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DESIGN FABRICATION AND PERFORMANCE ANALYSIS OF SEMICYINDRICAL SOLAR STILL

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***Abstract*- Solar stills are used for water desalination in remote areas and rural places with low congestion and limited demand. Solar still is a simple device which is used for distilling water by evaporation and condensation method. Solar radiation is free, abundant, available and need no transportation. Distillation is a natural phenomenon. This device is not popular because of it's lower productivity. One of the methods to increase the productivity of distillate output water is, by collecting the solar radiation from all direction. Hence the semi cylindrical solar still has a higher productivity rate compared to other type solar still, because of minimum depth and large area of collector surface. The semi cylindrical solar still has a wider collector surface area, because of its physical structure. The absorber surface plate is coated with black paint to absorb the solar radiation collected by the semi cylindrical collector. Then there is very small amount of heat loss in basin by insulating the wood. This semi cylindrical solar still is easily portable. The design and fabrication is very simple.**

Keywords: single basin semi cylindrical solar still

1. INTRODUCTION

Water demand for purposes, domestic, industrial and agriculture, has increased considerably .To meet this growing demand has been intensively exploited. Fresh water is an immediate need for human life for drinking water. More than two-third of the earth's surface is covered with water. Most of the available water is either present as seawater or icebergs in the Polar Regions. More than 97% of the earth's water is salty; rest around 2.6% is fresh water. Less than 1% fresh water is within human reach. Even this small fraction is believed to be adequate to support life and vegetation on earth. Nature itself provides most of the required fresh water, through hydrological cycle. A solar still (also known as solar distiller) is a device by which distilled or potable water can be produced from saline water, such as seawater or brackish water. Solar stills are normally used to provide a small scale of potable water needed in remote isolated locations, where there is plenty of solar energy and sources of saline water are available, or in emergency conditions when other sources of energy are not available [1].

Potable water can be produced at reasonable cost by solar stills which are relatively economical to build and simple to operate and maintain [2,3]. Solar distillation is a technology with a very long history. The first known application of solar stills was in 1872 when a still at Las Salinas on the northern deserts of Chile started its three decades of operation to supply a mining community with drinking water [4]. Most stills built and studied since then have been based on the same principles, though many variations in geometry, materials, methods of construction, and operation have been incorporated [4]. A review of various designs of solar stills was made by Malik et al. [5]. A conventional basin-type still is simply an airtight basin that contains a shallow layer of saline water, a sloped top cover of a transparent material (usually glass) to solar radiation, and side metal frame walls. The basin-type stills have been much studied and their behavior is well understood [4]. The cost of building and operating a conventional still is relatively low compared to those involving sophisticated designs. However, the conventional or standard basin-type solar still [5–8] proven to have a low thermal efficiency with low daily distillate productivity [9,10]. For example, Tayeb [11] found that the efficiency ranged from approximately 15 to 22% while Samee et al. [12] reported a typical efficiency of basin-type stills of 25%. Cappelletti [1] reported that a conventional solar still typically produces between approximately 5 l/m2 day (on a bright sunny summer day) and 2 l/m2 day (on a winter day). Moreover, Al- Hinai et al. [13] performed a parametric study on a conventional double-sloped single-basin solar still under climatic conditions of Sultanate of Oman at the Gulf region. They reported that under optimum design conditions, the still tends to give an average annual solar yield of approximately 4 l/m2 day. The efficiency and yield of the conventional solar still depend on different factors: the design and functionality of the still, location, weather conditions, etc. [1,5]. Their low thermal efficiency is due to the considerable shadow caused by the walls of the basin that tend to decrease the absorption of solar radiation that could have been used for water distillation process. In order to improve the performance of conventional solar stills, several other designs have been developed, such as the double-basin type [14], multi-basin [15,16], inverted trickle [17], multi-effect [18,19], regenerative [20], with reflectors [21], spherical [6], triangular [22] and pyramid type solar still [23,24]. Kalogirou [25] presented an excellent review on various types of passive and active solar stills. Among these types are the single-slope with passive condenser, double condensing chamber solar still, vertical solar still, and conical solar still. In this paper, a new simple design of a transportable semi cylindrical type solar still is presented and its steady-state performance under kovilpatti climatic conditions is evaluated.

2. DESIGN OF THE SOLAR STILL

A schematic diagram of the new semi cylindrical solar still is shown in Fig. 1 The basin of the still and absorber plate, and the collector were all fabricated using sheet metal. The basin contains the absorber sheet metal which has a surface area of 1.125 m2. A hole with diameter of approximately 25.4 mm was drilled into the tray to provide accessibility of saline water into the basin during initial filling and the bottom section of basin was insulated to reduce thermal losses to the surroundings. The absorber was coated with black paint to maximize absorption of the incident solar radiation on the basin. The semi cylindrical cover, located on the top of the solar still unit, was made of a transparent plastic with absorptivity and transmissivity equal to 0.9 and 0.8, respectively. The transportable support structure was made of galvanized steel and coated with green paint. For sealing purpose, an approximately 6.5 mm thick rubber ring gasket was used and placed between the cover and the collector support structure where they were tightened and held in placed at equal distances around the periphery of the still. The distillate output from the still was frequently collected using a plastic container placed under the outlet part of the tube shaped collector. K-types thermocouples were installed and used to measure the temperature of the water in the basin at several locations to ensure uniform temperature throughout the basin, and the temperatures of the inside cover and ambient.

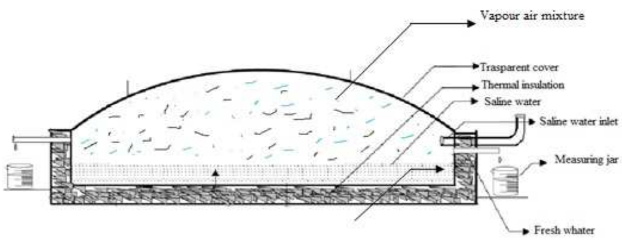

Figure 1 Schematic diagram of Semi cylindrical solar still.

3. EXPERIMENTAL PROCEDURE

Experimental measurements were performed to evaluate the performance of the solar still under the outdoors of Kovilpatti climatic conditions. Before the commencement of each test the basin was filled with saline water using the inlet port, as shown in Fig. 1, and the semi cylindrical cover was cleaned from dust. The tests started around 8:00 am when the still was allowed to warm up for approximately 1.5 h before measurements of distillate yield and temperatures were taken at every 30 min time interval for approximately 8.5 h. Six tests for six days were performed in a typical high solar insolation month (i.e. April) in a summer season to demonstrate the still's typical maximum efficiency. During these tests, the hourly measurements of wind speed and solar radiation were recorded. The saline water depth in the still basin was varied during the six days of testing in order to investigate the effect of water depth on the distillate productivity.

4. CONCLUSION

The single basin solar still can produce only small amount fresh water. The efficiency of the single basin solar still was in the range of 30-45%, with less than 5 L/m2/day. The different design of single basin solar still is can be used for further increasing the productivity rate of fresh water. Compare to the various design of existing single basin solar still newly developed semi cylindrical solar still will have higher efficiency.

REFERENCES

[1] Cappelletti GM. An experiment with a plastic solar still. Desalination 2002; 142:221–7.

[2] Al-Hayek I, Badran OO. The effect of using different designs of solar stills on water distillation. Desalination 2004;169:121–7.

[3] Hanson A, Zachritz W, Stevens K, Mimbela L, Polka R, Cisneros L. Distillate water quality of a single-basin solar still: laboratory and field studies. Sol Energy 2004;76:635–45.

[4] Duffie JA, Beckman WA. Solar engineering of thermal processes. 2nd ed. Wiley; 1991.

[5] Malik MAS, Tiwari GN, Kumar A, Sodha MS. Solar distillation: a practical study of a wide range of stills and optimum design, construction and performance. New York: Pergamon Press; 1982.

[6] Dhiman NK. Transient analysis of a spherical solar still. Desalination 1988;69: 47–55.

[7] Cooper PI. The absorption of radiation in solar stills. Sol Energy 1969;12: 333.

[8] Lof GOG. Solar desalination. In: Spiegler KS, editor. Principles of desalination. New York: Academic Press; 1966 [chapter 5].

[9] Tiwari GN. Recent advances in solar distillation. In: Kamal R, Maheshwari KP, Sawhney RL, editors. Solar energy and energy conservation. New Delhi: Wiley Eastern; 1992 [chapter 2].

[10] Fath HES. High performance of a simple design, two effects, solar distillation unit. Energy Convers Manag 1997;38(18):1895–905.

[11] Tayeb AM. Performance study of some designs of solar stills. Energy Convers Manag 1992;33(9):889–98.

[12] Samee MA, Mirza UK, Majeed T, Ahmad N. Design and performance of a single basin solar still. Renew Sustain Energy Rev 2007;11:543–9.

[13] Al-Hinai H, Al-Nassri MS, Jubran BA. Effect of climatic, design and operational parameters on the yield of a simple solar still. Energy Convers Manag 2002;43: 1639–50.

[14] Al-Karaghouli AA, Alnaser WE. Experimental comparative study of the performances of single and double basin solar-stills. Appl Energy 2004;77: 317–25.

[15] Tiwari GN, Singh SK, Bhatnagra VP. Analytical thermal modeling of multi-basin solar still. Energy Convers Manag 1993;34(12):1261–6.

[16] El-Sebaii AA. Thermal performance of a triple-basin solar still. Desalination 2005;174:2337.

[17] Badran AA. Inverted trickle solar still: effect of heat recovery. Desalination 2001;133:16773.

[18] Tiwari GN, Singh HN, Tripathi R. Present status of solar distillation. Sol Energy 2003;75:367–73.

[19] Yuichi Y, Haruki S. Development of small-scale multi-effect solar still. In: International

Solar Energy Conference; 2003. p. 167–173.

[20] Abu-Arabi M, Zurigat Y. Year-round comparative study of three types of solar distillation units. Desalination 2005;172:137–43.

[21] Tanaka H, Nakatake Y. Theoretical analysis of a basin type solar still with internal and external reflectors. Desalination 2006;197:205–16.

[22] Rubio-Cerda E, Porta-Ga´ndara MA, Ferna´ndez-Zayas JL. Thermal performance of the condensing covers in a triangular solar still. Renew Energy 2002;27: 301–8.

[23] Hamdan MA, Musa AM, Jubran BA. Performance of solar still under Jordanian climate. Energy Convers Manag 1999;40:495–503.

[24] Kabeel AE. Water production from air using multi-shelves solar glass pyramid system. Renew Energy 2007;32:157–72.

[25] Kalogirou SA. Seawater desalination using renewable energy sources. Prog Energy Combust Sci 2005;31(3):242–81.