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Comparative Study of Simple Basin Solar and Basin Solar Still with Additional Condensation Chamber Coupling to Flat Plate Collector

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***Abstract*:** *In this paper, we present an experimental investigation of tow solar stills. the fist is basin with an additional condensation chamber coupling to a flat plate collector. the second is a simple basin solar still. for that, the stills were designed, constructed and tested under Bouismail (Tipaza, Algeria) meteorological conditions. Solar radiation, temperatures at different position and fresh water were measurement. . The results obtained shows the existence of several parameters affecting the production of this kind of solar still. The Accumulative daily production obtained is equal to 4.07 l/day for the modified solar still and 2.6 l/day for the basin solar still. coupling the solar still with flat plate collector lead to increase the production by 53%*

Keywords: *Solar still , condensation chamber, solar energy, flat plate solar collector.*

1. Introduction

Water is a vital element for the survival of the human being, the needs for humanity increase in a continuous way. Algeria, suffered from the supply of drinking water for several years, has resorted to desalinate the seawater to meet water needs, especially for the agricultural and industrial sectors.

However, desalination of seawater is expensive, consumes energy and has a negative environmental impacts (greenhouse gas emissions). Also, it only supplies the coastal regions (North of the country) .

The supply of fresh water to the central and southern regions of the country is mainly from groundwater, these groundwater are very often salty and unfit for consumption. Faced with this problem, the use of solar energy is essential as an energy solution to the transformation of these salty waters into fresh water by solar distillers.

The basin solar still is the most system used to distillate the brackish water. the basin solar still has simple design, simple to carry out and to maintain. however, the basin solar still has a low production (3L/m2/day) and low efficiency .

to improve the production of the basin solar still several techniques have been used. this techniques can be divided into two parts. the first part consist to improve the evaporation by coupling the basin solar still with flat plate solar collector[1], a solar water heater [2], reflective plates [3], etc. The second part includes the improvement of the condensation by: the cooling of the glazing [4], the addition of a condensation chamber [5-6].

In this paper, we present experimental study of tow solar tills. the fist consist to an improvement of simple basin solar still. This improvement consists in the addition of a condensation chamber and a flat plate solar collector in order to improve the condensation of water vapor and the amount of evaporated water at the same

time. the second is a simple basin solar still with the same dimension characteristic of the first one. the simple still was constructed in order to find out the amelioration has made the new design. The experiment is carried out at the UDES site in Bouismail (Algeria) using sea water.

2. Experimental Setup and Operating Principle

The test bench consists of a solar stills with a condensation coupled to a flat plate solar collector. The solar still is single slope basin type of 0.8 m2 area. At the back, a chamber was added in order to increase the quantity of condensed water vapor. This chamber consists of a parallelepiped enclosure of dimensions (850 mm x 400 mm x 400 mm) made of galvanized sheet with 1 mm thickness. this enclosure is insulated with a layer of polyurethane (40 mm thickness) to minimize thermal losses. On the back side of the enclosure a tubular heat exchanger formed of 10 tubes is fixed in order to ensure the cooling of the water vapor inside the condensation chamber. The distilled water produced by the chamber is collected by an orifice beneath the chamber. This solar still was coupled to a flat plate collector of 1.90 m2 of area. (**Error! Reference source not found.**)

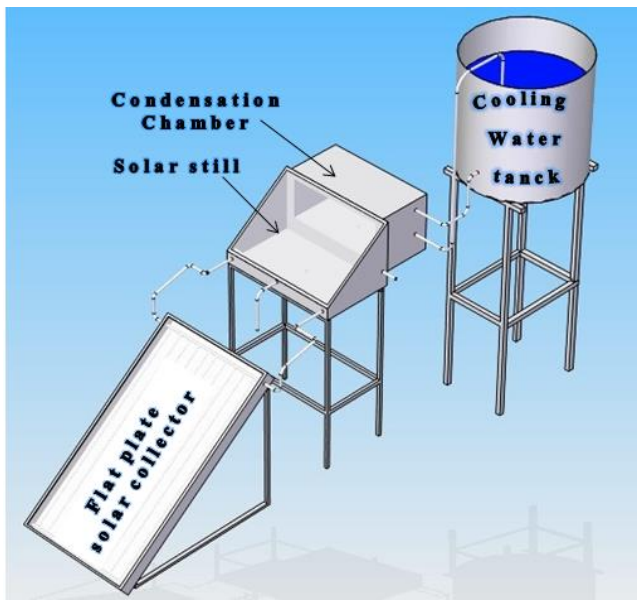

Fig. 1 A schematic view of the experimental step

Fig. 2: Photographic view of the experimental setup.

Temperatures at different points of the distillation system were measured by type K thermocouples, for glass (inner (T2) and upper (T1) faces), absorber (T5), brackish water (T4), vapor (T3, T7), cooling water (T8, T9) and condenser's walls (T6), Heating water (T10,T11) , (Figure 3). The solar irradiation was measured by a pyranometer (CMP 11). A data acquisition system, FLUNCK HYDRA SERIES II collects and stores data every

15 min. The fresh water yield was weighed every hour with a balance (KERN PCB 6000-0.1g of precision).The sea water taken on the site where the experimental device is installed.

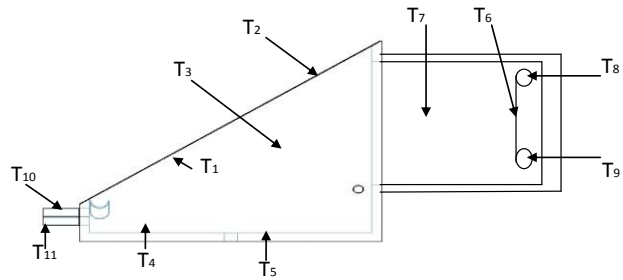

Fig. 3 : Postion of Thermocouples

3. Results and Discussions

The tests were carried out during a day of September 2013 at Bouismail (Tipaza; Algeria) (Latitude 36.63, Longitude 2.7° and altitude 40 m).

The day tests was characterized by a clear sky, an ambient temperature ranging from 21 C to 25.1 ° C, a wind speed varying from 0m / s to 4.5 m / s and A maximum solar radiation of 911.271 W / m². The water depth in basin solar still was taken equal to 3 cm.

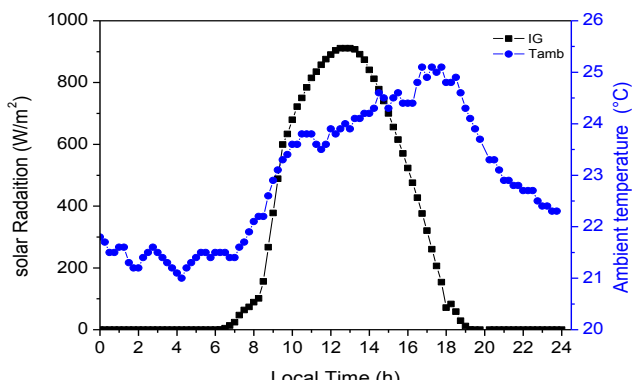

Fig. 4 Hourly variation of the solar radiation, ambient temperature during experiment day

The hourly variation of solar radiation and the ambient temperature are represented in Fig. 4. it can be noted the curve presents the shape of a bell whose maximum is at 12h30 local time (12 TSV , it is equal to 911.271 W/m2. the ambient temperature varied between 21 C à 25.1 °C.

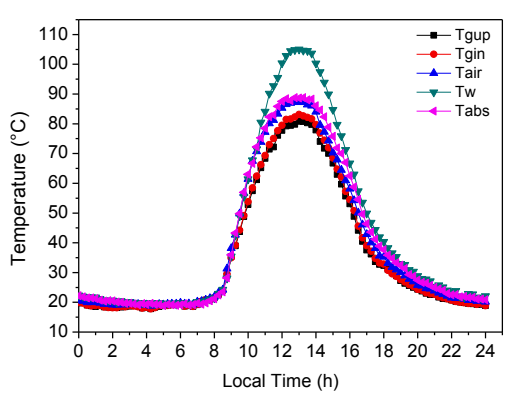

Fig. 5 : Hourly variation of temeprature of different media of vthe solar still during experiment day

Fig. 5 show the variation of temperature of glass (inner and upper surafce), water vapor, water and the absorber during the experiment day. We note that the variation of all temperatures follows the evolution of solar radiation. also, it can be seen that the higher temperature was water temperature, this is due to the energy input of the solar collector.

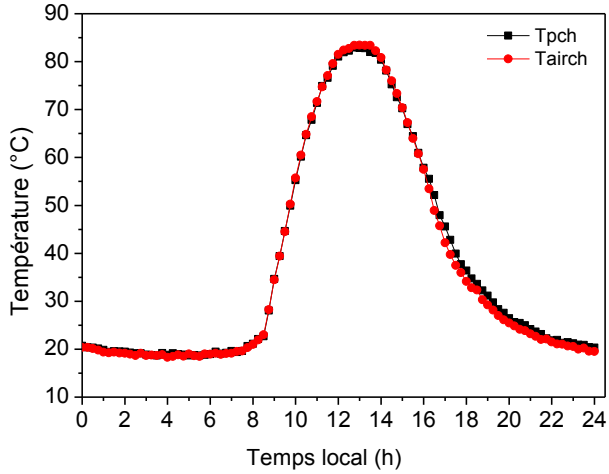

Fig. 6 : Hourly variation of temperature of cooling surface and water vapour in the condensation chamber during experiment day

Hourly variation of temperature of cooling surface and water vapour in the condensation chamber was represented in fig. 6. the position of the measurement of the temperature of the cooling surface and the water vapour temperature are closer. consequently, the temperature at these points have the same variation during the experiment day. the maximal temperature was measured at 14H15, which were equal to 82°C and 82 °C.

Fig. 7 illustrate the hourly variation of water production of modified solar still and the classical solar still. it can be noted that the production of distillate water started at 9H00. The production of the two stills increases to reach its maximum at 12h00 and then decreases. also, the most important production is observed between 11h and 13h. at the of the day. Along the day the production of the modified solar stills was greater than the basin solar still.

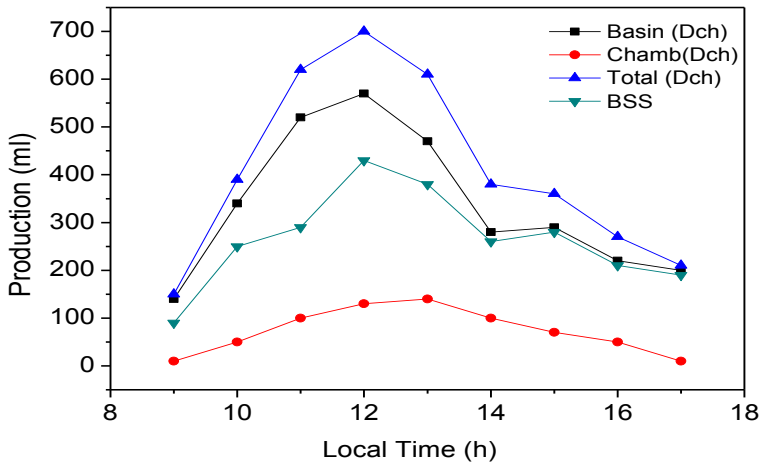

Fig. 7 : hourly variation of distillate during the experiment day

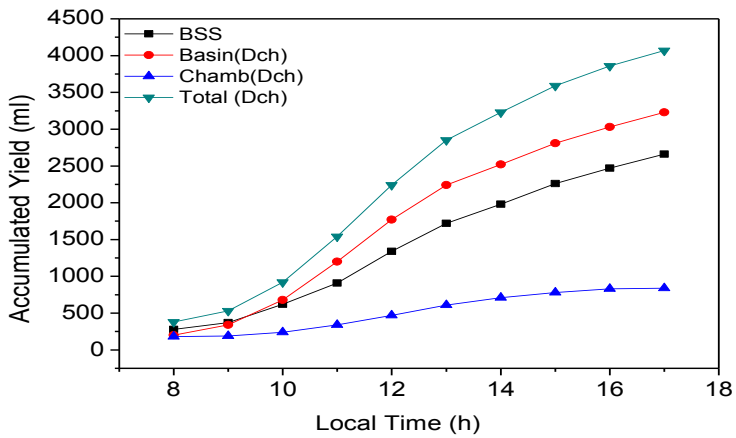

Fig. 8 Hourly variation of accumulated yield

The hourly Accumulated yield during the experiment day. we noted that the modified still produced 3230 ml and 840ml on the side of the basin and the condensation chamber respectively. Resulting in a total production of 4070 ml. while the production of the basin solar still produced 2660 ml. This gives an increase of 1410 ml (53%).

4. Conclusion

This paper consist to an experimental study of two solar stills. the first, is a simple basin still. the second is a modified basin solar still. the modification consist in adding to the solar still a condensation chamber and coupling it with flat plate solar collector. The tests were carried out under the meteorological conditions of the Bouisamail region (Tipaza, Algeria) during the day of 05/09/2013. The results obtained show that:
- the production of the distiller depends on several parameters, namely water temperature, wind speed and water depth .

- The daily production of the modified and the simple basin solar still during the experiment day. are 4070 ml / day and 2660 ml/day respectively

- The coupling the solar still with solar flat plate collector increase the production by 1410 ml (53%) compared to that of solar still at the same conditions.

5. Nomenclature

BSS : Basin solar still

Ch : condensation chamber

Basin : basin of solar stills

Dch : solar still with condensation chamber

T : temperature

Indice

Abs : absorber

Amb : ambient

air : air

ch : condensation chamber

g : Glass

p: wall

w: water

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