7. Desalination using FPC and SPC

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Abstract:

Present work is an effort to study the PV panel integrated solar still to generate power and to do desalination process to meet the water and power scarcity issues. The system performance is experimentally investigated from different aspects such as still productivity, still efficiency, PV panel power production, PV panel efficiency, and exergy efficiency. Results show that the maximum distillate output of 7.3 kg was obtained when ISPB still with the side wall and bottom insulation. The fresh water production from ISPB still with the side wall and bottom insulation, ISPB still with Side wall insulation and ISPB still without any insulation was 7.3 kg, 4.4 kg and 3.7 kg respectively. The daily energy efficiency and exergy efficiency of ISPB with the side wall and bottom insulation are higher compared to other cases. The daily efficiency of 34.5%, 38.3% and 71.2% and exergy efficiency of 1.3%, 2.3% and 4.5% was recorded for ISPB still without any insulation, ISPB still with the side wall insulation and ISPB still with side wall and bottom insulation respectively.

From the above literature, it is inferred thatstill basin made using steel plate gets easily corroded due to oxidation process but glass basin solar still produced higher yield without any corrosion issues. Solar panel efficiency depends on solar cell temperature, and also it needs periodic cleaning for higher efficiency. Integrated PV/T solar still is used for isolated communities facing electrical energy troubles and a scarcity of good quality water. Hence in this work, PV panel is used instead of steel plate in the basin to avoid corrosion which increases the solar panel and solar still's lifetime. It also generates power as an additional advantage. This setup results in thin water depth, higher evaporation rate, and moisture maintenance.

1. **Design and construction of the inclined solar panel basin still (ISPB still)**

Fig. 1 and Fig. 2 show the schematic diagram and experimental setup of an inclined solar panel basin solar still. It consists of a basin of PV panel (polycrystalline) mounted to an inclined solar still and kept in an inclined position. The efficiency of polycrystalline- PV panel is on average of 13-16%. The length and breadth of solar still were 1810 mm and 920 mm respectively with a side wall height of 150 mm. A normal 4mm thickness transparent glass was used to manufacture a solar still. The collector cover is made from a transparent glass of the same thickness. To reduce the vapor losses from the still basin to the surroundings, the ISPB still was fully sealed by silicon paste. In the basin of solar still, cotton thread is pasted in the space between the consecutive rows and columns of the solar cell. Cotton thread is acting as a wick materials and it increases the evaporation rate. Fig. 3 shows the water flowing arrangement in ISPB still. In this setup, water is flowing from the saline water storage tank through the control valve and PVC pipe to the basin of solar still. PVC pipe is equally holed to distribute the water uniformly to the still basin. The input feed water is maintained at a constant mass flow rate of 0.0023 kg/s. Hot water leaving from the still is collected in water storage tank and again it is set to flow from saline water storage tank. Temperature sensors were mounted on the solar still to measure the collector glass, PV panel, and exit water temperatures. At the end of the solar still, a distillate collector is placed so as to collect the condensed water from the inner glass surface.

Environmental parameters such solar intensity and wind velocity were measured using TES 1333 solar power meter and AM4836 cup anemometer respectively. The voltage and current generated from the solar panel weremeasured using a digitalmultimeter. The accuracy, range, and error of instruments used in the present experimental study are given in table 1, while the uncertainty analysis shows that the experimental error from solar meter, glass, basin, and exit water temperatures were found to be 3.04, 1.26, 1.27 and 1.28 % respectively. Cost analysis for the ISPB still is given in table 2.

Experiments were carried out by three different conditions i) inclined solar panel basin still without insulation ii) inclined solar panel basin still with side wall insulation iii) inclined solar panel basin still with the side wall and bottom insulation. All the experiments were carried out under natural solar radiation condition.

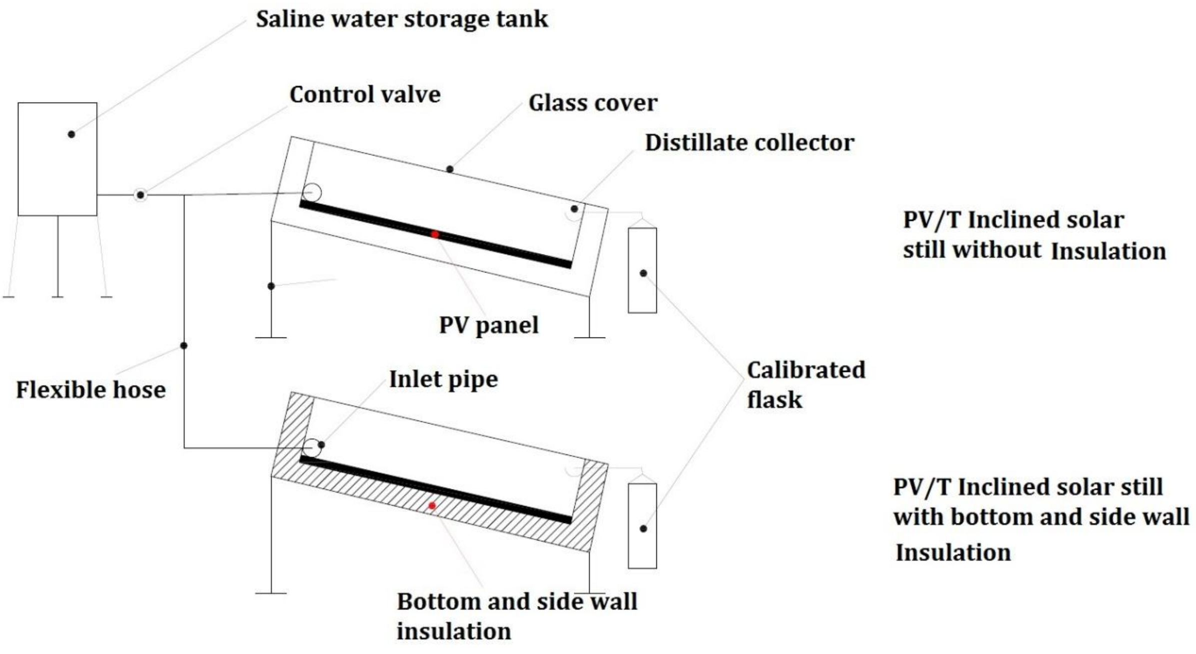

Fig. 1 Schematic diagram of modified PV/T solar still with and without insulation

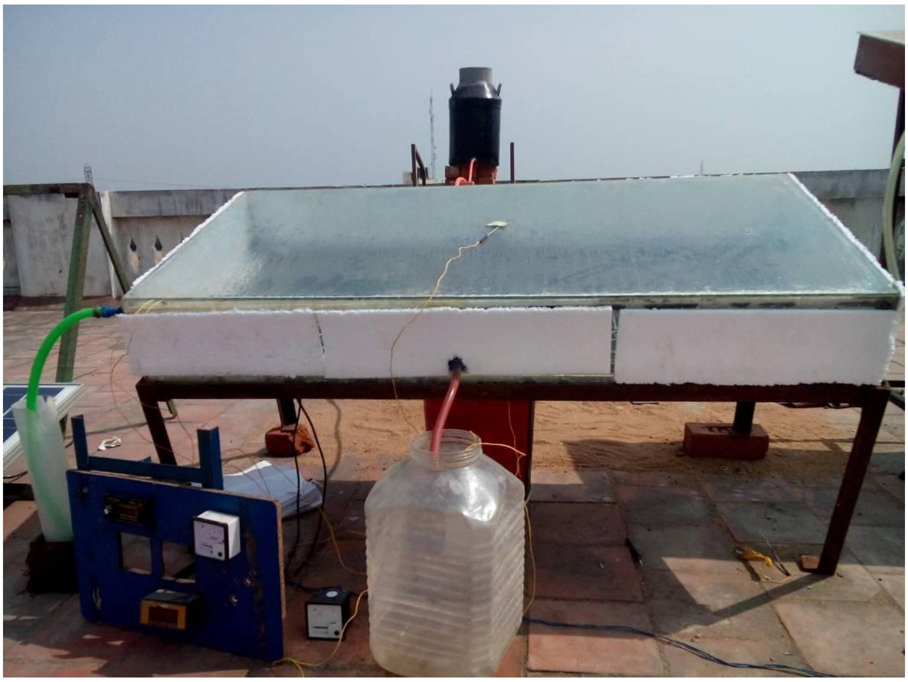

Fig. 2 Experimental set-up of inclined Solar panel basin solar still with insulation

Fig. 3 Water flowing arrangements in solar panel basin solar still.

2. CONCLUSIONS

The effect of the insulation on the performance of the ISPB still has been experimentally studied. The results indicated that the daily productivity and efficiency of ISPB still with the side wall and bottom insulation is higher than the side wall insulation and without insulation. The still efficiency is increased and the panel efficiency is decreased in the case of bottom and side wall insulation. The reason for higher efficiency of still and lower efficiency of the panel is higher heat gain in the basin. The improvement in production rate with the side wall and bottom insulation and side wall insulation is about 49 and 16% respectively compared to the without insulation condition. ISPB still with the side wall and bottom insulation and ISPB still with the side wall insulation increase the daily efficiency about 51.54 and 9.92 % respectively than the ISPB still without insulation. The exergy efficiency of ISPB still with the side wall and bottom insulation and ISPB still with side wall insulation increases about 71.11 and 43.48% respectively than the ISPB still without insulation.

CENTRE FOR EXCELLENCE IN ENERGY AND NANO TECHNOLOGY

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PROJECT MEMBERS DETAIL:

S.No	Name of The Project	Lab Utilization	Student Participated in the Project
1	Experimental Study on Novel Hybrid PV Desalination system using Hybrid Nanofluids	Sonication, PV & solar still test rig, solar power meter, temperature sensors, anemometer, calibrated flask	**(ACY 2016-17)** S. Aravindan R. Basheer Ahmed R. Bhuvaneshwar K. Kuralinniyan

PROJECT OUTCOME:

Paper Published

1. Kabeel, A.E., Arunkumar, T., Denkenberger, D.C. and Sathyamurthy, R., 2017. Performance enhancement of solar still through efficient heat exchange mechanism–A review. *Applied Thermal Engineering*, *114*, pp.815-836.
2. Manokar, A, Winston D,Kabeel, A.E& Sathyamurthy, R &Thirugnanasambantham, Arunkumar. (2017). Different parameter and technique affecting the rate of evaporation on active solar still -A Review. Heat and Mass Transfer. . 10.1007/s00231-017-2170-9