Effect of cover thickness on the yield of a solar distiller under the El oued climate, Algeria

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***Abstract*— The wilaya of El Oued (southeastern Algeria) suffers from a huge lack of drinking water, unfortunately the groundwater is sometimes too salty for them considered drinking water. The most economical way to obtain drinking water is solar distillation using free, renewable and non-polluting energy. Improvement of the single-slope solar distiller is a problem addressed by several researchers around the world. This study also aims at this point by the variation of the thickness of the glass (the condenser). Experiments show that the production is better improved when the thickness of the glazing is low e = 3 mm with a total production of 2313.2 ml /m2.d; when e = 5 mm the production is 1876 ml / m2.d and at the end when e = 6 mm the production is 1236 ml / m2.d. From these results can be said that any increase in thickness will be followed by a decrease in the productivity of distilled water.**

Keywords—Desalination, distilled water, evaporation, condensation, Solar radiation

I. Introduction

Algeria has the largest solar field in the Mediterranean basin and it has a large underground water reservoir in the southeastern region of Algeria (region of El Oued). This water is infected by the fluoride so what makes this water invaluable. Earth-water treatment plants have been designed for reuse of wastewater. A procedure followed by several countries in the world [1]. Seasonal changes have a remarkable effect on the productivity of a conventional solar distiller; this has been proven that production in the summer season is nine times greater than in the summer season [2]. A several studies are aimed at improving the performance of a small solar distillation station under real insulation for underground geothermal desalination of water in arid regions in southern Algeria. They are also aimed at the production of drinking water for the arid regions; the small station had a daily capacity of more than 15 l / m^2 [3-5]. At Batna city in Algeria was able to achieve a yield of a solar distiller of the order of 2.5 liters / day for an absorber surface of 0.54 m^2 [6]. One of the factors that also directly affect on the solar distiller is the glass cover. Double glazing increases the efficiency of a solar collector, but it reduces the efficiency of a solar distiller [7]. Cooling the glass improves the productivity of pure water [8, 9]. The objective of our work is to see the influence of the thickness of the glass on the performance of a single-slope still with three different thicknesses of glass (3, 4 and 5 mm).

II. Method and experiment

A. Solar distiller description

Figure 1 shows the single-slope solar distiller or simply the conventional distiller. this device is used to purify polluted water and return it to pure water. It is a very simple technique that uses solar radiation as energy. However, this type of device is distinguished by relatively low production compared to other desalination devices. As shown in Figure 1, this distiller has a very simple construction with a low investment cost.

The distiller used in our study consists essentially of a square wooden box of 0.5 x 0.5 m, a standard glass cover of 0.55 x 0.55 m, a thickness of 0.004 m; a PVC recovery tube 0.60 m long and 0.025 m in diameter located in the lower part of the distiller and finally a collection tank of pure water produced by the distiller.

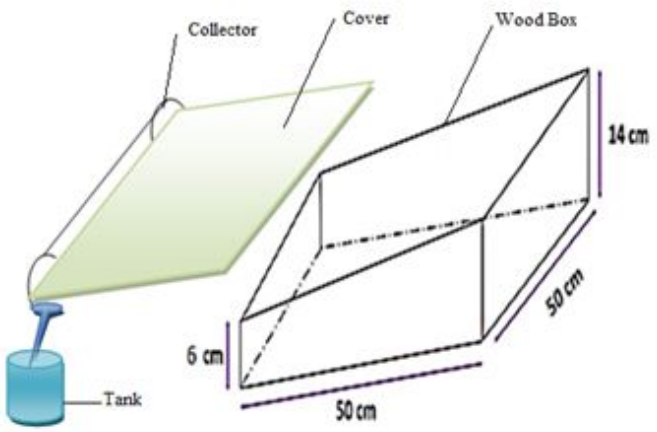

Fig. 1. Conventional solar distiller [7]

B. Principle of operation

Much of the solar radiation is absorbed by the black absorber at the bottom of the pond. Small amounts of energy are lost through reflection on the surface of the glass and on the surface of the water. The absorbed energy is mainly used to heat the water and to trigger the phenomenon of evaporation. The hot water vapor moves towards the cold inner surface of the hatch. The phenomenon of condensation starts and we see the appearance of the pure water droplets. The droplets slip under the gravity to the PVC tube where they will be collected in the collection tank.

C. Weather conditions of the experiment

The geographical coordinates of the city of El-Oued southeast of Algeria are 33.3676 ° north latitude and 6.8516 ° longitude. The experiment was done several times and since the results obtained are the same, so we chose the day 25/05/2017 as a reference day, the meteorological conditions of the experiment are presented in Table 1. Samples the temperature was done each hour by thermocouples K1 type. Similarly for the removal of the amount of distilled water is done manually by a graduated beaker.

TABLE I. Experience conditions

Meteorological conditions 25 May 2017	
Lever de soleil	5:41
Coucher de soleil	19:19
Température ambiante	35(C°)
L'humidité	25 %

D. The location of the thermocouples

The thermocouples are placed in the device as shown in Figure 3

- thermocouple 1 in the pond water;
- thermocouple 2 on the glass outside face;
- thermocouple 3 on the glass inner face;
- thermocouple 4 in the open air.

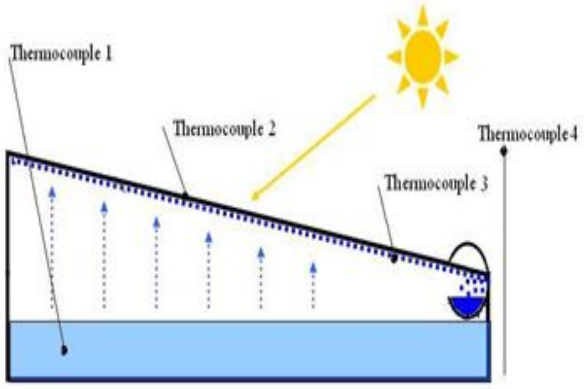

Fig. 2. The location of the thermocouples

III. Results and discussions

The experiment was conducted on May 25, 2017 in the climate of the region of El Oued, in the south-east of Algeria. Three similar solar stills have the same dimensions with the same angle of inclination (20 ° with the horizontal). The three distillers D1, D2 and D3 are exposed to the sun at the same time on the same experience table with the same quality and

quantity of water. Each distiller has a cover that differ in thickness from other distillers as shown in Figure 3.

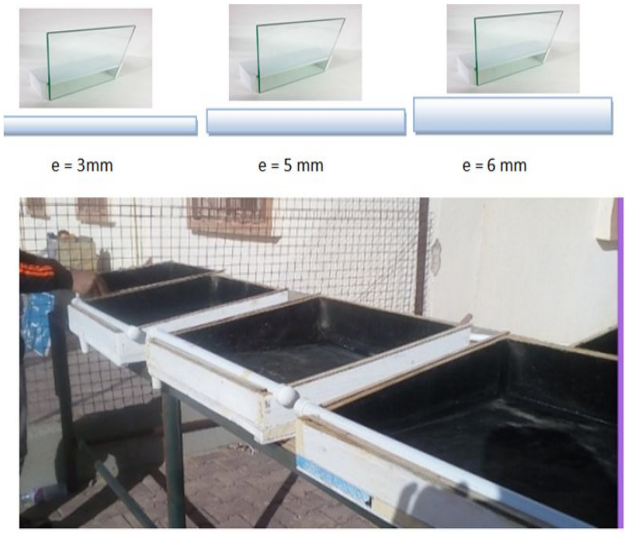

Fig. 3. Distillers in action

A. Solaire radiation evolution

Figure 4 illustrates the solar radiation evolution in the El Oued region in the sky (clear sky) with an unplanned cloud passage between 10:00 and 11:00h. Solar radiation reaches a maximum of 1100 W / m2 in the period 12: 00 - 14: 00h and begins to decrease after 14: 00h. this decrease in solar radiation which is remarkable in the graph is found on all the figures, proving that solar radiation has a great influence on solar distillation.

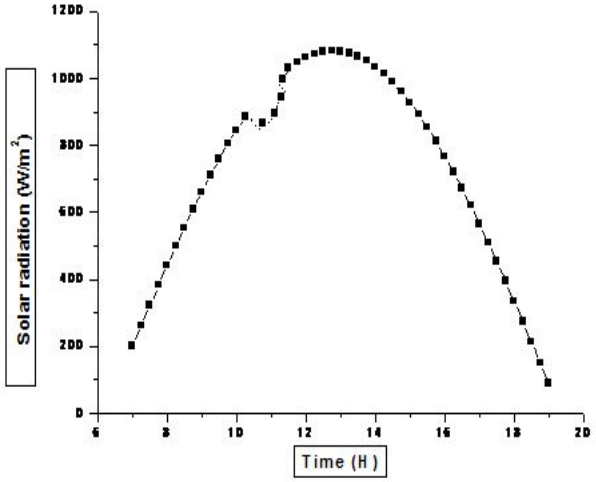

Fig. 4. Hourly evolution of solar radiation

B. Temperature ambient evolution

Figure. 5 represents the evolution of the ambient temperature as a function of time and it is noted that the increase in temperature reaches the maximum with a value of 43 ° C in the period 12: 30 - 14: 30h and begins to decrease after 15: 00.

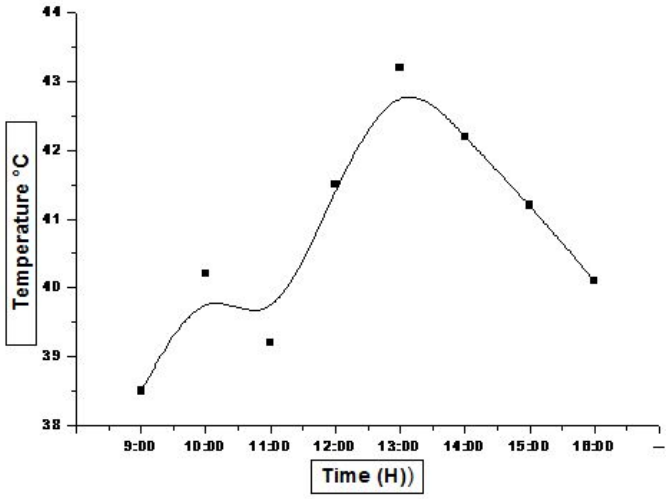

Fig. 5. Hourly evolution of ambient temperature

C. Outside glass temperature

Figure 6 shows the evolution of the temperature of the outer pane of the three distillers over time. This temperature has an indirect influence on solar distillation. The 3 graphs the same pace. In the same way we notice the effect of solar radiation during the period from 10:00 to 11: 11h.

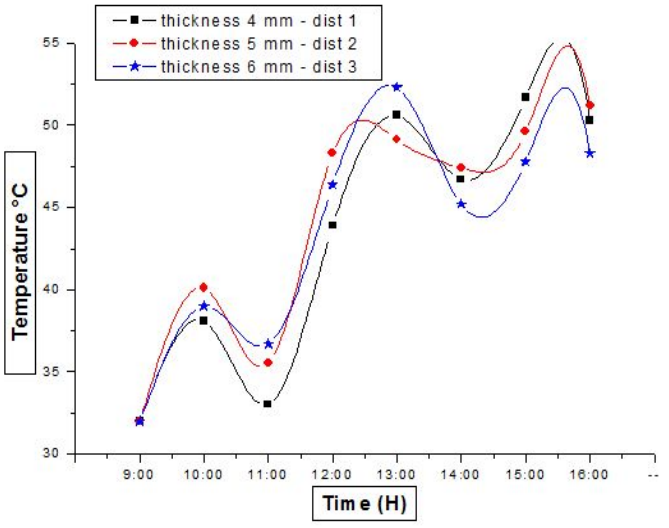

Fig. 6. Evolution of the temperature of the outer glass of the three distillers

D. Inside glass temperature

Figure 7 shows the evolution of the temperature of the inner pane of the three distillers as a function of time, but notes that the distiller D 3 at 6 mm has a more interesting decrease than the others and also notes that the temperature of the inner glazing of Distillers at 3 mm and 5 mm are higher. The inner side temperature of the glass is maximum at 13: 00h for the three distillers. It is 64 ° C for D1, 68.3 ° C for D2 and for D3 is 67 ° C.

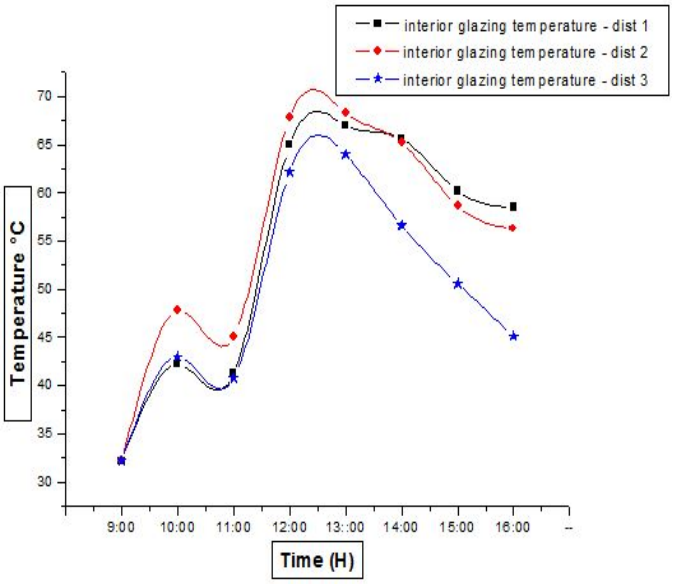

Fig. 7. Evolution of the temperature of the inner glass of distillers

E. Water temperature

Figure 6 shows the evolution of the temperature of the water inside the three distillers as a function of time. The temperature of distilled water is a very important factor in the phenomenon of solar distillation. The graph shows that this temperature increases over time and that the water temperature of the distiller at 3 mm is greater than that of the distiller at 5 mm and the distiller at 6 mm. The influence of the passage of the clouds between 10:00 and 11:00, is also very clear in the graph.

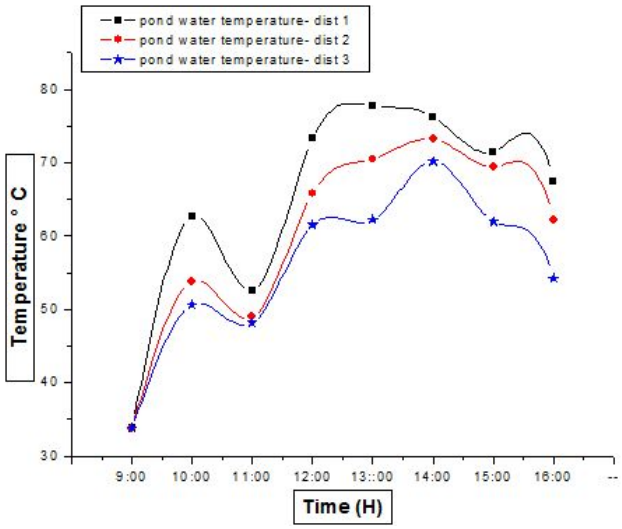

Fig. 8. The evolution of the water temperature of the distillers

F. variation in productivity

The figure shows the productivity of the distilled water of the three distillers, it is very clear that the amount of water produced by the distiller at 3 mm (in black) is very large compared to that of the distiller at 5 mm (in red) and finally the distiller at 6 mm (in blue). The first droplets appeared in the distiller at 3 mm. In the first sample we collected a quantity of water from the distiller at (3 mm) but we received nothing from the other two. The largest amount was harvested between 12:00 and 15:00 or solar radiation is maximum.

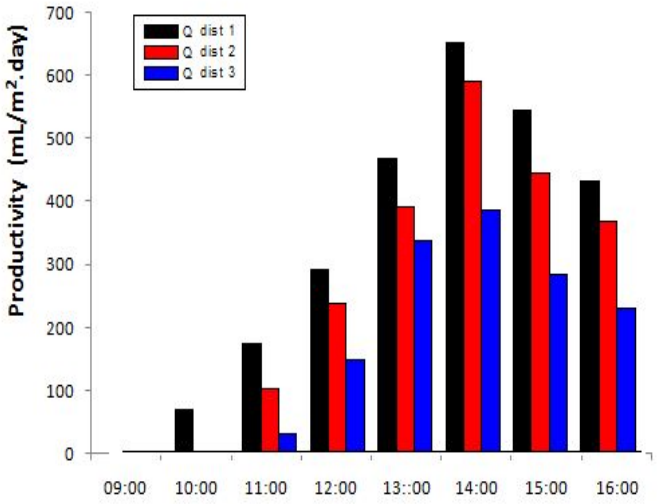

Fig. 9. The variation in productivity of the distillers

IV. Conclusion

From the results obtained in this chapter, it is very clear to see the influence of the variation of the thickness on the productivity of the distilled water. Each time increases the thickness and notes that productivity decreases. Experiments show that the production is better improved when the thickness of the glazing is low e = 3 mm with a total production of 2313.2 ml /m2.d for the distiller D1; when e = 5 mm, the production is 1876 ml / m2.d for the distiller D2 and at the end when e = 6 mm, the production of the distiller D3 is 1236 ml / m2.d. It can be deduced that any increase in thickness will be followed by a decrease in productivity in pure water.

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