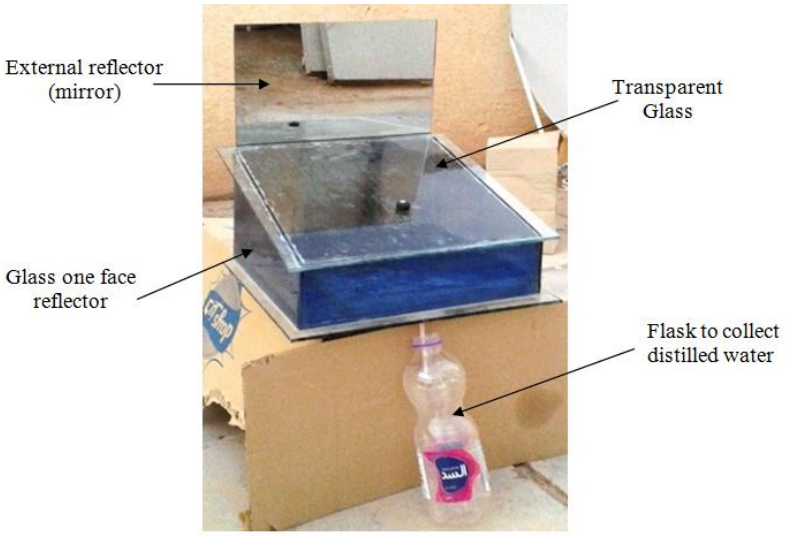

Figure 3: A photographic picture of the Single Slope Solar Still with external reflector (mirror)

3. Results and Discussion

The product water is measured hourly by calibrated beaker of 1 liter volume. The productivity of the still with respect to the solar radiation has been studied. The results of the during some days of (August 2018 and September 2018) are shown in figure (4). The average daily production of the single slope solar still has the same behavior and the variation in its productivity from one day to another depending on the variation in solar

radiation and the other meteorological factors like clouds. It is clear from the figure that the productivity of the still has the same behavior with respect to the solar radiation behavior. A maximum production is at midday while a lower one is at the first and the end day hours. Also at the first hours the inner surface of the single slope solar still enhances to quick the condensation of the vapor which arises from the horizontal basin on it because of its lower temperature. Productivity of the solar still has been increased due to increase in temperature difference between water surface and inner surface of condensing glass cover. The maximum value arrived to (1120 ml/m^2/hr) in the hour (13 pm) in the day (29/8/2018), while lower value arrived to (272 ml/m^2/hr) in the hour (16 pm) in the day (6//2018).

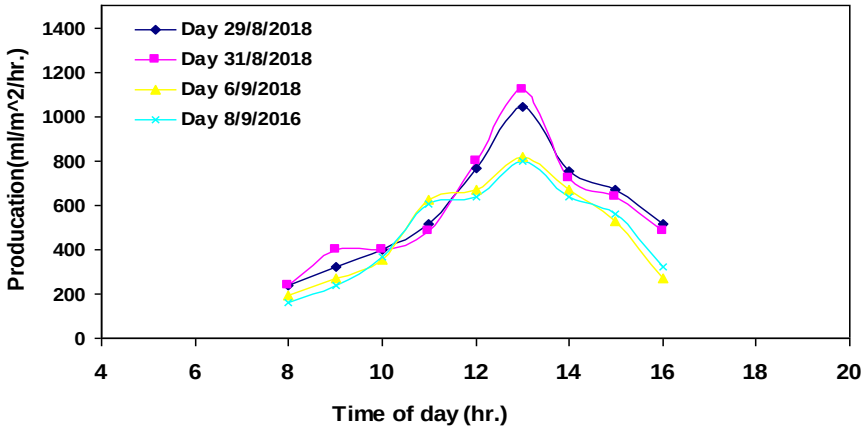

Figure 4: Hourly productivity of the single slope solar still during some days of (August 2018 and September 2018).

The daily production of distilled water of the single slope solar still with the solar radiation through some days of (August 2018 and September 2018) are shown in figure (5), this figure shows that the daily production has a maximum value arrived to (5280 ml/m^2/day) for the day (31/8/2018) where the sky is clear (there is no dust), while the less value of production is (4336 ml/m^2/day)for the day of (8/9/2018) where the sky is not clear but partly cloudy and the weather contains some dust storms., where the production of the solar still has been depending on the intensity of solar radiation.

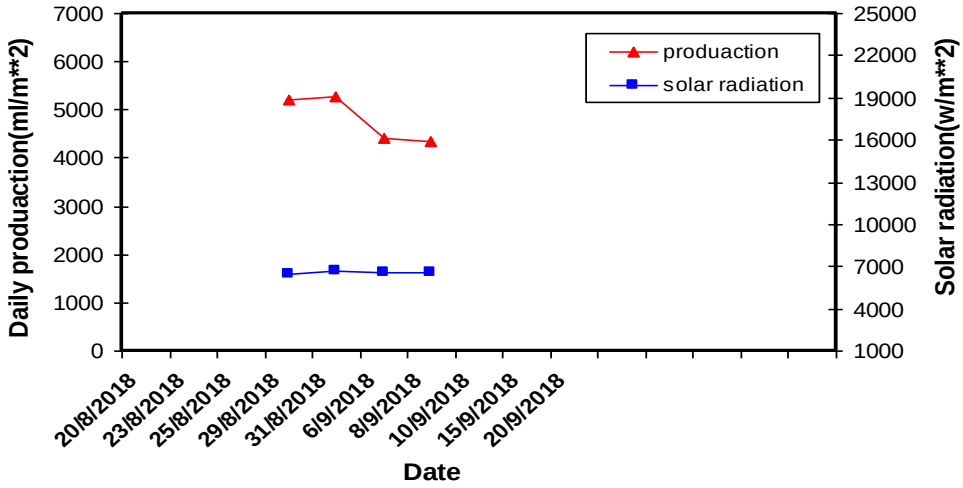

Figure 5: Daily production of the single slope solar still with the solar radiation through some days of (August 2018 and September 2018)

The thermal efficiency (E) of the still was calculated for the some days of (August 2018 and September 2018) using the following equation [15] .

$$E_{bsn} = \frac{P \times L}{I \times A_b} \times 100\%$$

Where: E_{bsn}: Thermal efficiency, P: Daily output of distilled water, L: Latent heat of water evaporation (KJ / Kg), I: Daily solar radiation (W / m². day), A_b: Area of the basin if the still (m^2).

The maximum efficiency of the experimental still varies from (42 % - 52 %). Table (1) shows the results of the thermal efficiency of the single slope solar still with internal reflector.

Table 1: Thermal efficiency of the single slope solar still

Date	Production (ml/m^2/day)	Solar radiation(w/m^2)	Efficiency %
29-8-2018	5216	6513.3	50.2
31-8-2018	5280	6645.4	51.8
6-9-2018	4400	6562.4	42.2
8-9-2018	4336	6566.8	42.1

The Solar radiation for ambient air was recorded continuously for one hour for the some days of August 2018 and September 2018 show in Figure (6).

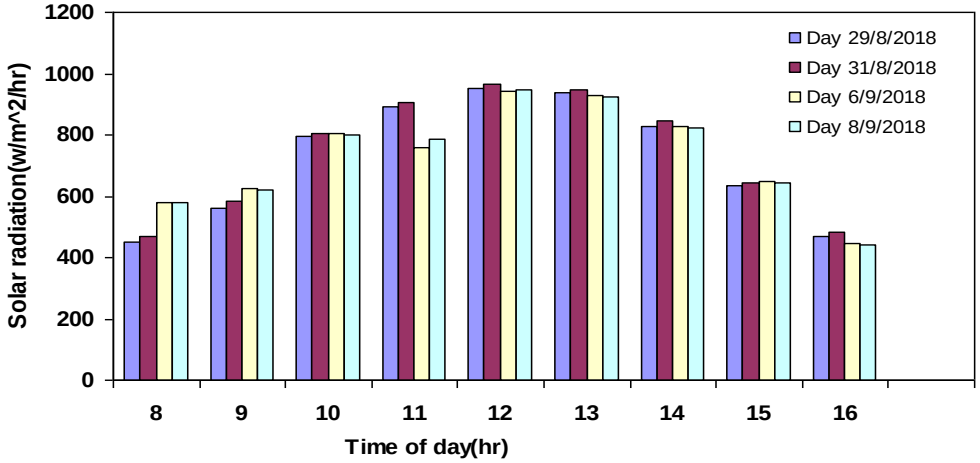

Figure 6: The Solar radiation for ambient air along the daily hours for the some days of August 2018 and September 2018

From Figure (6) we observe that the Solar radiation for ambient air has a highest value at mid day (11 hr.- 14 hr.), this is because of the effect internal reflector (glass one face reflector), also the maximum value of the solar radiation for ambient air arrived to (965 w/m^2/hr) for the day(31/8/2018) at the hour (12 pm), while the minimum value of the Solar radiation for ambient air arrived to (443 w/m^2/hr) for the day(8/9/2018) at hour (16 pm). Figure (7) show the temperature of ambient air was recorded continuously for one hour at the some days of August 2018 and September 2018. Figure (7) we observe that the temperature of ambient air has a highest value at mid day, also the maximum value of the temperature of ambient air arrived to (51 °C) for the day (31/8/2018) at hour (13 pm), while the minimum value of the temperature ambient arrived to (39 °C) for the day (29/8/2018) at hour (8 am).

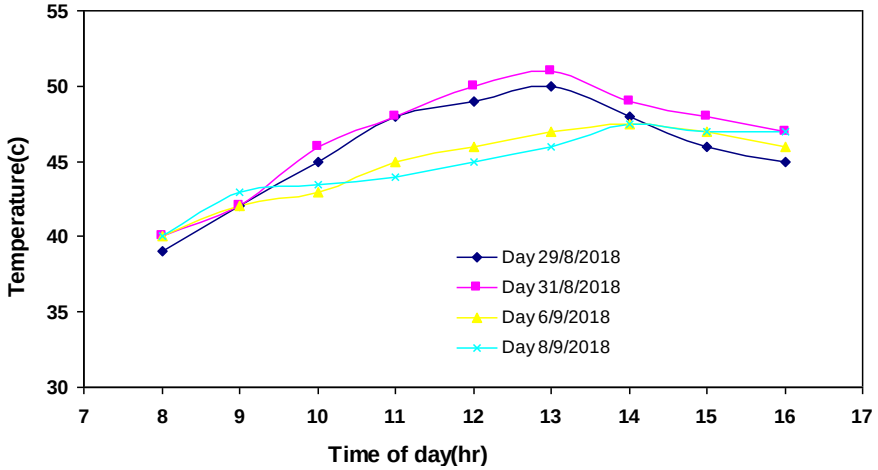

Figure 7: The change in the temperature of the ambient air along the daily hours at the some days of August 2018 and September 2018

Figure (7) we observe that the temperature of ambient air has a highest value at mid day, also the maximum value of the temperature of ambient air arrived to (51 °C) for the day(31/8/2018) at hour (13 pm),while the minimum value of the temperature ambient arrived to (39 °C) for the day(29/8/2018) at hour (8 am).

4. Conclusions

The main observations and conclusions that can be obtained from the results of this work are the following:
Solar distillation is particularly useful to give drinking water to small and isolated villages. Solar distillation can partially support humanity's needs by fresh water with free energy, simple technology and a clean environment. The hourly variation behavior of yield is similar to that of solar intensity. The largest part of distillate production was seen to take place between noon and sunset, where the productivity was increased with the increase of solar radiation, the day average of distillate production of the single slope solar still has the same behavior and the variation in its productivity from one day to another due to the variation in the solar radiation and the other meteorological factors like clouds. The distillate production can be increased when the temperature of the brackish water increases. The single slope solar still is the best design appropriately in Basra region in this work. The maximum efficiency of the experimental still varies from (42 % - 52 %).

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