International Journal of Advance Engineering and Research Development (IJAERD)
Volume 1,Issue 3, April 2014, e-ISSN: 2348 - 4470 , print-ISSN:2348-6406

Investigation on performance of solar still with screens.

Sudhanshu N Prajapati [1], Hitesh N Panchal [2] Vishal N Thakkar [3]

[1] *ME Student, Mechanical Engg Dept. SPIT, Piludara, sudhanshu.prajapati@ymail.com*
[2] *Mechanical Engg Dept. GPERI, Mevad, Mehsana, engineerhitesh2000@gmail.com*
[3] *Mechanical Engg Dept.SPIT, Piludara,vishal.thakkar2988@yahoo.co.in*

Abstract- Distillate output of solar still is low because its difference between water and glass cover temperature is low. In solar still temperature difference of water and glass cover increased, automatically distillate output is increased. Thermal conductivity is heat conducted per unit time per unit cross sectional area perpendicular to direction of heat conduction. It is also a good parameter for increasing temperature. Temperature of water is increase by inserting various screens and glass cover temperature is decreased by sprinkler attachment at top of the solar still. Aluminum screens and GI screens are easily available in market and it is also very cheap hence it can be used for increasing distillate output.

Keywords- solar stills shallow basin, screens (Aluminium & galvanised), temperature controller, thermocouples, discharge ouput.

I. Introduction

People can survive from day, weeks or months without food, but cannot suffer for more than a week without water.The body uses water for digestion, absorption, circulation, transporting nutrients, building tissues, conveying away waste and maintaining body temperature. The average adult consumes about 2.5 to 3 liters of water per day to drink.

Today fresh water demand is increasing continuously as discussed by El-Sebaii et al. (2009) because of the industrial development, intensified agriculture, improvement in standard of life and increase in the world population. Merely 3% of total water are potable but this measure is also evenly not distributed over the globe. Lack of clean water is a prime component in inhibiting regional/economic growth. Frequently, water sources are brackish/containing harmful bacteria, so cannot be used straight off for drinking use. The oceans constitute an unlimited source of urine but are bad for human use due to their salt content in the range of 3% to 5%. In addition, there are many coastal locations where seawater is abundant, but potable water is not available. Hence it is an urgent demand for neat and pure drinking water in many countries. In order to resolve this problem, some new drinking water sources should be learned and new water desalination techniques be trained.

P K SRIVASTAV AND S K AGRAWAL. (2013) [1] They used blackened jute cloth as absorber which is floated with the help of thermocouple piece and compare this modified still with conventional basin type solar style inthe same size under similar condition on both clear and partially clear day and they found that modified still get 68% more distiller output than conventional in clear day, where it was nearly 35% higher on cloudy days. T. V. ARJUNAN ET AL.(2013) [2]they used different colour sponge liner on the inner wall surface of the solar still and they found the effect of sponge liner thickness and colour on the performance of the solar still. They use different type of thickness of sponge liner and different coloured of the sponge liner. From the experiment they found that 1) the sponge liner in still increase the temperature difference between water and glass by decreasing the temp of glass.2)the solar still with black sponge liner give higher output than other, which is 43.5% higher than the convestional.3)this modified sponge lined still reduce the conduction heat losses from the inner wall surface to outer wall surface. A E KABEEL ET AL. (2013) [3] they made still uses a rotating fan with a verticalshaft. The ratating fan rotate with the help of dc motor powered by small photovoltaic system. Theexperiments were conducted with various fan rotation speeds of 30,35,40and 45 rpm and saline water depth of 1,3,5,and 7 cm.and the result found that daily productivity of this modified still increase with increasing the rotational speed of fan. R RAJANARTHINI ET AL. (2013) [4] they made a double slope wick type solar still with varying thickness of insulation beneath the tilted wick portion. They found that the efficiency of the still to be 46% for the insulation thickness of 0.06 m beneath the tilted wick portion and sides of the still. And they also obtained that the distilled water has much lesser value of electrical conductivity and mineral as compared to the raw water.

D BECHKI ET AL.(2010) [5]They made double slope solar still with intermittent one side shading of the north glass cover and compare with conventional double slope solar still. They found that the optimum partial shading time was from 12 h.00 to 13 h.45.The procedure of intermittent shading of the north glass cover of the solar still resulted in a further 12% improvement in the daily yield. K.KALIDASA MURGAVEL ET AL. (2009) [6] they made double basin single basin passive type solar still with heater placed at a lower place the interior basin.The solar radiation heat is simulated by using 2 kW electrical resistance heater placed inside the lavatory. The heat supply is varied using control circuit. And they found that the production rate improves with increases of water and glass temperature. Only at higher operating temperature, the production rate increase with the reduction in temperature difference between ice and urine.N. RAHBAR AND J.A. ESFAHANI (2013) [7] they work on to investigate the natural result in 2D single slope, solar still. A numerical model based on SIMPLEC algorithm is employed for the solution of mass, momentum, energy and concentration equation. The solutions are performed for several values of aspect ratio and Rayleigh number between 2.5 and 5.5 and between $5*10^6$ and $5*10^7$ respectively. They found that, for givingan aspect ratioRayleigh number direct effect on nusselt number. On the other hand, for a fixed Rayleigh number, the value of missed number decrease when the aspect ratio increase. S. KUMAR, G.N. TIWARI (2011) [8] They developed the effect of design, operational and climate parameter for instantaneous exergy of passive solar still. The parameter, namely effective absorptivity of basin liner (0.9-0.6), glass cover, tilt ($15-45^0$) and wind velocity (0.0-10m/s) have been taken into account. They found that with decrease id absorptivity (0.9-0.6) with time, the energetic and exegeticefficiencies, decrease by 21.8%and 36.7%respectively. They found that glass cover, tilt is to be insignificant and respective efficiencies, decrease by 0.75% and 0.47per degree increase tilt. V. VELMURUGAN ET AL. (2008) [9] they used different materials like wick type, sponges and fins inside solar still. And they found that productivity increased 29.6%, when wick type material is used, 15.3% productivity increase when sponges were used and 45.5% increased when fins were used. NAFEY ET AL (2001) [10]they used black rubber and gravel in the solar still. And they found that distil output is 20%increase in 10 mm thickness black rubber and 19% increase in 20-30 mm gravel.

II. **Experimental Set-up**

Main aim of the solar still is to get increment in distillate output. It is found from the literatures that, the higher distillate output obtained from solar still by increasing the temperature of water. For an increasing temperature of water, researchers have used fins, heater, and wick material, sponge etc. But no one tried to use screens inside the barn. Screens have variety available in market and with use of screen, temperature of water could be increase and hence distillate output would be increase and compared with conventional solar stillResearch says that, temperature difference of water and glass cover increased, automatically distillate output is increased. Here, temperature of water is increase by inserting various screens. First of all, with help of energy balance equation, mathematical modelling of solar still is carried out. Three solar still will fabricate single slope solar still with aluminium screen, GI screen and alone solar still. Apply some climate conditions on each still with depth of brine 0.01 m.Then after compared experimental results with mathematical model. Accuracy is also determined

III. **PROCEDURES**

A cross sectional view of a schematic diagram and a line diagram of a single slope, single basin solar still is as shown in Figs. 4.1 and 4.2 respectively, whereas Fig. 4.2 is the photographs of fabricated solar still for the present experiment Fig. 4.3 shows the experimental setup of solar still. The experimental setup consists of a 3 passive solar distillation unit whit condensing glass cover inclination of 30°, fabricated to accommodate 0.20 m water depth maximum. The bottom surface of each still was painted black for higher absorptivity

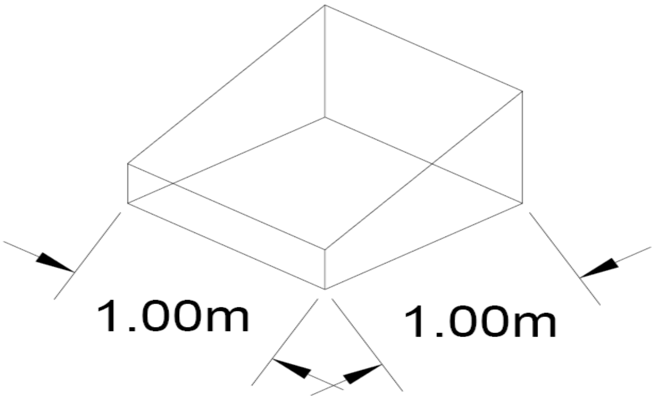

Figure 1 Representation of 1m² area of solar still

Figure 2 Actual fabrication of solar stills.

It is concluded that the output of steel is maximum for the least water depth in the basin. However to experiment for various types of screen in the solar still with water depths the basin is designed for a maximum depth of 0.20 m. Moreover, to avoid the spilling of basin water into the distillate channel made of plastic and to prevent the contact of distillate channel with glass cover vertical side of the steel was adept at 0.30 m, whereas the height of the vertical side was kept 0.83m. The effective basin area of each still is kept 1 m × 1m and it is made of fiber reinforced plastic (FRP) of 5 mm insulation thickness. This Fiber reinforced plastic is manufactured by sticking many layers of corrugated sheets with special chemicals in such a manner that air is entrapped between their corrugated cavities, which provide a high degree of insulation for heat flow, which is a highly desired quality of solar still material. Condensing cover or glass cover made of plane glass. Here, for three stills, different two type of screens are used and one still alone. All stills have thickness of 4 mm glass cover. Here, glass cover fixed to top of the vertical wall of the still using rubber gasket on both side of glass with asphalt band to make it leak proof. The output from the still is collected through a channel fixed at the end of the

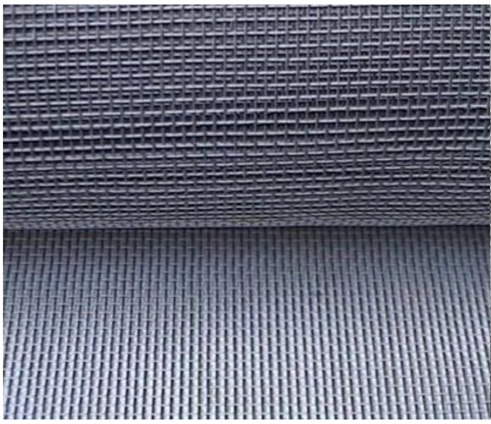
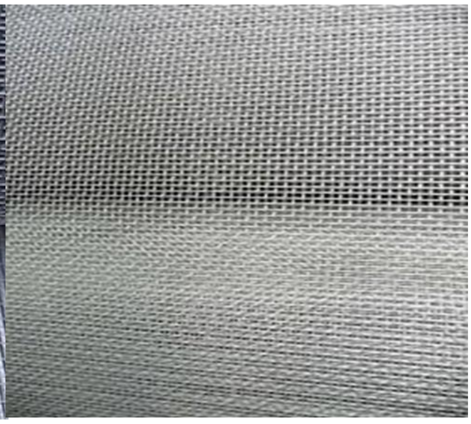

Figure 3 (a) galvanized iron type screen ***Figure 3 (b) Aluminium type screen***

smaller vertical side of the basin. A plastic pipe is connected to this channel to drain the distillate water to an external measuring jar.

Figure 4 Experimental set up of solar stills.

4.3. Procedure of Experiment

The experiments were performed in march 2013 but typical five days in a week. The experiments were conducted on different five days at home, Mehsana for different screens and same water depth. All experiments were started at 6 AM local time and lasted for 24 h. In each day experiment same water depth was used for solar stills having different screens and alone screen for performing 2 months.The following parameters were measured every hour for a period of 24 h.

- Inner glass cover temperature
- Water temperature
- Ambient Temperature
- Ambient air velocity

- Distillate output

Water and glass cover temperatures of all three solar stills were recorded with the help of temperature sensors. Temperature sensors measures temperatures.Temperature sensors having a least count of 0.1°C. The distillate output was recorded with help of external measuring jar having least count of 1 ml.

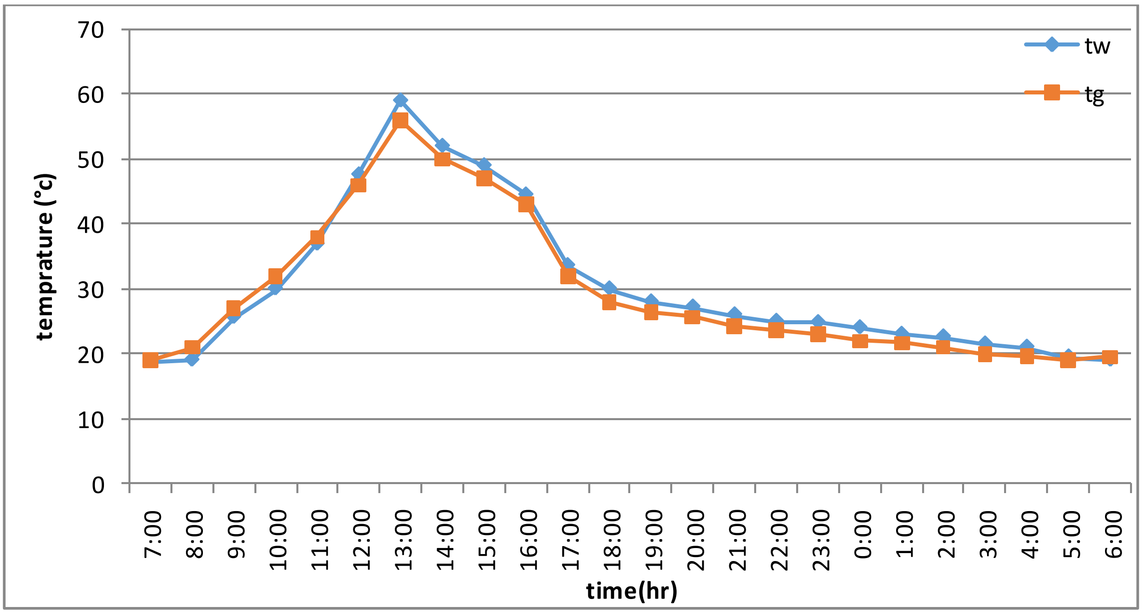

Figure 5temperature vs Time of conventional solar still.

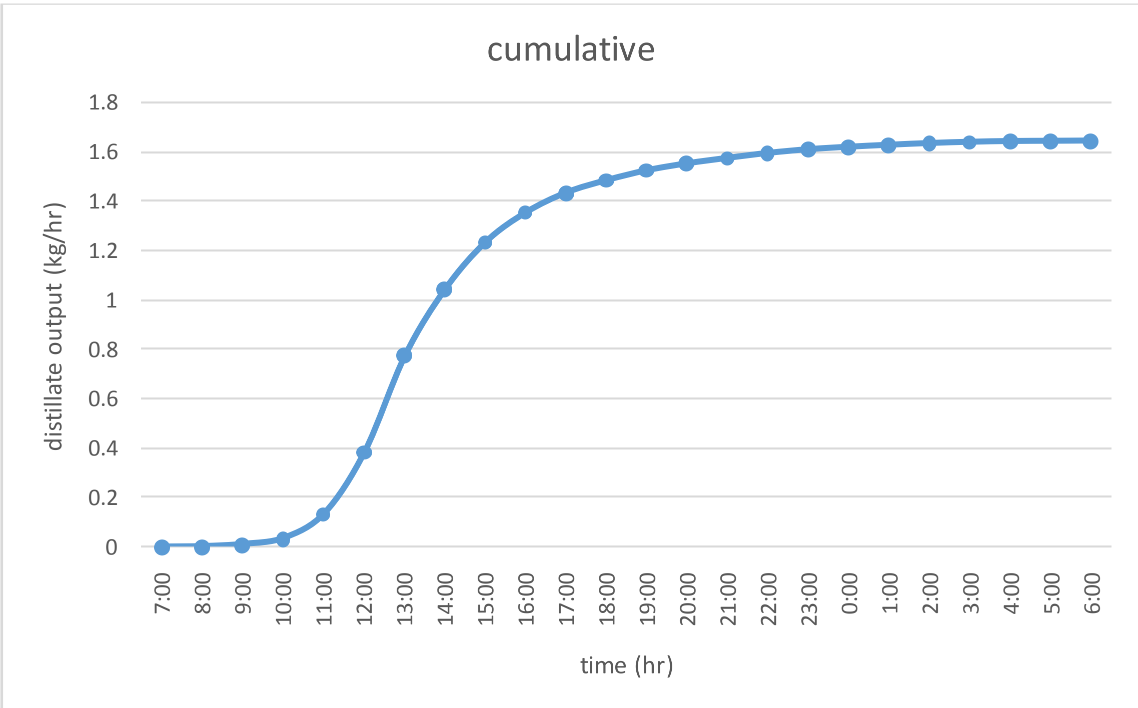

Figure 6 Distillate water vs Time in conventional solar still.

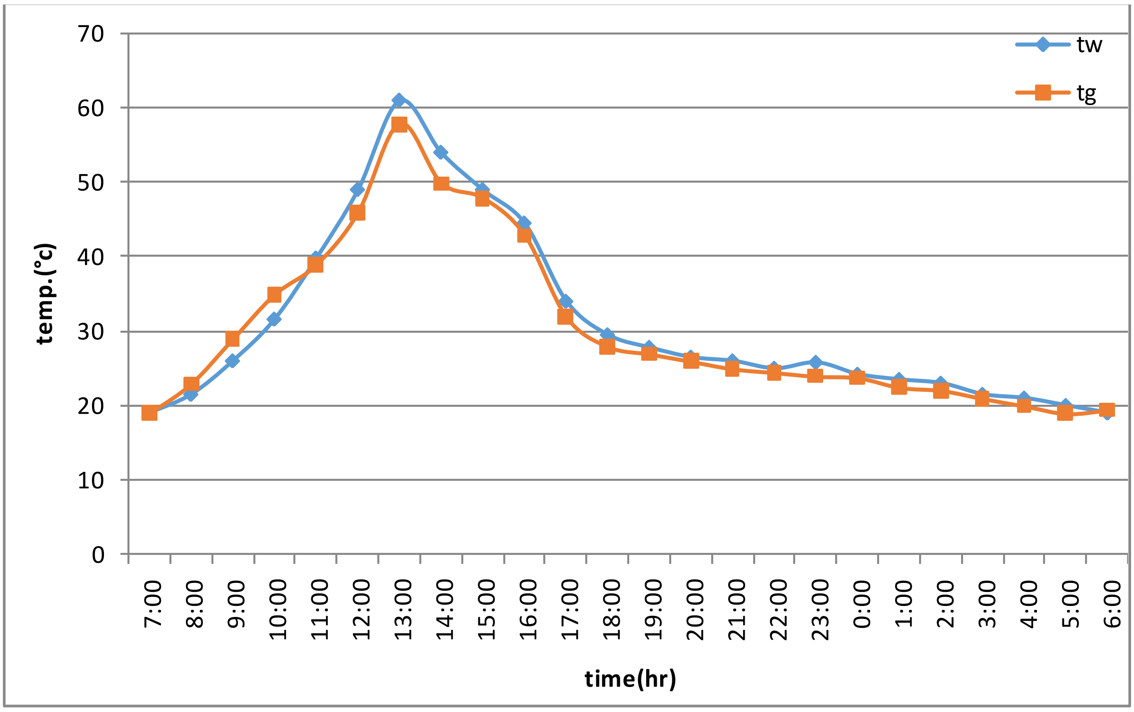

Figure 7temperature vs Time in a solar still with galvanized iron screen.

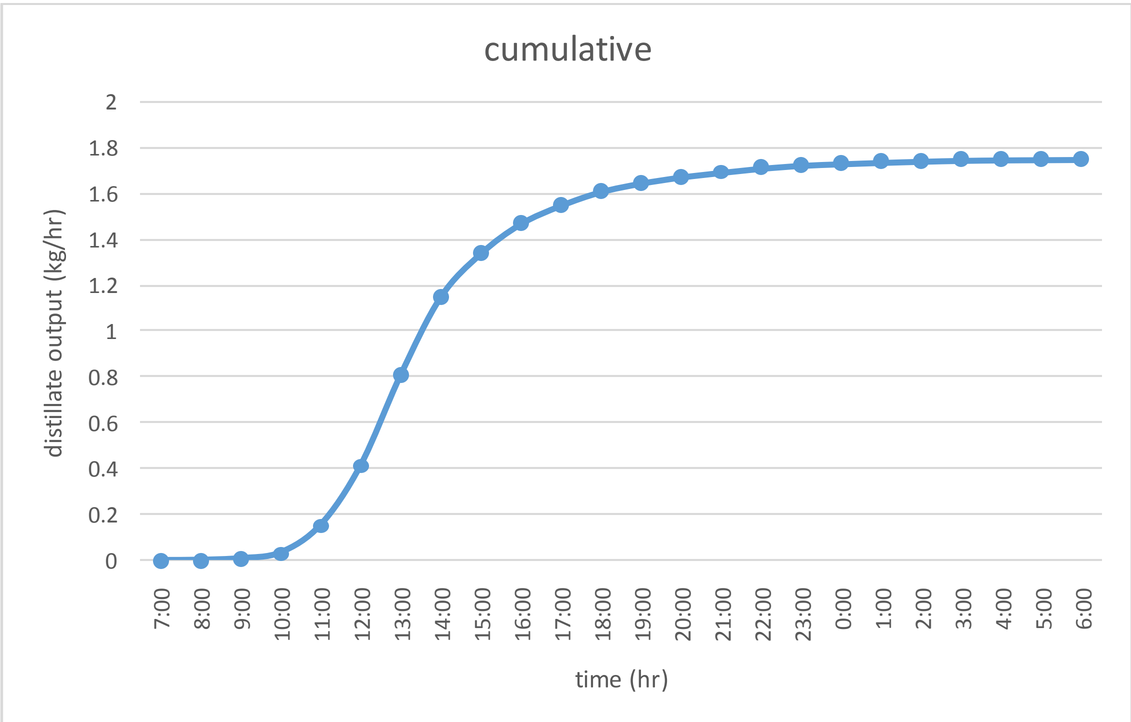

Figure 8 Distillate output vs Temperature in solar still with galvanized iron screen.

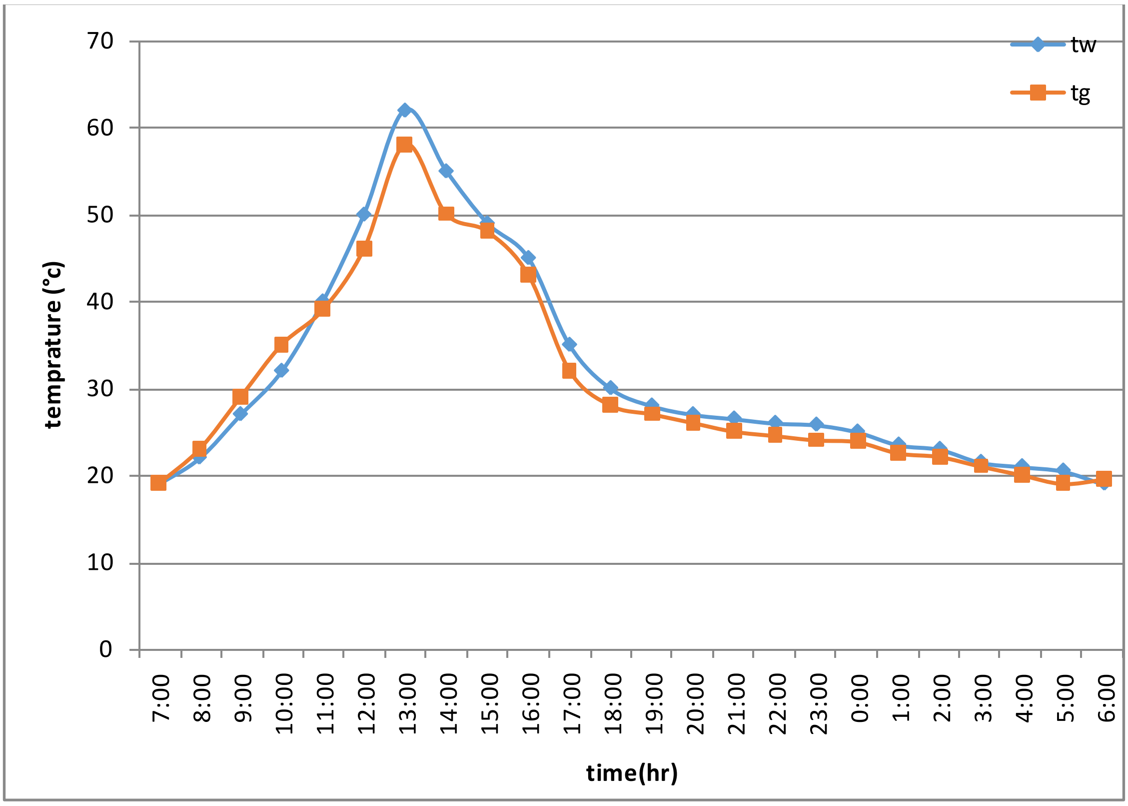

Figure 9temperature vs Time in a solar still with aluminium screen.

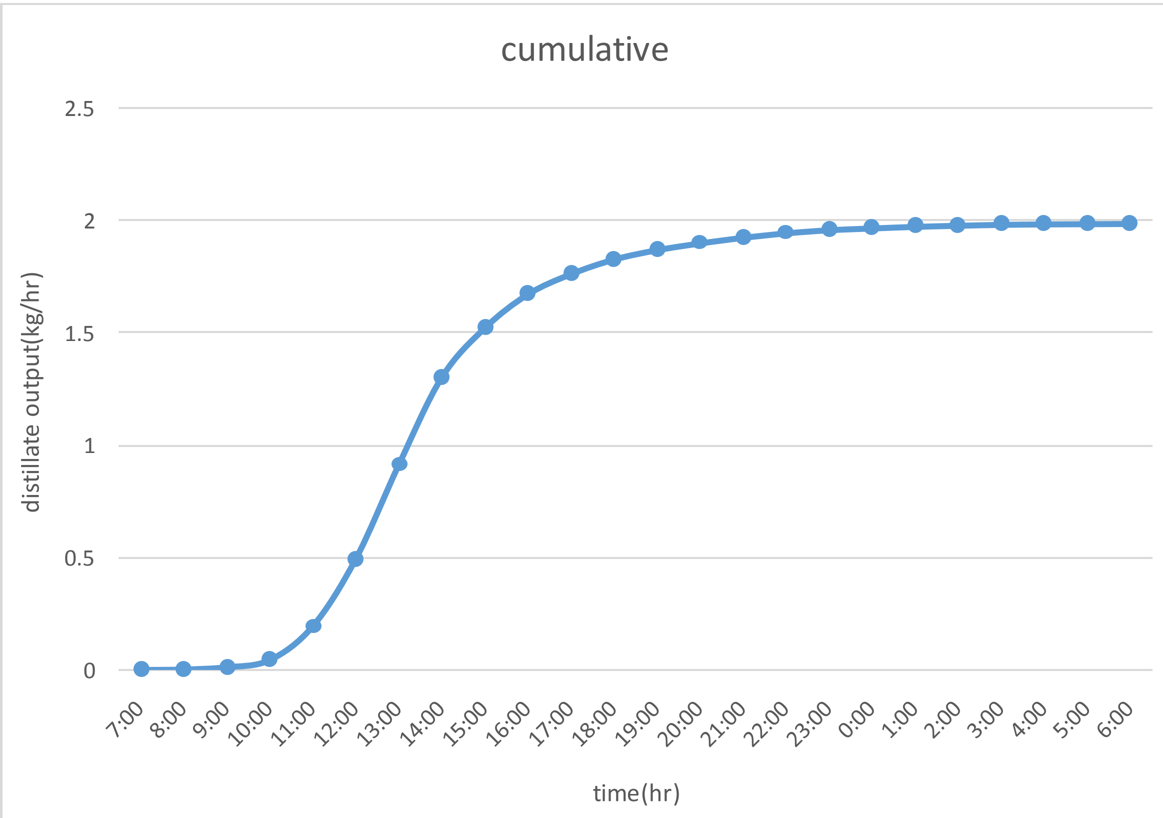

Figure 10 Distillate output vs Temprature in solar still with aluminium screen.

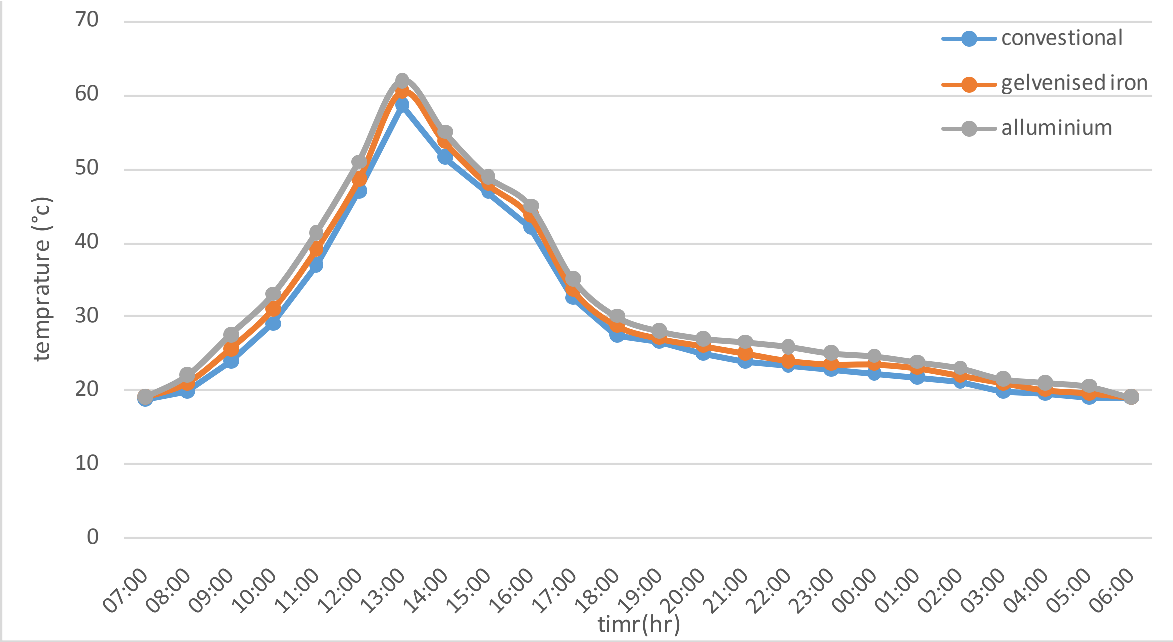

Figure 11 Comparison of water temperature (Tw) in a solar still with aluminium screen, galvanized iron screen and alone.

From the above graph we can see that the temperature of water in a solar still with aluminium screen is higher than conventional and solar still with galvanized iron screen.

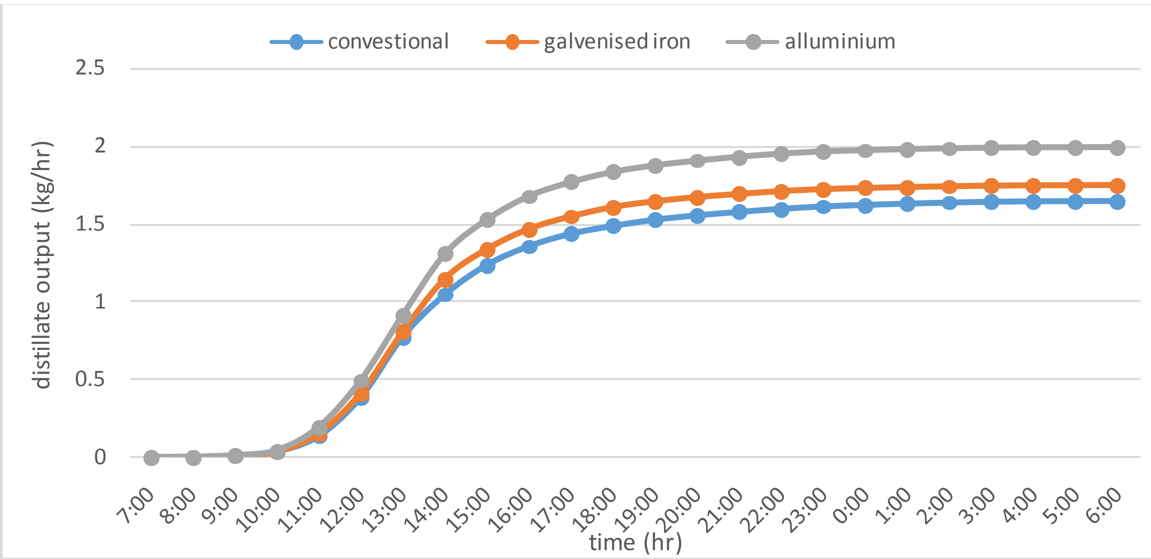

Figure 12 comparison of distillate output in solar still with aluminium screen, galvanized iron screen and alone.

From the above graphs we can conclude that the water temperature of a solar still with aluminium screen is higher than solar still with GI screen and conventional solar still so that the temperature difference between water and glass cover is higher in aluminium screen therefore due to temperature difference the distill output of solar still to aluminium screen is higher than solar still with GI screen and alone (conventional solar still).

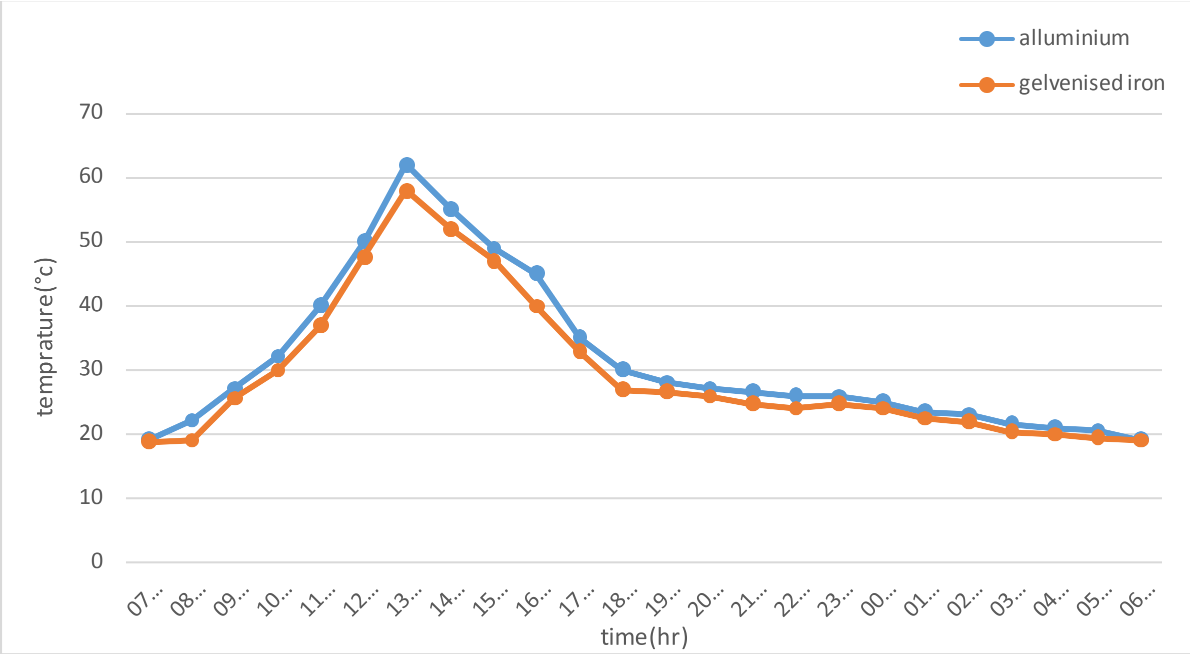

Figure 13 comparison of water Temperature (Tw) in solar still with aluminium screen and galvanized iron screen.

From the above graph we can see that the water temperature of a solar still with aluminum screen is higher than galvanized screen, solar still so that the temperature difference between water and glass is higher in a solar still with aluminium screen hence the distillate output of solar still with aluminium screen is higher than solar still with galvanized screen.

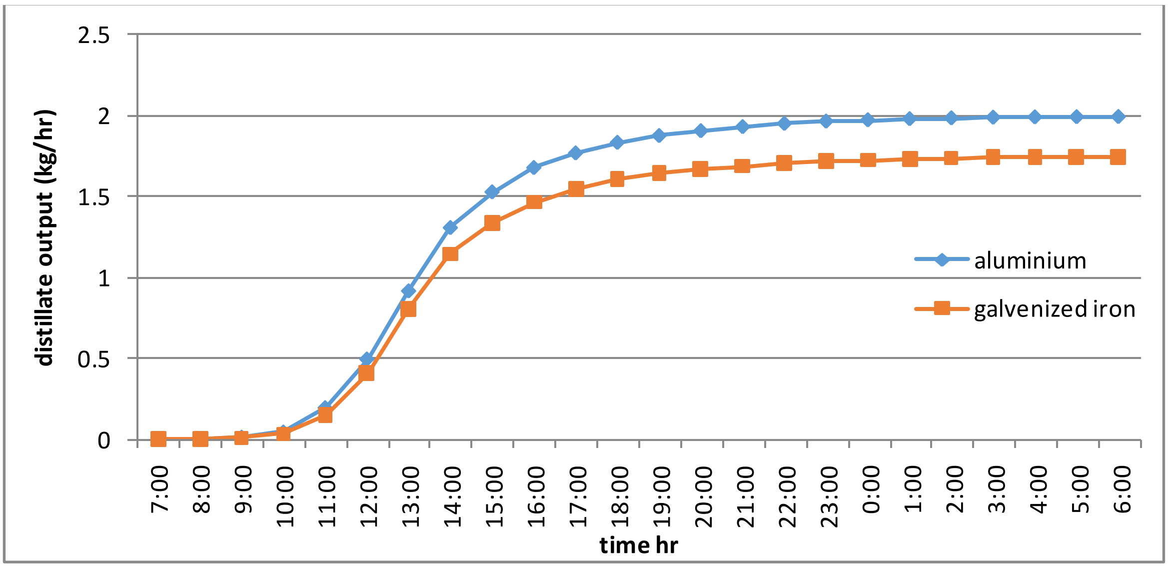

Figure 14 comparison of distillate output in solar still with aluminium screen and galvanized iron screen.

IV. Conclusion

From the above experiment solar still with aluminium screen gives higher distillate output than solar still with galvanized iron and conventional solar still. Solar still with aluminium screen gives 13.66% higher output than solar still with galvanized iron screen and 22.77% higher than conventional still. Also conclude that the solar still with galvanized iron screen gives 6.25% higher output than conventional solar still.

References

1] P.K. Srivastava, S.K. Agrawal. Experimental and theoretical analysis of single sloped basin type solar still consisting of multiple low thermal inertia floating porous absorbers./ Desalination 311 (2013) 198–205

2] T. V. Arjunan et al.The Effect of Sponge Liner Colors on the Performance of Simple Solar Stills . Energy Sources, Part A, 34:1984–1994, 2012

3] A.E. Kabeel et al.Augmentation of the basin type solar still using photovoltaic powered turbulence system / Desalination and Water Treatment 48,182–190,2012

4] R. Rajanarthini et al. Performance analysis of double slope wick-type solar still with varying thermal insulation beneath the wick surface./ Desalination and Water Treatment 51 (2013) 2076–2086

5] D. Bechki et al.Effect of partial intermittent shading on the performance of a simple basin solar still in south Algeria./ Desalination 260 ,65–69,2010

6] K Kalidasa Murugavel.Modeling and Verification of Double Slope Single Basin Solar Still Using Laboratory and Actual Solar Conditions./3,228-235**,**2009

7] N. Rahbar and J.A. Esfahani.Estimation of convective heat transfer coefficient in a single-slope solar still: a numerical study./ Desalination and Water Treatment 50 ,387–396,2012

8] S. Kumar, G.N. Tiwari. Analytical expression for instantaneous exergy efficiency of a shallow basin passive solar still./ International Journal of Thermal Sciences 227,1-7,2014

9] V.VELMURUGAN ET AL.Single basin solar still with fin for enhancing productivity/ Energy Conversion and Management 49 ,2602–2608,2008

10] Nafey AS, Abdelkader M, Abdelmotalip A, Mabrouk AA. Solar still productivity enhancement. Energy Conversion and Management,42(11):1401-8,2001

11] SalahAbdallah, Abu-KhaderMazen M, Badran Omar. Effect of various absorbing materials on the thermal performance of solar stills. Desalination ,242(1-3):128-37,2009

