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Experimental Analysis of Parabolic Disc Type Solar Still

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Abstract
The daily water distillation of the single basin conventional solar still is limited. In the present work, experimental analysis of a parabolic disc type solar still and conventional solar still are investigated. The solar radiation is focussed to the single point to produce higher basin temperature. The water is flown continuously inside the copper receiver to utilize the incident solar radiation. The hourly readings were taken to analyse the thermal performance of the parabolic disc type solar still and conventional solar still. The water collection of parabolic disc type solar still is increased about 40% over conventional solar still.

Keywords : *Parabolic disc type solar still, Conventional solar still, water distillation.*

1. Introduction

Water is the basic requirement that all people need to survive. The people could live only for a few days or a few months without water. The water scarcity may direct to serious health hazards or even death. In global, 71% of the Earth's surface is water. Nearly 97% of water resources found on the earth's surface are stored in the oceans and seas and it is salty. Remaining 3% of the total water resources are fresh water. The major amount of fresh water is found frozen in the form of ice sheets and glaciers. A solar still is a simple device used to produce distilled or portable water from saline water sources such as sea water or brackish water. But the productivity of the solar still is limited. And so solar stills are normally used to provide small scale portable water needed in remote isolated locations. Many researchers optimized the constructional and operational parameter to increase the productivity of the solar still. El-Sebaii et al. [1] put attempt to improve the daily productivity of the single-slope single basin solar still integrated with a Shallow Solar Pond to carry out solar distillation at a relatively high temperature. Jianyin et al. [2] constructed a multi-effect solar still with corrugated shape structure, which augments the condensation rate. Akash et al. [3] performed the experiments for various cover angles of the solar still. The internal and external reflectors are utilized by Hiroshi Tanaka [4] in the single basin solar still. Dwivedi et al. [5] conducted the experiments for the solar still integrated with the flat plate collector which offers 51% higher productivity when compare with the double slope passive solar still. Tiwari et al. [6] fabricated a multi wick solar still with electrical blower. A pyramid shaped solar still was fabricated by Kabel [7] which gives 45% higher productivity than conventional solar still. Arunkumar et al. [8] constructed the tubular solar still with the water and air flow on the condensation cover and found that a tubular solar still with the cold water flow has the highest productivity. The effect of a water film cooling the glass cover was used on a single basin and it was concluded that the proper use of the film-cooling parameters may increase the still efficiency by up to 20%. The optimum mass flow rate of the cooling water over the glass cover was found to be 1.5 m/s [9]. Nafey et al. [10] studied on the main parameters affecting the performance of the solar still.

2. Experimental procedure

2.1 Conventional solar still

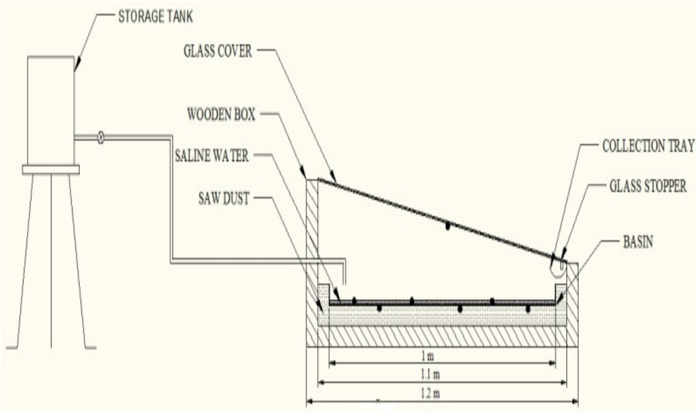

Fig.1 conventional solar still

The schematic diagram of a conventional single basin solar still is shown in Figure 1. The conventional solar still arrangement contains a storage tank, solar still, measuring jar, temperature measuring devices and pipe networks. And the figure 2 shows the conventional solar still arrangement. The solar still basin is made up of 2mm thick Galvanized Iron (GI) with 1m x 1m dimension at the depth of 0.12 m. The still basin is painted with matte black colour completely, in order to increase the rate of absorption of solar radiation.

Fig.2 conventional solar still

The solar still basin is enclosed inside a wooden box having dimension of 1.2 m × 1.2 m with a thickness of 0.19 m and height 0.1m. The inner sides of the wooden box are painted with white colour in order to reflect more solar radiation to the water surface. The space between the wooden box and the still basin is filled with sawdust in order to reduce the heat losses from still basin to the surroundings due to conduction. The plain glass of thickness 5mm is placed on the top of the wooden box at the latitude angle of 10^o. The plain glass acts as a condenser. The outer five sides of the wooden box were enveloped by sheet metal, in order to protect the wooden box from solar radiation and rain.

2.2. Parabolic disc type solar still

Figure 3 shows the experimental arrangement of the parabolic disc type solar still. The Parabolic Solar still consists of the parabolic disc, absorber tray, flexible PVC tube and measuring jar. Reflective glass pieces are fixed over the top surface of the parabolic disc. The Parabolic Disc concentrates the solar radiation in the point focus and tends to fall on the copper tray. The diameter of the Parabolic Disc is 1.2 m. The absorber tray is of rectangular shape with dimension 10 cm x 10 cm. The absorber tray made of copper is placed at the focal point of the parabolic disc. And the tray is coated with black paint to increase the rate of absorption. The higher temperature is achieved at the focal point. The water is flown on the top side of tray. The insulation material is wounded over absorber tray to reduce the losses due to heat transfer from the tray to the atmosphere.

Fig.3 Parabolic solar still

The mass of water is kept at very low level and so the water gets vaporized quickly even at low radiation. The water level is maintained in .5 cm height throughout the experiment. The water vapour is passed through the cooling heat exchanger for condensation. The condensed water drops slides down and collected in a measuring jar.

4. Results and discussions

Two solar stills were fabricated separately. One is conventional solar still and the other one is parabolic disc type solar still. Here the conventional solar still is kept as a reference. Experiments were conducted on the both stills at the same time and the results were tabulated. The taken readings plotted on a graph and the results were compared. Graph which indicates the hourly productivity of the both stills is shown below. From the graph we can come to know that the productivity of the parabolic solar still is higher than the conventional solar still. Since the solar radiation falling on the parabolic disc arrangement is converged to point focus, higher temperature is obtained at the point of focus.

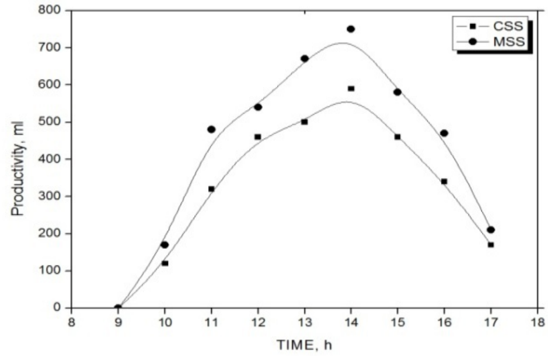

Fig. 4 performance of paraboloic disc type solar still

Where in contrast there are no focusing arrangements available in the conventional solar still. Compared to the conventional solar still higher temperatures can be obtained in the parabolic disc type solar still. The higher temperature was achieved in the solar basin at all the times. Thus the time required to evaporate the saline water is reduced. It is found that the productivity increased by 45.5%, when fins are used at the bottom of the still.

4.1 Error analysis

Table. 1 Accuracies and ranges of measuring instruments

Sl. no .	Instrument	Accuracy	Range	% Error
1	Thermocouple	$\pm 1^0$C	0 – 100^0 C	0.25
2	Kipp-Zonen solarimeter	±1 W/m^2	0 – 5000 W/m^2	0.25
3	Anemometer	±0.1 m/s	0 – 15 m/s	10
4	Measuring beaker	±10 ml	0 – 1000 ml	10

Table 1 shows the degree of error analysis for different measuring instruments used in the experiments. The least error occurred in any measuring instrument is equal to the ratio between its least count and minimum value of the output measured.

5. Conclusion

Experiments to find the yield of the distilled water from conventional still and concentrated solar still were carried out. From the results it is found that the average daily production of distilled water from the parabolic disc type solar still is higher compared to the conventional solar still. The average daily output of 2.810 liters/day is achieved where in contrast the ordinary solar still has produced 2.220 liters/day.

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