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Solar Energy using in solar desalination technique developing for Tribasin-solar stills with Experimental analysis of correlation methods

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ABSTRACT

An experimental analysis of a Tribasin s solar still is a device that produces clean, drinkable water from the Saline water by using the energy of the sun. In this a Double Slope–Tribasin Solar still has been performed on clear sunny day on summer and winter seasons at *Vel Tech Multitech* Dr. Rangarajan Dr. Sakunthala Engineering College, Avadi, at Chennai in Tamil Nadu India March 2014 to April 2015. The experimental analyses of the system have been shown that the first, second and third basin contributes 35.71%, 35.7 % and 28.5% of the total distillate yield respectively. He experimental analysis of Tribasin solar still have been made for one of the typical days calculation improve with other solar still.

Keywords: Tribasin Solar Still, Transient theory, Regenerative effect, correlation method

1. INTRODUCTION

A Solar still is a device that produces clean, drinkable water from the dirty water by using the energy of the sun. In convectional solar still the heat transferred from water in the basin to the condensing cover elevates the temperature of the cover, thereby reducing the rate of distillation and efficiency [1]. Many researchers have designed different designs of solar still for effective distillation. To augments the temperature of the water in the basin, an additional thermal energy from an external mode is supplied to the evaporator in active distillation [2]. Velmurugan et.al [3] has designed and tested a stepped solar still made of fin sponge fin and sponge alone in the trays and interval that the productivity is 80% higher than ordinary single basin solar still. Murugavel et al. [4] has designed a single basin double slope solar still with thin layer of water in the basins made up of different materials. He also proposed a new model to stimulate the double slope single basin solar still in actual sun shine and laboratory condition.

Moreover, Tanaka and Nakatake [5] investigated the effect of vertical flat plate external reflector on the productivity of the tilted wick solar still. They proposed a geometrical method to calculate the solar radiation reflected by the external reflector and absorbed on the evaporating wick, and also performed numerical analysis of heat and mass transfer in the still to predict the distillate productivity on four days (spring and autumn equinox and summer and winter solstice days) at 30^{o}N latitude. They found that the external reflector can increase the distillate productivity in all but the summer seasons, and the increase in the daily amount of distillate averaged over the four days is predicted to be about 9%.While, Sadineni et al. [6] indicated that

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there is a significant reduction in the performance with a double-pane glass compared with a single-pane glass. Due to the reduced temperature difference between the evaporating water and condensing glass in a still with double-pane glass used both as transparent cover and condensing surface, the productivity reduced significantly. They also observed that the proposed design is superior in productivity (20% improvement) compared with a conventional basin-type solar still. In addition, Abdallah et al. [7] investigated the performance of a basin type solar still system with three different design modifications. Installing internal reflecting mirrors gave an average of 30% increase in the amount of distilled water produced when compared with a classical fixed solar still system. Modifying the still design from a flat basin into step-wise basin gave a higher production rate with an average increase of 180%. Also, coupling the modified still design with a sun tracking system gave further improvement, reaching up to a 380% increase in the production rate of distilled water.

In this present work, an attempt has been made to design and study the performance of a double slope Tribasin solar still. Experimental analysis have been carried out glass cover, basin, water temperature, distillate output, and efficiency of the system results are presented and discussed.

2. EXPERIMENTAL ANALYSIS OF TRIBASIN SOLAR STILL

In the double slope tri-basin solar still, two double slope evaporation basins have been made basin area 50cm and 50cm and evaporation height is 22cm adjacent to each other. A third basin over the v-shaped condensing cover is made two transparent glass covers have used to make double slope for the

Figure 1: Photograph of double slope Tribasin solar still

Figure 2: Photograph of experimental testing in sunny days double slope Tribasin solar still

third basin. The whole assembly behaves as two double slope basin solar still and one V-shaped double slope solar still. The V-shaped basin makes use of the latest heat from condensation released at the lower surface of the glass covers of the two basins respectively. Consequently, evaporation takes place in three basins and the total productivity of the system is the sum of productivity of the individual basins.

The study investigated the relationship between hourly productivity and hourly solar radiation incident on the double slope tri-basin solar still. Utilizability function is developed from daily solar radiation and compared to that of Dunkle's model which uses monthly average solar radiation as input. The experimentation unit has been placed on a stand and oriented south-facing. Water depth in the still is kept constant during the experiment and at the end of each hour, ambient temperature; solar radiation and productivity are measured. Experimentation is done from 9.00 am to 5 pm.

The solar radiation falling on the v shaped glass cover, after transmission through the v shaped and lower glass covers and water masses, is absorbed by the basin liner. A part of the energy is utilized to heat the lower basin water by convection and the test is the lost to the ambient through the insulation. There is a transfer of energy from the lower basin one and lower basin second. Water surface to the glass cover one and lower glass cover second by evaporation, convection and radiation.

The following assumptions have been made in writing the energy balances of the components of the Tribasin solar still.

1. The Heat capacities of the class cover, the absorbing material, the condensing covers and the insulation are negligible.
2. The inclination of the glass cover is very small.
3. The solar distiller unit is vapor Leakage proof.
4. There is no vapor leakage in the still, thus the water vapor is condensed in to water.
5. The water surface and the glass cover are parallel.

3. RESULTS AND DISCUSSION

Experiments have been carried out with the Tribasin double slope basin solar still integrated for number of days during March 2014 to April 2015. Observations for one of the four typical days in the month of October and May have been used to predict the performance of the system. Hourly variation of solar radiation and ambient temperature for four experimental days has been depicted in Figure 3.

From the figure 3, it is observed that the hourly variation of solar radiation and ambient temperature have same trend. Solar radiation intensity and ambient temperature is found to be maximum at noon and then decreases gradually till 5pm.

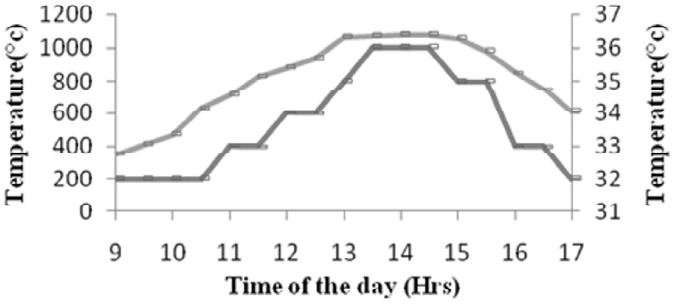

Figure 3: Hourly variations of solar radiation and ambient temperature.

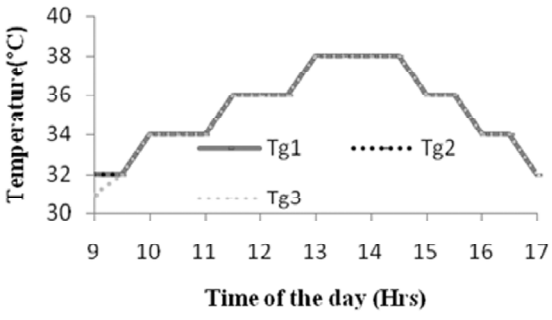

Figure 4: Hourly variations of Glass temperature

The analytical expressions derived for the basin, water and glass cover temperature have been used to evaluate the instantaneous temperature of the same with the measured climatic and design parameters of the still. The calculated values have been compared with the experimental observations to predict the validity of the thermal model. Figure 4, 5 and Figure 6 have shown the measured and calculated value of temperature of the glass cover, water and basin temperature experimental analysis of Tribasin solar still.

Figure 7 variation of Mass of water with respect to time distillate yield of the still is higher working hours of the system of the days. The still working days had shown a maximum distillate yield of 0.330, 0.320 and 0. 230 kg/m^{2}hr during 13.00 pm to 13.30 pm. The experimental results in day-time distillate yield during 9 am to 5 pm of the Tribasin solar still are 4.655, 4.605 and 2.901 kg/m^2.

For the solar still use for night-time collection during 5 pm to 8 am is 0.823, 0.802 and 0.342 kg/m^2 and total of 5.4784, 5.4428 and 3.843 kg/m^2 is obtained. The Tribasin solar still has shown a good performance throughout the summer and winter days because of the auxiliary heat provided by during day-time.

Figure 8 has shown the hourly variation of efficiency of the still has shown higher efficiency during 9 am to 5 pm than the solar still. The average efficiency of the still in during 9 am to 5 pm is third basin contributes 35.71%, 35.7 % and 28.5% of solar still.

The Tribasin solar still experimental analysis of *Vel Tech Multitech* Dr.Rngarajan Dr.Sakunthala Engineering College, Avadi, at Chennai in Tamil Nadu, India sunny hours calculation of efficiency of system developed in correlation equation for the temperature elements of the still and distillate yield and efficiency have been derived as

For water temperature in summer and winter

$Y = 1.000\ x - 0.799$

$Y = 0.905\ x - 3.975$

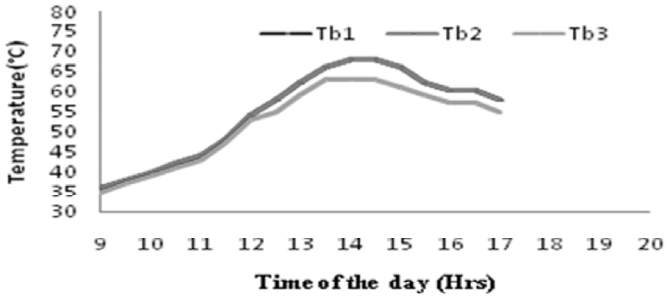

Figure 5: variation of basin temperature with time

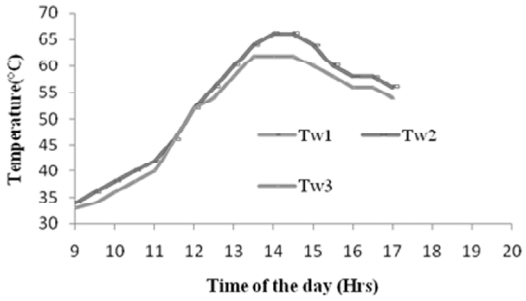

Figure 6: variation of water temperature with time

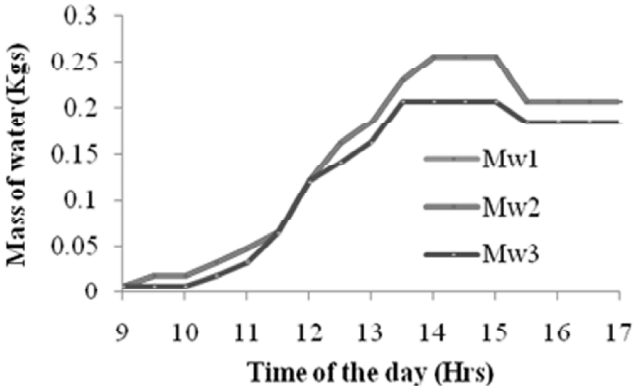

Figure 7: variation of Mass of water with respect to time

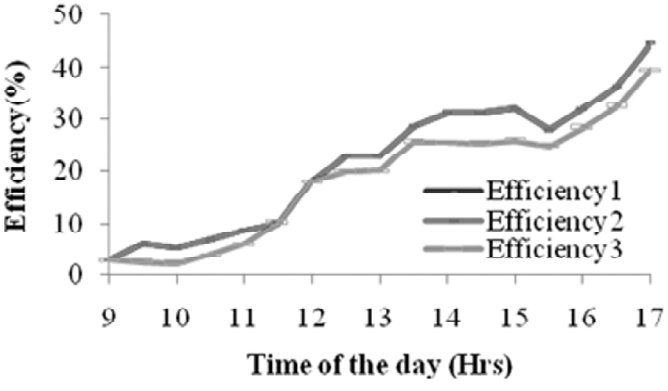

Figure 8: variation of Efficiency with respect to time.

For glass cover temperature in summer and winter

$Y = 1.023\ x - 1.559$

$Y = 1.064\ x - 2.870$

For distillate yield in summer and winter

$Y = 0.980\ x + 0.008$

$Y = 1.002\ x - 0.001$

For efficiency in summer and winter

$Y = 0.977\ x + 1.070$

$Y = 0.979\ x + 0.976$

The thermal modeled glass cover temperature has some asymmetry due to the unavoidable factors such as cloud, wind and ambient temperature. Regarding the distillate yield and efficiency, there exists symmetry between modeled and experimental observations which correlated better. This model provides the information about the dynamical effects taken place inside the enclosure during the working hours of the still. The regression coefficients for the summer and winter days same have the better correlation with a strong thermal inertia of the still.

4. CONCLUSION

The thermal model developed is validated with the experimental observations and the model is found to be suitable for the design optimization. The saline water to the basin area of the still have been used at least water depth in the three basins to induce faster evaporation. The average efficiency of the still with three basins is 35.71%, 35.7 % and 28.5%. The correlation equation can be used to simulate the proposed system for any climatic conditions for large scale installations. The correlation model is the energy balance equation of the temperature difference element of the still evaporating surface and glass cover is higher throughout the day for the still. The regression coefficient of the concluding correlation approaches to unity, and the correlation may be a perfect positive correlation with least error.

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