



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

# IJIRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 7, July 2021

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 7.569



9940 572 462



6381 907 438



ijirset@gmail.com



www.ijirset.com

# Performance Enhancement of Solar Still with Evacuated Tubes and Perforated Fins

Yogesh R. Patel<sup>1</sup>, K.D.Parmar<sup>2</sup>, V.P.Chaudhari<sup>3</sup>

P.G. Student, Department of Mechanical Engineering, H.C.E.T, Sidhpur Gujarat, India<sup>1</sup>

Assistant Professor, Department of Mechanical Engineering, H.C.E.T, Sidhpur Gujarat, India<sup>2</sup>

P.G. Student, Department of Mechanical Engineering, H.C.E.T, Sidhpur Gujarat, India<sup>3</sup>

**ABSTRACT:** Solar still is a simple device uses the solar energy to convert the available brackish or saline water into potable water. The low distillate output wouldn't make it as popular as RO (Reverse osmosis) system. Hence, the lots of efforts have been made by the different researchers from all around the world to enhance the distillate output of the solar still. Generally 3 litres/day/m<sup>2</sup> capacity is consider for the passive solar stills.

In this present research work, the solar still of 1 m<sup>2</sup> area has been coupled with the evacuated tubes to enhance the temperature water in the basin of the still. Two cases has been compared for the given still namely with and without use of the perforated fins. Generally, the fins increased the surface area of the water, but the perforated fins not only increase the surface area of water but also store some water in holes, so the off-sunshine hour's distillate output also remains higher. Study has been carried out from 1<sup>st</sup> March to 15<sup>th</sup> March 2021; it has been used for testing the two conditions i.e. with and without use of perforated fins. From the research work, it has been concluded that the distillate output of solar still with perforated fins found higher for the sunshine as well as off-sunshine hours during the experimental days. The reason behind higher distillate output from the active solar still with perforated fins is the higher surface area of water as well as lower preheating time.

**KEYWORDS:** Solar still with evacuated tubes, Distillate, Perforated Fins.

## I. INTRODUCTION

Clean water is the basic necessity of the human race for all the domestic, industrial, and process work for day-to-day life. Clean water resources are very limited as only almost 3 % of the freshwater is available from the total water body on this planet. Almost 70% of that freshwater is in the glaciers and snow, so at the end, the human being has only 0.25% of the freshwater is available in water bodies like rivers and lakes. Population growth, Industrialisation, and Agricultural need has risen up the demand of the freshwater day by day. Hence people have increased the exploitation of the available resources which leads to water scarcity all across the world, so researchers all over the world have started to look after the solution in form of the desalination of the seawater or brackish water. By the use of solar energy, saline water is converted into potable water. Different desalination techniques are invented and put into the work for potable water need fulfilment like Electro dialysis, Reverse osmosis, Multi-stage flash desalination, Multi-effect desalination, Vapour compression desalination, Membrane Desalination, Humidification and Dehumidification, and solar stills. Among all this said desalination system solar desalination is the cheapest and easiest approach but suffering from the low yield. Hence in this work attempt is made to increase the yield by the attachment of the evacuated tubes and the perforated fins in the solar still basin. A comparative performance investigation is carried out between with and without perforated fins for the same unit.

## II. RELATED WORK

El-Sebaei et al. [1] used the stearic acid as an energy storage medium in the solar still and noticed the significant hike in the fresh water production rate. Wick material increases the exposure area for evaporation in solar still and thereby elevated fresh water yield. A single basin double slope solar still was inspected with the aluminium fin and wick materials in basin. It was claimed that the fin with cotton cloth has better distillate output compared to the other materials. Hansen et al. [2] a single basin single slope solar still was evaluated with a corrugated absorber plate and wick materials in the basin. The modification elevated the basin heat transfer rate and resulted in notable fresh water yield compared to the conventional solar still. Omara et al. [3] Fins had been used in the solar still to increase the radiation

absorption area and the basin heat transfer rate to the water. Rectangular fins were adopted in a single basin solar still with sponges, pebbles, black rubber and sand in the basin. Velmurugan et al. [4] Peak production rate of 7.5 kg/m<sup>2</sup>.day was realized with the porous fin in summer season. The significance of fins with respect to its numbers, its height and shadow effect on the fresh water yield capability of a solar still was demonstrated that the distillate output accelerated with the number of fin and height of fin. El-Sebai et al. [5] a comparative study was performed between the conventional solar still, vertical finned solar still and corrugated finned solar still. Both the finned solar stills gave better results compared to the conventional solar still and augmented the distillate by 40% with the vertical finned solar still and 21% by corrugated finned solar still. Omara et al. [6] An experiment was carried out in a pin-finned wick solar still attained 23% superior distillation rate compared to the solar still without pin-finned wick in basin Alaian et al [7] The rise in basin water temperature escalates the distilled water productivity. External collectors have been used to supply the preheated water to the solar still. An evacuated tube solar collector connected to a Solar still was checked by varying the water flow rate and water depth. The integration of solar collector augmented the water temperature in solar still. A mass flow rate of 0.06kg/s and the water depth of 0.03 m were found to be optimum. Panchal et al (2020) have carried out comparative experimental investigation among the, Conventional solar still (CSS), Solar still with vertical and inclined fins (30-degree inclination), used for six-month experimentations from July 2019 to December 2019 at Gandhinagar, Gujarat. They found that the yield of the Inclined fins solar still is highest among three, subsequently followed by Solar still with vertical fins and conventional solar still, output increment yield was 26.77% for still with inclined fins and 24.19% for still with vertical fins with respect to conventional still due to increase still basin heating area. They also found the output water from raw water has improved quality for drinking.

### III. METHODOLOGY

Design the experimental setup in CAD software and fabricate it as per design dimensions. The inner surface of the basin is painted black to absorb the maximum solar radiation. Assemble the components of setup and equipped with measuring points. Put temperature sensors at the inner surface of the glass cover and in the basin water. For comparison Single unit is taken under testing for two varying situations say with and without perforated fins. Experimentation is carried in the month of March 2021 and data is collected. Naturally, raw water is heated in sunlight with the help of a basin along with perforated fins and evacuated tubes, Hence water gets evaporated and condenses at the inside surface of the glass cover which is drains down to the collecting channel under gravity. This collected water gets out by outlet pipe given to the channel and collecting in the bottle which is measured with measuring jar. Hourly temperature, Radiation data, and Distilled water collection have been recorded manually. Compare the results obtained from the collected data of the systems then derive the conclusion.

#### Assumptions made for Experiment:

- Glass Cover Inclination Angle 23°.
- Entire unit is south facing located at GEC(23.8093°N, 72.1034°E), Patan, Gujarat
- Design of Solar still is made up of Galvanized Steel of 1m<sup>2</sup> Area.
- 27 numbers of perforated fins of 10 mm diameter and 40mm height are

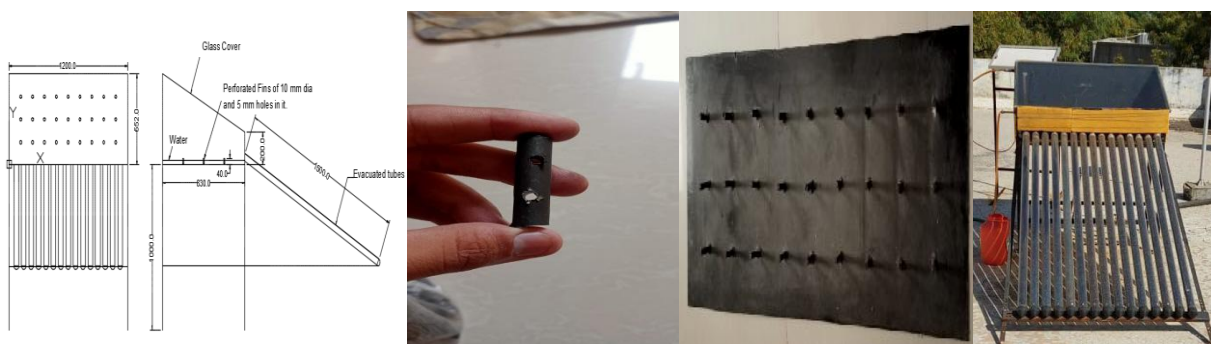
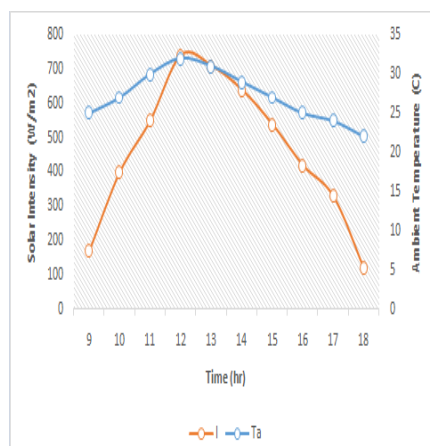


Fig. 1 (a) Schematic Diagram (b) Perforated Fins (c) Perforated fins attached to the basin plate (d) Experiment Setup

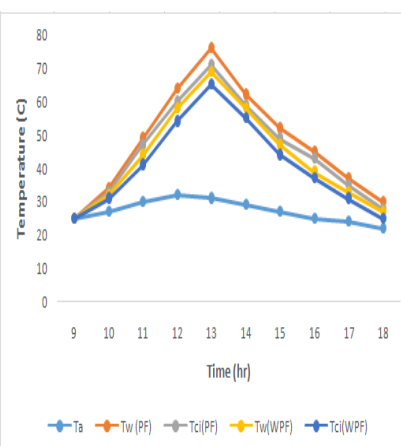


## IV. EXPERIMENTAL RESULTS

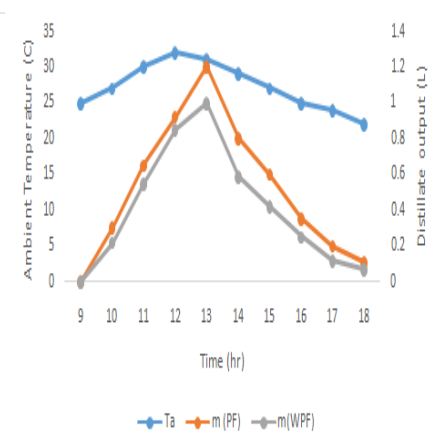
Fig. 2 (a) shows the comparison between the solar intensity as well as ambient temperature for the time interval during the experimental day. It is found that the curve of ambient temperature and solar intensity does not remain the same all the time during the experimental day. The experiments start during morning 09 am so the ambient temperature as well as solar intensity found increased up to noon and then it reduces. Here the maximum ambient temperature and solar intensity 32 degrees celsius and 740 W/m<sup>2</sup>. Fig. 2 (b) shows the variations of water, inner glass cover, and ambient temperature with respect to time during the experimental day. It is found that the water and inner glass cover temperature curve remains similar trend during the experimental day. The reason behind the similar trend is the same phenomena of rising or fall in temperature and both depend on themselves. Also, the time of obtaining higher water as well as inner glass cover temperature also found same i.e. 01: 00 pm. Here perforated fins have been used to increase the surface area as well as reduce the preheating time of water. It is the reason for the higher water temperature in the case of perforated fins coupled solar still as compared with the absence of fins. Also, the higher water temperature leads to the higher inner glass cover temperature too. Also, the higher inner glass cover temperature reduces the condensation temperature, so the distillate output remains lower. It has also been found that the solar intensity remains maximum at noon and higher water temperature is found at 1 pm. The reason is the heat capacity of the water and also the small reduction of the solar intensity at 1 pm as compared with noon. Fig. 2 (c) shows the variations of the distillate output with and without the use of the perforated fins used in the experimental day. The distillate output (m) is the main outcome from the saline water in the basin. Also, it is produced due to the evaporation as well as condensation process that occurred in the solar still. It is shown that the distillate output of the solar still with and without the use of the perforated fins found a similar trend. But during morning 09 am to 01 pm afternoon the difference between the with and without the use of perforated fins was found lower as compared with during the 01 pm to 05 pm during the experimental day. The reason is the solar intensity remains lower at the time of 09 am so the water temperature also remains lower and hence, the evaporation and condensation remain lower and distillate output is lower. Between 01 pm to 05 pm, the average solar intensity remains higher as compared with the 01 am to 01 pm. That is the reason behind the variations of the distillate output. Also, it is seen that the use of perforated fin increased the surface area of water, so the temperature (water and inner glass cover temperature) remains higher as compared with the absence of the perforated fins in the solar still. Also, maximum distillate output received in both the cases, at 01 pm and output was 1.2 L. Cumulative variations of the distillate output are shown in Fig. 2 (d). Cumulative distillate output is the sum of the respective hours used in the experimental days. i.e. the cumulative output at 12 pm is the summation of the distillate output received at 09 pm, 10 pm, 11 pm, and 12 pm too. From the Fig 2 (d) it has been found that the cumulative distillate output of the solar still with perforated fins remains higher as compared with the absence of the fins.



(a)



(b)



(c)

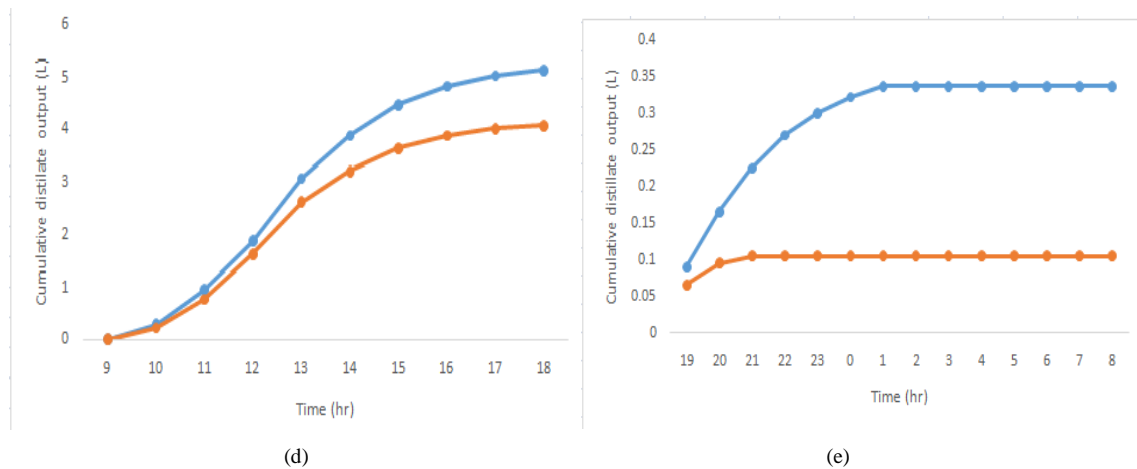


Fig. 2.(a) variation of solar intensity and ambient temperature (b) variation of water, inner glass cover temperature and ambient temperature (c) Hourly variation of the distillate output with and without use of perforated fins during sunshine hours (d) cumulative hourly variation of the distillate output with and without use of perforated fins during sunshine hours (e) Hourly variations of the cumulative distillate output during off sunshine hour during experimental day.

Fig.2(e) Exhibits the hourly as well as cumulative distillate output received during the off-sunshine hours during the experimental day as well as off-sunshine hours. it has been found that the due to higher heat capacity of the water in the solar still with perforated fins, the water temperature remains somewhat higher so the evaporation as well as condensation remains continue in less quantity as compared with the sunshine hours. so the distillate output of the solar still with perforated fins found higher as compared with the absence of the fins. also the maximum cumulative yield of 0.372 l of water obtained during the off-sunshine hours from the solar still with perforated fins.

## VI. CONCLUSION

Solar still is a very simple device which is used to convert the available brackish or saline water into the potable water by use of solar energy. The water temperature and inner glass cover temperature are two main parameters on which the distillate output of the solar still depends. Higher water temperature and lower inner glass cover temperature always leads to the higher distillate output from the solar still. The use of the evacuated tubes coupled with the solar still supply the hot water to the basin, also the higher water temperature leads to higher evaporation rate. The use of the fins increased the surface area of the water, because the area of the basin is 1 meter square and fins also leads to increment in overall surface area of the water increased. The water temperature and inner glass cover temperature of the solar still with use of perforated fins remains higher during the experimental day. The higher water temperature in the basin leads to the higher evaporation rate of the water which leads to higher distillate as well as cumulative distillate output of the water as compared with the absence of the perforated fins. The heat capacity of the water as well as the storage of the water in the fins due to the presence of perforation the distillate output also obtained from the solar still with fins. Also it remains higher as compared with the solar still with absence of fins. Solar still with the evacuated tubes and perforated fins is a found best configuration to increase the distillate output.

## REFERENCES

- [1] El-Sebaei, AA, Al-Ghamdi, AA, Al-Hazmi, FS and Faidah, AS 2009, 'Thermal performance of a single basin solar still with PCM as a storage medium', Applied Energy, vol. 86, pp. 1187-1195.
- [2] Hansen, RS, Narayanan, CS & Murugavel, KK 2015, 'Performance analysis on inclined solar still with different new wick materials and wire mesh', Desalination, vol. 358, pp.1-8.
- [3] Omara, ZM, Kabeel, AE, Abdullah, AS & Essa, FA 2016, 'Experimental investigation of corrugated absorber solar still with wick and reflectors', Desalination, vol. 381, pp. 111-116.
- [4] Velmurugan, V, Deenadayalan, CK, Vinod, H & Srithar, K 2008a, 'Desalination of effluent using fin type solar still', Energy, vol. 33, pp. 1719-1727.
- [5] El-Sebaei, AA, Ramadan, MRI, Enein, SA & El-Naggar, M 2015, 'Effect of fin configuration parameters on single basin solar still performance', Desalination, vol. 365, pp. 15-24.



- [6] Omara, ZM, Hamed, MH & Kabeel, AE 2011, 'Performance of finned and corrugated absorbers solar stills under egyptian conditions', Desalination, vol. 277, pp. 281-287.
- [7] Alaian, WM, Elnegiry, EA & Hamed, AM 2016, 'Experimental investigation on the performance of solar still augmented with pin-finned wick', Desalination, vol. 379, pp. 10-15.
- [8] Mevada, D., Panchal, H., Sadasivuni, K. kumar, Israr, M., Suresh, M., Dharaskar, S., & Thakkar, H. (2020). Effect of fin configuration parameters on performance of solar still: A review. *Groundwater for Sustainable Development*, 10(September 2019), 100289. <https://doi.org/10.1016/j.gsd.2019.100289>



**Impact Factor:  
7.569**



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 **9940 572 462**  **6381 907 438**  **ijirset@gmail.com**



[www.ijirset.com](http://www.ijirset.com)

Scan to save the contact details