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A Review On Various Solar Still Characteristics Being Analysed Using Software

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Abstract

The process of turning saline water into drinking water may be accomplished fairly quickly using a solar still. It is influenced by a variety of factors, such as the temperature of the interior and exterior glass covers, the vapour in the air, the temperature of the basin, etc. The production of the distillation is directly inversely proportional to all such factors. As a result, a model is created using Computer Aided Design software. The simulated results and experimental results agreed well. The results of the simulation were used to determine the hourly and cumulative distillate output, and they showed good agreement with the experimental findings. Finally, simulation findings are a crucial tool for understanding the function of a solar still.

Keywords: Computer Aided Design software, simulation, solar still, saline water.

Introduction

Saline water reclamation technology will spread more widely as a result of the current water shortage to tackle this problem. A solar still could help some countries with their lack of drinkable water because many of them experience very high levels of sun radiation. A relatively common device for turning saltwater into drinkable water is solar still. It requires very little upkeep and is very simple to construct using materials that are readily available locally[12] One of the few practical options for treating drinking water in many parts of the world where there is widespread water contamination is the concept of solar water treatment or solar distillation. Although easy in theory and operation, a frequent tool used for this is the solar still, which has poor productivity [1]. All man-made desalination systems use the same fundamental principle to create fresh water from salty resources like how rainwater is created naturally through the hydrological cycle. Membrane separation systems do this because it is not possible to automatically remove salts from water [2]. On the other hand, solar desalination turns out to be the most practical and affordable method of refining the dissolved salt solution. This technique has no expenditures since it harnesses the free, plentiful energy from the sun that is naturally present [3]. Renewables still are a fairly straightforward method of water distillation. It comprises a container with a transparent cover and painted black interior surfaces. Saline or salt water is put inside the container to be cleaned. The water is heated as a result of the solar radiation passing through the transparent cover and being collected by the reservoir liner [4]. Under the glass surface, the evaporated water condenses and is condensed in a trough that is fitted along the length of the side. Rajaseenivasan et al. have provided a thorough and insightful review of multi-effect solar stills [5]. A double basin active solar still is chosen for future development and evaluation metrics based on various literature reviews, and it is subjected to being coupled with an evacuated tube collector for high heat water feeding into the basin of the solar still. It is recommended that the 1 m^2 produced solar still basin be tested by being turned into a double basin within the solar still using a glass tray. As a result, the upper portion's heat loss was decreased, increasing the amount of pure water produced. It has been observed that output with a double basin is higher than with a single basin since the upper glass's thermal energy has been significantly reduced [1]. Due to the standard solar still being extremely low productivity, numerous improvements to still design have been undertaken in the past to increase productivity. Both symmetrical and asymmetrical sun stills had been employed by Alhayek and Badran. [6]. The effectiveness of an angled solar hot water distillation system that generates both hot and fresh water. It was discovered that using black wick resulted in a 23% increase in distillate output[7]. The majority of the previous research succeeded in boosting or enhancing distillate yield from a traditional solar still. The temperature of the vapour, the water in the basin, the outer top cover, and the inner glass all affect how much distillate is produced. In the current study, a software method known as ANSYS CFD is used to validate such temperatures. Last but not least, real solar still's daily and overall distillate output is compared to ANSYS CFD simulation [12].

Process and Layout for Experiments

Both stills have identical internal dimensions of 0.5 m and 0.5 m. The area of the lower basin is 0.25 m^2. The mild steel plate used to construct the SB still basin has a thickness of 1.4 mm, and its height is 18 cm. The transparent cover for the basin's iron frames was made of clear window glass with a thickness of 4 mm. It is positioned at a 30^o incline to the horizontal. The apparatus is equipped to gather distillates from two locations (South and North). The lower and upper basins of the DB are still present. The top basin was created of 4 mm transparent window glass with a 30^o tilt, and the lower basin was built using the same methods as SB. schematic diagrams of the Single Basin solar still has been shown in figure 1. The upper bowl stands 14 cm tall. A piece of glass with a height of 7 cm is used to divide the upper basin into distinct compartments, and silicon glue is used to attach it to the glass cover. As a clear cover, window glass with a 4 mm thickness is utilised. The device is equipped to gather distillates from four different locations (upper basin-south, north and lower basin-south, north). The 50 mm thermocouple served as insulation for both stills. For supplying preheated saline water at varied preheated temperatures, the lower basin is connected to a water storage tank and an electric coil heater.[15] A inter solar still is created with a 0.5 x 0.5 m2 surface area. The bottom of the basin is composed of a G.I. sheet. A wooden box is used to cover the exterior. To minimise heat loss, thermocol is utilised as insulation between the basin and the wooden box. A glass cover that is 3 mm thick and 300 degrees slanted covers the entire surface. The condensed water is collected in the condensate collection tube where it is removed for usage using a glass stopper that is placed at the end of the glass. The second layer of glass covers the space of the top basin. Five divisions are created by dividing the topmost basin with a glass stopper. For the inlet and outflow pipes, holes are provided on both basins. The electric coil heater is linked to the lower basin. To supply the lower basin, preheated water is needed. Water from the input tank is used to fill the upper basin with cold water.[15] schematic diagrams of the Double Basin solar still have been shown in figure 2.

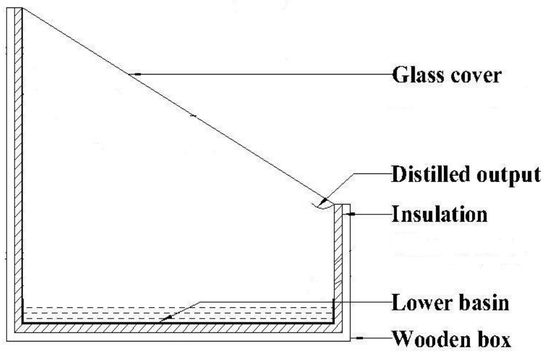


Figure .1 schematic diagrams of the Single Basin solar still

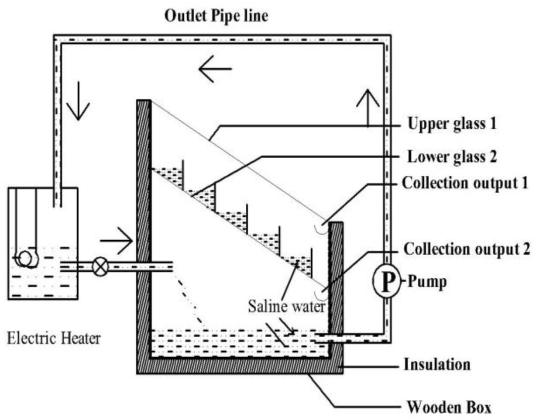


Figure.2 Schematic diagrams of the Double Basin solar still

Results and Discussion of Simulation

For CFD analysis, ANSYS R18.2 software is employed. Utilizing ANSYS Workbench 13, the model geometry was built and its meshing was carried out. The tetrahedral unstructured mesh was employed. We tested the sensitivity of the simulation output to grid size.

Boundary Physics

Table no .1 explains the physics boundary condition for solving the problem

Sno.	Name of Boundary	Description
1	Domain	Boundaries
2	volume.1	Boundary - glass
3	Type	Wall
4	Boundary - in	Velocity-Inlet
5	Boundary - out	Pressure-Outlet
6	Boundary - plate	Wall
7	Boundary - wall	Wall

Table .1 Boundary Conditions Simulation User Data

Figure 3 shows the results of the temperature range which lies between 3224e+002 to 3004e+002 shown below

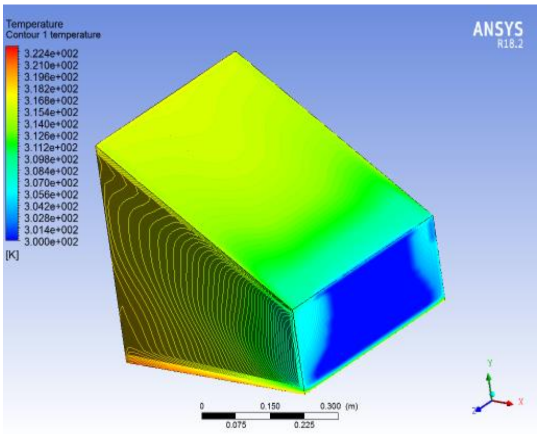


Figure .3 Temperatures

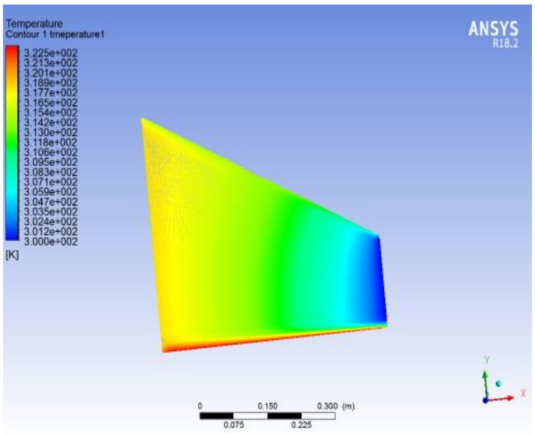
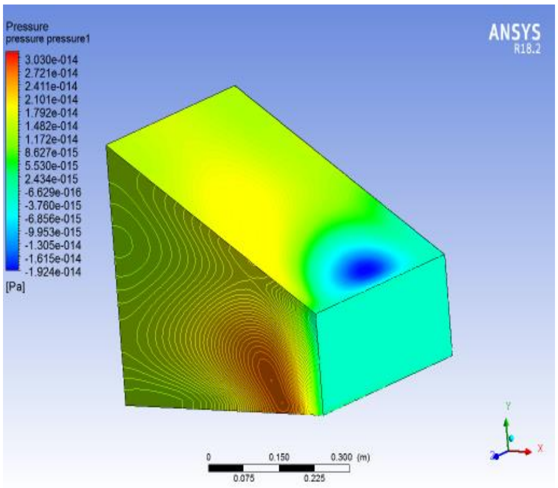


Figure .4 Temperatures distribution

Figures 4 and 5 show the results of temperature distribution and pressure respectively, Figure 6 shows the results of inner pressure shown below.



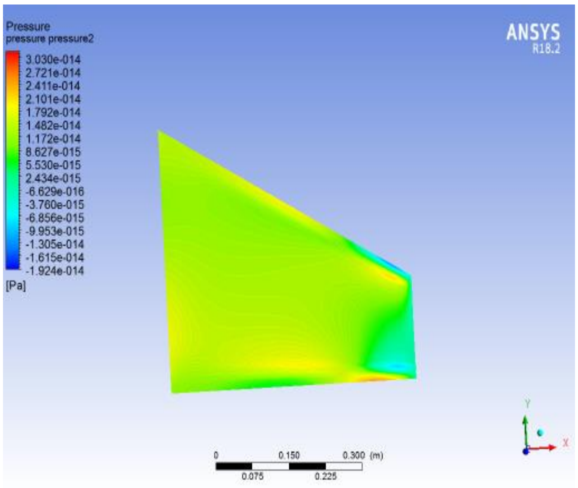


Figure 5 – pressure **Figure 6 –inner pressure**

Figure 7 shows the results of turbulence eddy dissipation and Figure 8 shows the results of Inner turbulence eddy dissipation shown below.

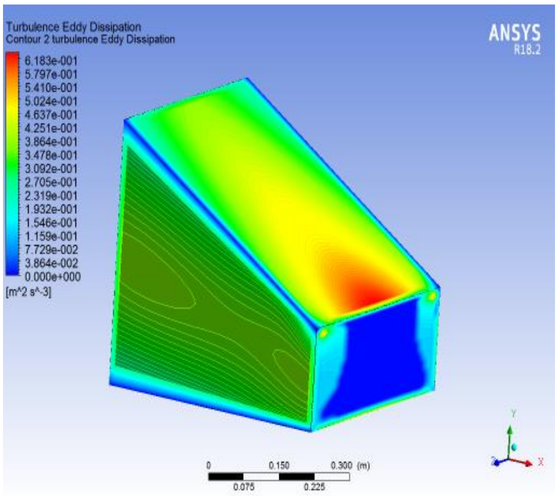
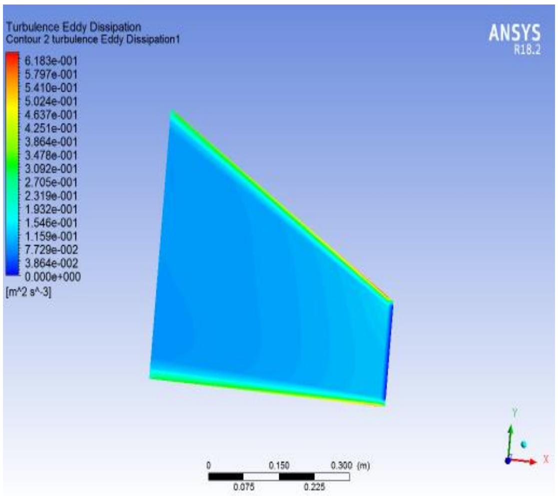



Figure 7 turbulence eddy dissipation **Figure 8 Inner turbulence eddy dissipation**

Figure 9 shows the results of Turbulence kinetic energy and figure 10 shows the results of Inner turbulence kinetic energy shown below

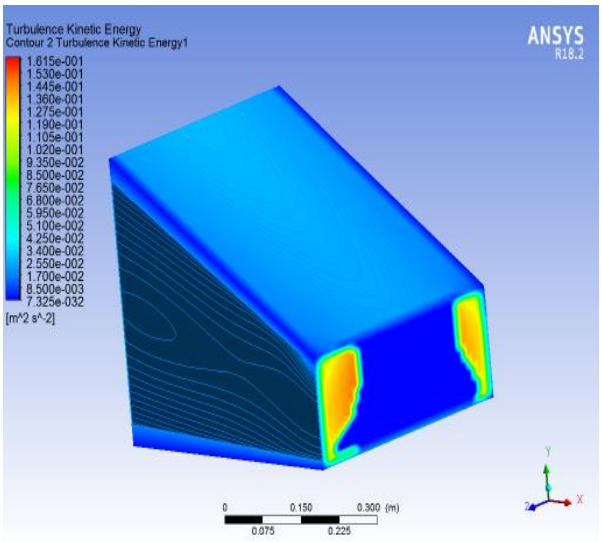
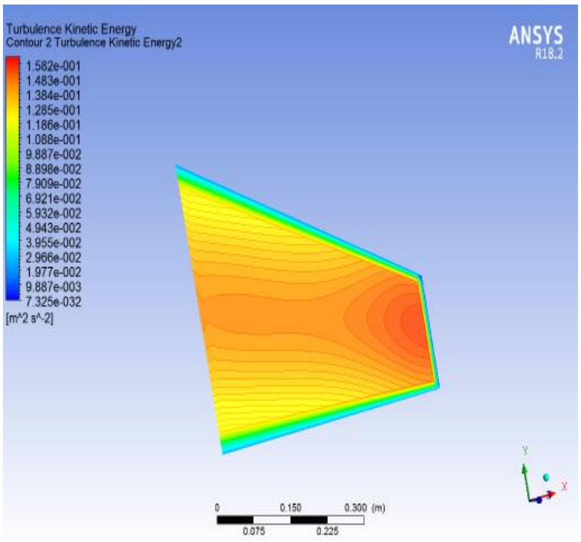
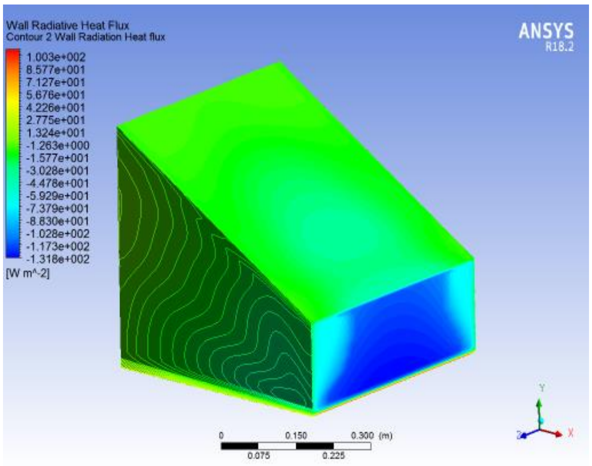



Figure 9 . Turbulence kinetic energy **Figure 10.Inner turbulence kinetic energy**

Figure 11 shows the results of the Wall heat transfer coefficient and Figure 12 shows the results of Wall radiation heat flux shown below.



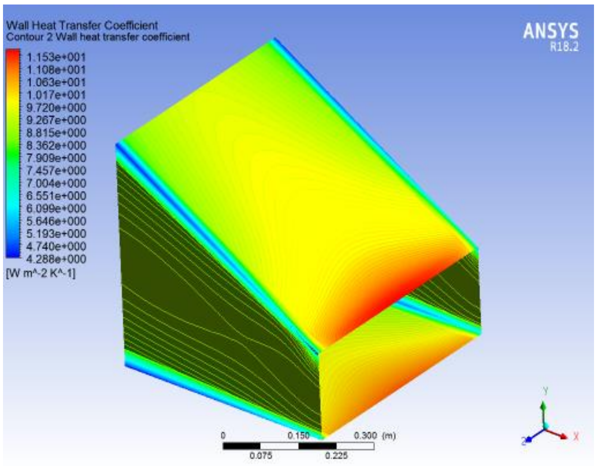
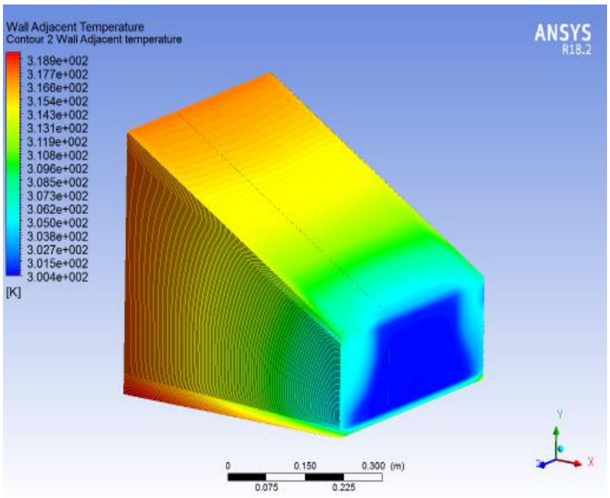


Figure 11.Wall heat transfer coefficient **Figure 12 –Wall radiation heat flux**

Figure 13 shows the results of the Wall adjacent temperature Figure 14 shows the results of the Inner wall adjacent temperature and also figure 15 shows the results of Do irradiation and Figure 16 shows the results of Inner irradiation shown below



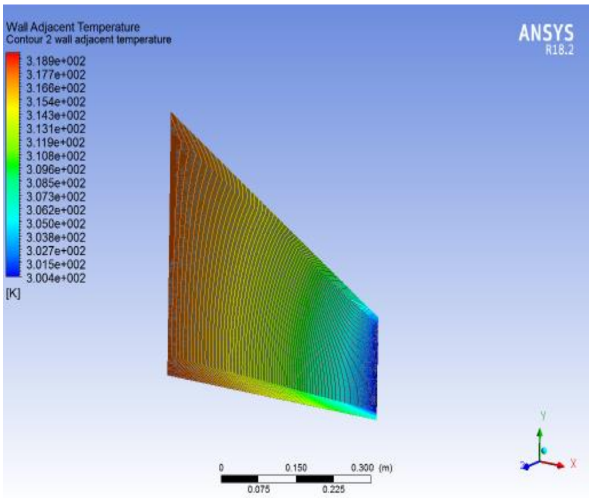


Figure 13. Wall adjacent temperature **Figure 14. Inner wall adjacent temperature**

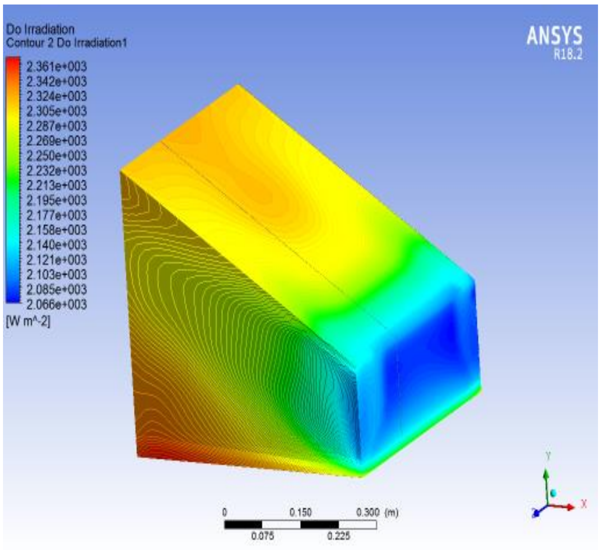


Figure. 15 Do irradiation

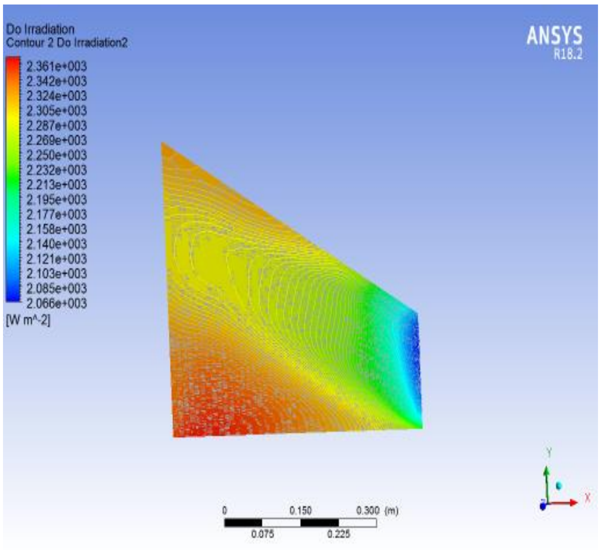


Figure. 16 Inner does irradiation

Conclusion

Vapour phase and dehydration processes must occur in a solar still to yield distillate output. To simulate both collection and absorption processes, models of the original structure of experimental solar still were created in ANSYS CFD. For a variety of settings, simulation results using ANSYS CFD work were obtained. The outcomes of the simulation were discovered to be rather comparable. Therefore, it follows that using ANSYS CFD software to forecast a solar still's performance is straightforward and that even in challenging scenarios, ANSYS CFD will produce accurate results.

Reference

1. Mitesh I Patel, P M Meena and Sunil Inkia (2011) ‘Experimental investigation on single slope double basin active solar still coupled with evacuated glass tubes’ Rajasthan, India. International Journal of Advanced Engineering Research and Studies, IJAERS/Vol. I/ Issue I/October-December, 2011/4-9
2. Aqeel Y. Hashim (2011) ‘A new design of a single slop double- basin solar still (SSDBS)’ Journal of Basrah Researches, Volume 37.Number 2.
3. T. Rajaseenivasan, T. Elango, K. Kalidasa Murugavel (2012) 'Comparative study of the double basin and single basin solar stills' Desalination.
4. K.S. Reddy, K. Ravi Kumar, Tadhg S. O'Donovan, T.K. Mallick (2012) ‘Performance analysis of an evacuated multi-stage solar water desalination system’ Desalination.
5. K.Kalidasa Murugavel, Kn.K.S.K.Chockalingam, K. Srithar(2007) ‘Progresses in improving the effectiveness of the single basin passive solar still’ Desalination 220 (2008) 677–686
6. V.Velmurugan, K. Srithar, (2010) ‘Performance analysis of solar stills based on various factors affecting the productivity—A review’ Renewable and Sustainable Energy Reviews.

7. K. Kalidasa Murugavel, K.Srithar (2010) ‘Performance study on basin type double slope solar still with different wick materials and minimum mass of water’ Renewable Energy 36 (2011) 612-620.
8. Akash, B. A., M. S. Mohsen, O. Osta, and Y. Elayan. 1998. “Experimental Evaluation of a Single-Basin Solar Still Using Different Absorbing Materials.” Renewable Energy 14: 307–310.
9. Boukar, M., and A. Harmim. 2001. “Effect of Climatic Conditions on the Performance of a Simple Basin Solar Still: A Comparative Study.” Desalination 137: 15–22.
10. Boukar, M., and A. Harmim. 2004. “Parametric Study of a Vertical Solar Still Under Desert Climatic Conditions.” Desalination 168: 21–28.
11. Dutt, D. K., A. Kumar, J. D. Anand, and G. N. Tiwari. 1989. “Performance of a Double-Basin Solar Still in the Presence of Dye.” Applied Energy 32: 207–223
12. Hitesh N. Panchal & Nikunj Patel (2018) ANSYS CFD and experimental comparison of various parameters of a solar still, International Journal of Ambient Energy, 39:6, 551-557, DOI: 10.1080/01430750.2017.1318785
13. Badran, O.; Abu-khader, M.M. Evaluating thermal performance of a single slope solar still. Heat Mass Transf. 2007, 43, 985–995.
14. Rosseland Radiation Model Theory. Available online: https://www.afs.enea.it/project/neptunius/docs/fluent/ html/th/node113.htm (accessed on 12 January 2018).
15. Kaliappan S, Rajkamal M.D, Ganesan V.G, Manikandan P. Experimental investigation on single basin and double basin solar desalination. Int. J. Chem. Sci. 2016;14(2):1121-32.
16. Panchal, Hitesh, Manish Doshi, Prakash Chavda, and Ranvirgiri Goswami. 2010. “Effect of Cow Dung Cakes Inside Basin on Heat Transfer Coefficients and Productivity of Single Basin Single Slope Solar Still.” International Journal of Applied Engineering Research, Dindigul 1 (4): 675–690