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Performance and Analysis of Single Slope Solar Still

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ABSTRACT: To enhance the productivity of basin type solar still, double slope solar still was fabricated. For further increase in the productivity of the double basin solar still, black granite stones and black jute cloth were used. In addition to this, internal and external mirrors were also used. Three identical solar stills were constructed and tested. The daily production of solar still without any modification (still-I), still with basin materials (still-II) and still with basin materials and reflectors (still-III) were 1.83, 2.26 and 2.99 liters per day respectively. The productivity of solar still- I, II and III were 36.57, 45.14 and 59.71% respectively.

KEYWORDS: Desalination, Insulation materials, Reflecting Mirror, Solar still.

I. INTRODUCTION

Water is a most valuable resource of the earth. The plants, animals, human beings and all living creatures need water for their existence. In the world, one person in five lack access to safe drinking water. Nearly 97% of the available water in our planet is salty sea water. About 2% of the water exist in polar regions in frozen state. Only 1% water is available for human consumption. But many water sources are brackish and contain harmful bacteria. Desalination is the best solution for the above problem. Many desalination techniques are available to get fresh water. Solar distillation is one of the cheapest methods to solve this problem. Murugavel and Srithar [1] theoretically modeled a single basin double slope solar still. The yearly average production was 4.75 liters/m² day. Rajaseenivasan et al. [2] tested the efficiency of the solar still with river sand, metal scarp and charcoal and distillate output increased by 26.74, 29.3 and 33.7% respectively. Prakash Malaiyappan and Natarajan Elumalli [3] coupled various basin materials like helical copper coil, aluminum fins, and long hollow stainless tube with solar basin. The combination of the above three increased the productivity by 92%. From the above discussion; it is clear that the productivity of the solar still can be increased by adding heat storage materials in the basin and spreading wick material in the basin water. Further internal and external mirrors can also be used to increase the performance of the still. Our objective is to optimize the performance of the double slope solar stills with basin materials and reflectors.

II. EXPERIMENTAL SETUP

To increase the efficiency of the solar still a double slope solar still was fabricated. The dimension of the basin was 1mX 0.6mX0.4m. It was made up of galvanized iron of 2 mm thick. The basin was placed inside the wooden box and a gap of 1.5cm was maintained between the basin and outer cover. The gap was filled by saw dust. The inner surface of solar basin was painted black to increase the absorption of solar radiation. The basin cover was covered by a double slope glass cover. The basin cover was made up of 4mm thick transparent glass and an angle of 30° was maintained.

2.1 Basin materials

To increase the efficiency of the solar still, heat storage material was spread in the bottom of the basin. The black materials have greater heat absorption and storage power. So half inch thick black granite pieces were used as basin material. Further the evaporation can be increased by using wick material in the base. So the black jute cloth was spread in the basin water.

2.2 Reflecting mirrors

To focus more solar radiation into the still, external reflectors were used. The reflecting mirror of size 40cmX60cmX1cm was fitted on a steel frame. The angle of the reflecting mirror was adjusted with the help of the

stand. Periodically the angle of mirror was adjusted so that maximum solar rays were focused into the basin. Further the four inner walls of the basin was covered by reflectors to minimize the loss of heat to the ambient and reflecting back of radiation into the still.

3. Experimental procedure

Experiment was conducted as per the following program. 1. Solar still-I No modification was made. 2. Solar still II- Basin materials added. 3. solar still III- Basin materials and reflectors added. The experiment was conducted during the month of March 2016 in Villianur, Pondicherry, India. The experiment was conducted in the three solar stills simultaneously. The experiment was started at 8.00 hrs and continued up to 18.00 hrs. Before the experiment was started, 5 liters of saline water was poured into the three solar stills. The experiment was repeated for seven days.

IV. RESULTS AND DISCUSSION

4.1 Double slope solar still alone

In this experimental setup, no modification was added with the double basin solar still. The output of distilled water varied with changes in ambient temperature. When ambient temperature increased, the production also increased. The ambient temperature ranged between 32^oc and 38^oc. As a result, the output also ranged between 1.6 liters and 2.2 liters. The average output of the double slope solar still without any modification was 1.83 liters and maximum daily productivity attained was 44%. But the average daily productivity was 36.57%.

4.2 Double slope solar still with basin materials

In this experimental setup, black granite gravel and black jute cloth were used in the basin of the double slope solar still. In this modifications improved the performance of solar still. The output of the solar still ranged between 1.9 liters and 2.8 liters. The maximum output of 2.8 liters was obtained when ambient temperature was 38^oc. The average output was 2.26 liters and it was higher than the solar still I by 0.6 liters per day. The average daily productivity was 45.14% and it was higher than the productivity of solar still-I by 8.57%.

4.3 Double slope solar still with basin materials and reflectors

In this experimental setup, along with basin materials, internal and external reflectors were also used. As a result, there was spectacular improvement in the performance of the modified solar still. The distillate output reached the maximum of 3.6 liters when the ambient temperature was 38^oc. The production ranged between 2.4 liters and 3.6 liters along with variation in the ambient temperature. The average output was 2.99 liters and the maximum daily productivity reached was 72%. The daily average productivity which was 36.57 in solar still –I improved to 45.14 in solar still-II. It further improved to 59.71 in solar still-III

4.4 Comparative performance of solar stills

The comparative performance of the solar stills. The performance of solar still is greatly determined by ambient temperature and the modifications attempted in the still. The performance of the solar still-II was higher than the solar still-I. The performance of the solar still III was higher than the performance of solar still-I and solar still-II. Further the performance of all the above three stills varied along with ambient temperature. The relationship between the ambient temperature and the performance of the three solar stills are given in the fig.1.

4.5 Increase in productivity

Compared to solar still –I the productivity of solar still-II and solar still-III was higher. In other words the basin

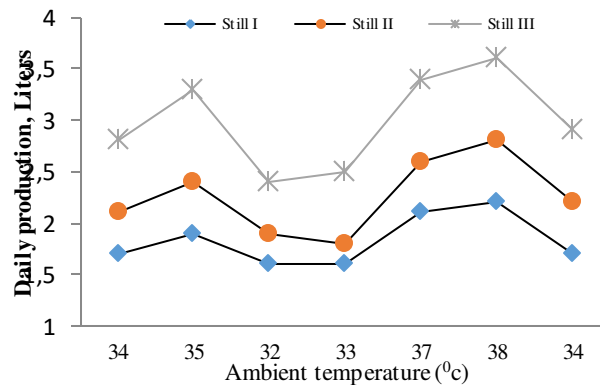


Fig.1 Performance of solar stills

materials added with still and reflecting mirror fitted with the still improved the performance. To what extent the Modifications improved the productivity of the modified solar stills is given in fig.2.

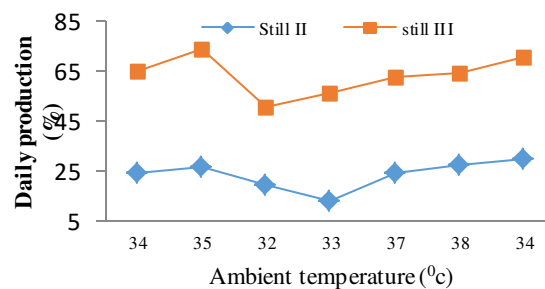


Fig.2 Productivity increase

V. CONCLUSION

Three identical solar still were fabricated. In solar still –I no modification was made. In solar still-II basin materials, i.e., black granite stone and black jute cloth were used in the basin. In addition to that, in solar still-III, internal and external mirrors were fitted with it.

1. The daily productivity of solar still-I, II and III were 36.57, 45.14 and 59.71% respectively.
2. The productivity of solar still-II was 23.08% higher than solar still-I and the productivity of solar still-III was higher than solar still-I by 62.97%.
3. The distillate production slowly increased and reached the maximum at 13 hrs and then it declined

To conclude, the spreading of basin material in still basin and fitting internal and external mirrors significantly increased the distillate production in double basin solar still.

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