Design and Performance Analysis of Solar Still Using Sun Tracking System

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Abstract-*This paper presents evaluation of performance of solar water distillation using solar still coupled with sun tracking system. Solar distillation is a simple, cheap and most attractive technique among other distillation pro-cesses and it is particularly suitable for small-scale units at locations where solar energy is in significant amount. In this paper, experimental investigations were carried out on single slope basin type solar still with solar tracking system. The significance of employed solar tracking in conventional solar still is to increase solar incident radiation throughout the day, to increase overall distilled output of the solar still. An automatic solar tracking system employed using dc motor coupled with chain sprocket, to track maximum possible solar radiation by rotating solar still with the movement of the sun. Experimental results were carried out between the hours of 8:00 am to 6:00 pm for a period of 15 days and analysed.the result clearly show that the greater yield occurred between 12:00 pm to 3:00 pm in a day. It was observed that the average yield of conventional basin type solar still (tracked) is about 300 ml/day as com-pared to solar still (fixed) 220ml/day in December-January (winter season).*

Keywords-Solar energy, solar tracker, solar still, Distillation, re-newable energy.

I. INTRODUCTION

Water is the gift of the nature which is very much essential for the life on earth. Although water is available in plenty of amount on the earth but it's not drinkable. 97 % percent of the total water present on the earth lies in the oceans, remaining 2 % is brackish and only 1 % is fresh water.

Next to oxygen, fresh water is the most important substance for sustaining human life. Access to fresh water is considered to be a basic human need. However, the increased use and misuse of this resource by the population growth and increased industrial activities may lead to a condition where whole world have to think about the management of water resources.

II. CONVENTIONAL SOLAR STILL

There are so many technologies available to distill water but distillation of the water takes place using heat of the sun is called solar still. Solar still is quite cheap and simple. It consists of shallow blackened basin with transparent glass cover. The sun heats the water of the basin causing evaporation. Evaporated water vapour rises, condensed by the cover and runs down into the collecting trough leaves salts, minerals and impurities in the basin.

Despite the fact that this technology can provide a cheap source of potable water but this device is only 30% efficient and require 2m2 to provide for one person's daily needs. The solar stills have often been used in the region where there is abundant supply of solar energy is present.

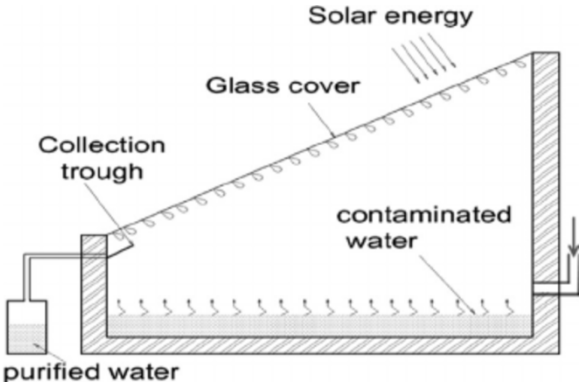


Fig: 1. Schematic diagram of conventional solar still

Many adaptations have been made to the solar still design to improve the efficiency, however not so much attention has been paid to sun tracking. In this thesis, a small sized basin-type solar still was designed to investigate the effect of sun tracking on the performance of conventional solar still using actual environmental conditions.

This study will investigate the use of sun tracking to improve the distilled water yield from a conventional solar still.

III. EXPERIMENTAL SET UP

The experimental setup is one of the simplest types of solar stills. It has an effective area of 1720 cm2. The frame is made of Galvanized iron. It has a top cover of transparent glass and the interior surface of its basin is blackened to enable absorption of solar energy to the maximum possible

extent. The outer body is made of plywood, 8 mm thick and shaped as an inclined box placed on a horizontal tracking system. While the identical fixed solar still is faced south direction. The whole assembly was air tight made with help of double sided tape and clips. Different parts of the still will be explained in the following:

A. Basin liner

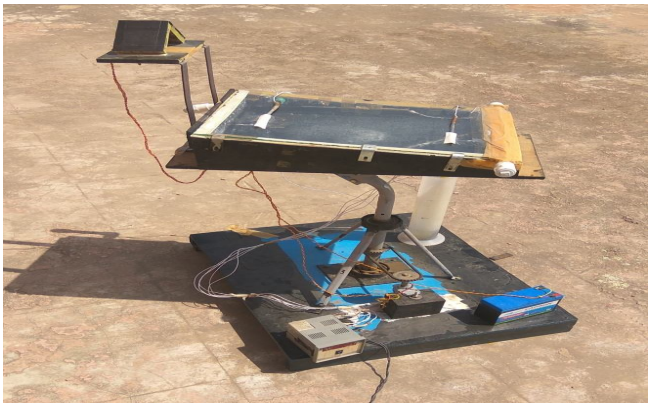
This is the major part of the solar still. It absorbs the incident radiation that is transmitted through the glass cover. The basin liner should be resistant to hot saline water, have a high absorption of solar radiation. A very large amount of the solar radiation, direct and diffused, falling in the still is absorbed by the blackened base. Small reflection losses occur by the glass surface and the water surface. The energy absorbed at the base is largely transferred to the water in the still and a small fraction of it lost to the ambient by conduction through the base. The water enters the basin through an inlet tube. A trough made of PVC is fixed inside the still, and is tilted so that condensed water can be accumulated in the glass beaker outside the still through a plastic pipe.

B. Transparent cover

The cover of the solar still must transmit maximum solar radiation with minimum amount of absorption and reflection. It also acts as resistance to thermal radiation heat transfer from the basin to the atmosphere. It was fixed at 160 with the horizontal on the top of the inclined still.

C. Insulating material

The insulating material is used to reduce the heat losses from the bottom and the side wall of the solar still. In this work, the insulating material is thermocol (polystyrene) of 10 mm thickness and 0.045 W/m2 K thermal conductivity.



D. Measuring instruments

Various types of measurement instruments were used such as:

(1) Pyranometer: To measure the total radiation.
(2) Glass beaker: To collect the distillate water.
(3)Temperature thermometer: to measure temperature at various points in the still by thermocouples (type-k). The accuracy of this device is in the range of 0.5°C for the temperature measurements between 1 and 99°C.

Fig: Measuring instruments

IV. PERFORMANCE ANALYSIS

The performance analysis of the experiments are represented in the form of the graphs ,to show the variation of the various parameters i.e. solar intensity, basin water temperature ,external glass cover temperature, still inside temperature and distilled yield using sun tracking system in solar still. All the readings are taken in the month of December in sunny day.

Comparative study of solar radiation intensity, temperature of basin, glass and inside temperature of solar still and distilled yield are shown in graphical from fig. 3.1, 3.2, 3.3, 3.4, and 3.5 respectively.

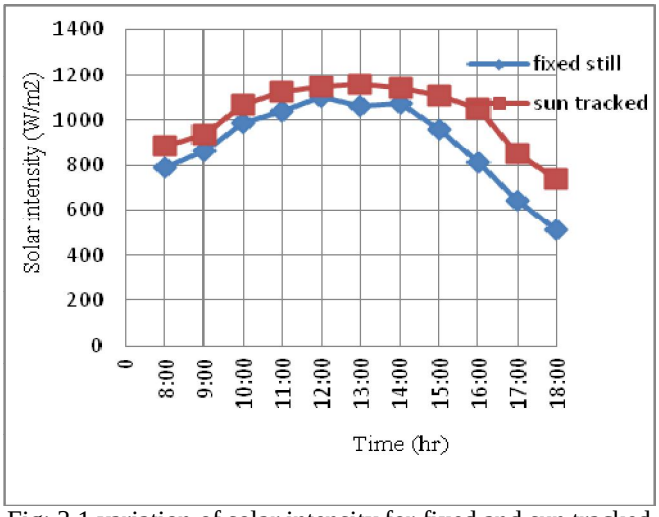


Fig: 3.1 variation of solar intensity for fixed and sun tracked solar still.

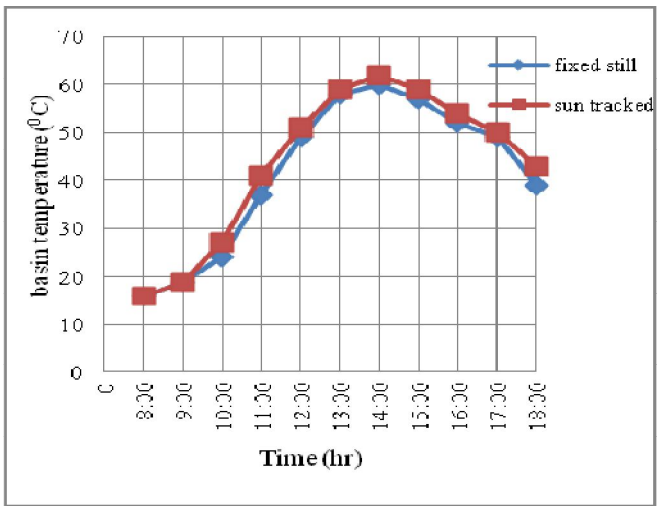


Fig: 3.2 variation of basin temperature for fixed and sun tracked solar still.

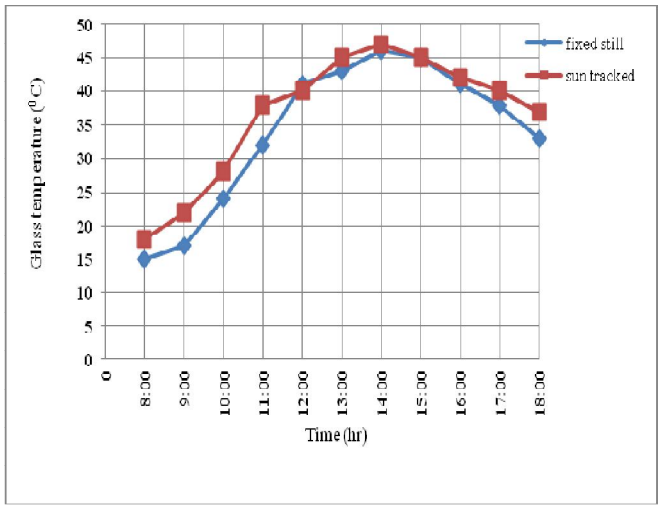


Fig: 3.3 variation of glass temperature for fixed and sun tracked solar still.

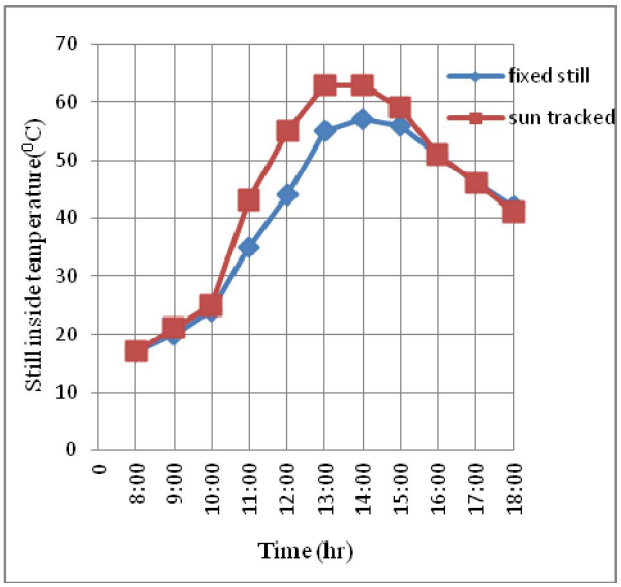


Fig: 3.4 variation of still inside temperature for fixed and sun tracked solar still

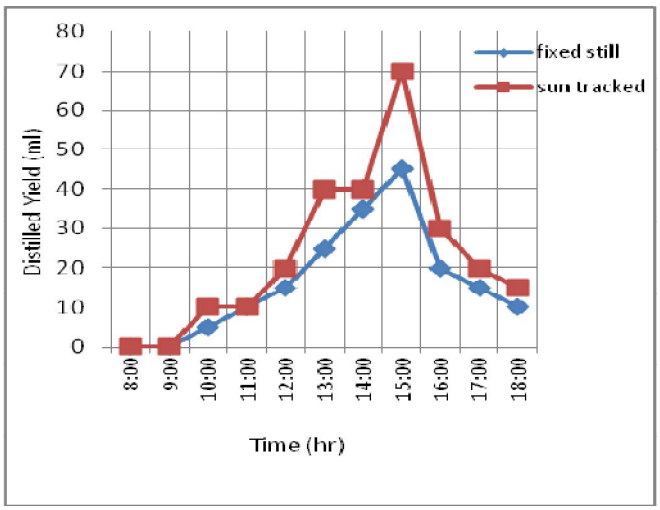


Fig: 3.5 variation of distilled yield for fixed and sun tracked solar still.

V. CONCLUSION

From study it can be concluded that the single basin type solar still made up of galvanized iron sheet is fabricated and tested for both tracking and without tracking of sun. The distilled yield rate of single solar still can vary with glass temperature, inside temperature of single solar still, basin temperature, radiation intensity. It was observed that the average yield of conventional basin type solar still (tracked) is about 36% higher as compared to solar still (fixed) in December-January (winter season).

REFERENCES

[1] Mohammed Mustapha Belhadj, H. Bouguet-taia, Y. Marif, M. Zerrouki, D. Bechki, M. Benhammou " Theoretical and Experimental Study of the Solar Still Coupled To a Vertical Still with Water Film" International Journal of Engineering Research and Applications, ISSN: 2248-9622, Vol. 4, Issue 3,Version 1, pp.547-552, March 2014.

[2] D. W. Medugu, L. G. Ndatuwong "Theoret-ical analysis of water distillation using solar still" International Journal of Physical Sciences Vol. 4 (11), pp. 705-712, November, 2009.

[3] Rohit Agarwal "Concept of Mechanical So-lar Tracking System" IOSR Journal of Mechan-ical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X, pp. 24-27,

[4] Pankaj Kalita, Anupam Dewan, Sangeeta Borah "A review on recent developments in so-lar distillation units" presented at Indian Acad-emy of Sciences, Vol. 41, No. 2, pp. 203–223,February 2016.

[5] J. D. Obayemi, F. O. Anafi, S. T. Azeko, E. K. Arthur, D. Yiporo "Design and Fabrication of a Single Slope Solar

Still with Variable Col-lector Angle" International Journal of Scientific & Engineering Research, ISSN 2229-5518,Volume 5, Issue 1,P-1523, January 2014.

[6] Manoj Kumar Sain, Godhraj Kumawat "Per-formance Enhancement of Single Slope Solar Still Using Nano-Particles Mixed Black Paint", Advanced Nano science and Technology: An International Journal (ANTJ), Vol.1, No.1, 2015.

[7] Hitesh N Panchal, Dr. P. K. Shah "Effect of varying glass cover thickness on performance of solar still: in a winter climate conditions", International Journal of Renewable Energy Re-search, Vol.1, No.4, pp.212-223, 2011.

[8] Ravi Gugulothu, Naga Sarada Somanchi, Sri Rama Devi R ,Hima Bindu Banoth "Experi-mental Investigations on Performance Evalua-tion of a Single Basin Solar Still Using Differ-ent Energy Absorbing Materials", International Conference On Water Resources, Coastal And Ocean Engineering , Aquatic Procedia 4 , pp. 1483 – 1491, 2015.

[9] Talal K. Kassem "Optimization the Perfor-mance of Single Basin Solar Still with Corru-gated Wick Surface at High Places", Interna-tional Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395 - 0056, Vol-ume: 03 Issue, 01 - Jan-2016.

[10] R.Sivakumaran, P. Jidhesh "Improvement Techniques in Performance and Productivity of Solar Stills" International Journal of Engineer-ing Science and Computing, Volume 6, Issue No. 9, September 2016.

[11] Dr. K. Ashok Reddy "Performance Analysis and Evaluation of Solar Still System" Interna-tional Association of Scientific Innovation and Research (IASIR), ISSN (Print): 2279-0047 ISSN (Online): 2279-0055, pp. 144, 2016.

[12] Hitesh N. Panchal , Mitesh I. Patel, Bakul Patel , Ranvirgirigoswami , Manish Doshi " A Com-parative Analysis Of Single Slope Solar Still Coupled With Flat Plate Collector And Passive Solar Still" IJRRAS ,Vol7,Issue2 , May 2011.

[13] Prof. Nilamkumar S Patel, Prof. Reepen R Shah, Mr. Nisarg M Patel, Prof .J. K .Shah, Mr. Sharvil B Bhatt "Effect of various parameters on different types of solar still: Case Study" In-ternational Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, Issue 5, May 2013.

[14] Erwin Normanyo, Akparibo Richard Awingot "A Solar Radiation Tracker for Solar Energy Optimisation" British Journal of Applied Sci-ence & Technology, ISSN: 2231-0843, 2016.

[15] Ankit Anuraj and Rahul Gandhi "Solar Track-ing System Using Stepper Motor" International Journal of Electronic and Electrical Engineer-ing, ISSN 0974-2174, Volume 7, pp. 561-566, 2014.

[16] Aman Garg, Ketan Kumar, Parveen, Rohit Kumar, Mrs. Sanju Saini "solar tracking: an ef-ficient method of improving solar plant effi-ciency" International Journal of Electrical and Electronics Engineers ISSN- 2321-2055 (E) , Volume 07, Issue 01, Jan- June 2015.