International Journal of Energetica (IJECA)
https://www.ijeca.info
ISSN: 2543-3717 Volume 7. Issue 1. 2022
Page 23-27

Effect of plastic fins on a traditional solar still's efficiency

A. Khechekhouche[1*], A. M. de Oliveira Siqueira[2], Nabil Elsharif[3]

[1]*Technology Faculty, El Oued University, ALGERIA*
[2]*Chemical Engineering Graduate Program, Federal University of Viçosa, BRAZIL*
[3]*Mechanical Engineering Department, University of Benghazi, LIBYA*

[*]Corresponding author E-mail: *abder03@hotmail.com*

Abstract –*Solar distillation is a relatively straightforward and environmental method. It is used in many countries and especially in isolated areas to treat polluted water. In this context, two similar solar stills of 50 x 50 cm were used in the same climatic conditions in order to test the influence of plastic fins on the performance of this device. The results show that there is a negative effect on the output of the distiller with a rate of 8.8 %. So this way is not recommended for researchers in this field.*

Keywords*: Solar energy, Solar distillation, Water output, Pure water.*

Received: 02/04/2022 – Revised 05/05/2022 – Accepted: 27/05/2022

I. Introduction

Solar energy is a plentiful, renewable, free, and environmentally friendly source of energy. Algeria is a North African country with a fascinating energy potential, namely solar energy [1-3]. This energy can be used to treat dirty underground water [4-7].

Several research labs throughout the world produce their prototypes [8-10]. According to the literature [11,12], the solar still is a straightforward device to construct. It is a process that is directly tied to the intensity of solar radiation, and any change in the latter causes a change in the still's productivity. An experimental investigation found that productivity is 1127 ml during the summer and 119 ml during the winter when solar radiation is low [13].

The purpose of all investigations, whether experimental, numerical, or simulation-based, is to increase the solar still's production. Studies on cooling the glazing, or the condenser, have been focused on improving the efficiency of this device. According to the findings of a study on the cooling of a solar still's glass cover, daily production increased by 32.8 % [14]. Another recent study discovered that combining a high thermal conductivity absorber with a glass cover cooling system increases efficiency from 105.9% to 107.7% [15-17].

Others conducted an experimental investigation to see the effect of variation in glass cover thickness and the use of double glazing on the performance of conventional solar stills, while others concentrated their research on modifying the angle of cover to best maximize their device. The findings show that the angle of the glazing, as well as the thickness of the glazing, has a direct impact on the solar output. In the case of double glass, the data suggest that the solar still performance is significantly reduced [18-22].

The heating of brackish water is another component of the study. Some study has used phase change materials (PCM) in the field of solar distillation to boost the productivity of the solar still. It raises the temperature of the water and speeds up the evaporation process. This substance is effective in the solar still, although its performance is dependent on the type of material and its concentration [23,24]. Despite their high cost, nanofluids have been utilized in solar distillation for a few years. On the one hand, the data demonstrate that the rate of

improvement varies greatly depending on the composition of the nanofluid and its concentration in the solar still's water basin. Other criteria, such as the quality of the water to be treated and its thickness, come into play as well [25,26]. The use of available tools such as CFD, Matlab, or others to examine heat and mass transfer, temperature evolutions, and other aspects of solar stills is known as numerical modeling. They are efficient tools for constructing mathematical models that researchers can use to validate their findings [27-30].

The heating of brackish water is another focus of the study. Some research has been done to improve the productivity of solar stills. The heating of brackish water is another focus of the study. Some studies have used pebbles, granites, metal plates, charcoal, Aluminum wastes, Palm Fibers, sand, or sponge pieces to boost the solar still's output. The results demonstrate that natural material improvement ranges from 15% to 273 %, with cubic sponge pieces having the highest upgrading value [31-37].

The objective of this work is to see the effect of plastic fins on the performance of a conventional solar still.

II. Material and method

Two solar stills were tested in March at the University of El Oued, south-eastern Algeria. The first still SSR is taken as a reference still and the second SSM still is taken as a modify still. So plastic fins were placed in this second still in order to know the effect of the fins on the output of our device as shown in Figure 1. Temperature and water quantity measurements are taken every hour during the 8 hours of the experiment.

Figure 1. Measurement system setting up

III. Results and analysis

III.1. Solar radiation and ambient temperature

Sun distillation depends heavily on solar radiation. The progression of this radiation over time is depicted in Figure 2. Additionally, it displays the changes in ambient temperature over time. Note that the maximum radiation is 880 W/m^2 between 12:h00 and 13:h00 and the maximum ambient temperature is 31°C at 14:h00.

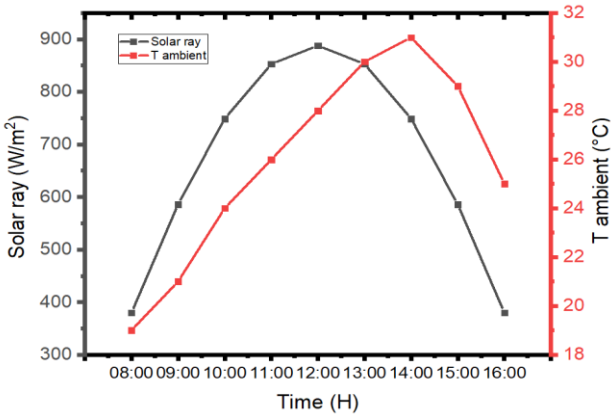

Figure 2. Evolution of solar radiation and ambient temperature

III.2. Internal glass temperature evolution

Figure 1 represents the evolution of the temperature of the glass cover (inner face) during the duration of the experiment. We notice that the temperatures increase until reaching their maximum values between 13:00h and 14:00h and we note that the temperatures of the inner face of the two stills are almost the same, which suggests that the temperature of the water will influence the output of the stills.

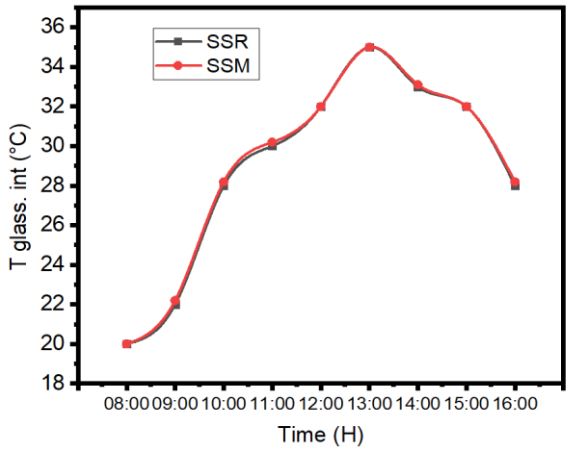

Figure 3. Evolution of internal glass cover temperature

III.3. Water temperature evolution

A live image of the experiment is shown in Figure 4 along with the water temperature variation of the two solar stills. It should be noticed that the SSR's water temperature is higher than the SSM's water temperature. This illustrates that the plastic fins on the solar still's water basin have no beneficial impact on the water's ability to be heated.

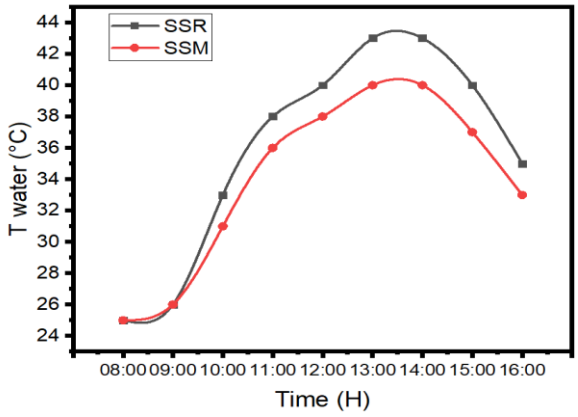

Figure 4. Water temperature evolution

III.4. Accumulation output of pure water

Figure 6 represents the output of the 2 solar stills as a function of time. We notice from the beginning of the experiment, that the output of SSR is higher than the output of SSM and this is throughout the experiment.

The change in pure water accumulation from the two solar stills is seen in Figure 7. Keep in mind that over the course of the experiment's eight hours, the SSM distiller gathered 432 ml of pure water, and the SSR distiller 470 ml. Therefore, there is a 38 milliliter discrepancy. What demonstrates that plastic fins cannot be viewed as a technique for solar distillation enhancement

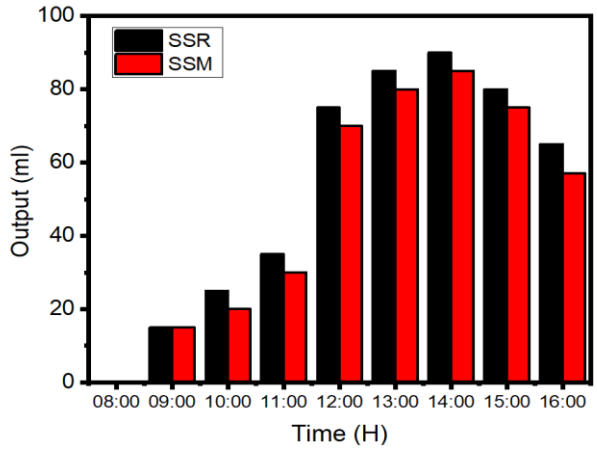

Figure 6. Evolution of hourly output

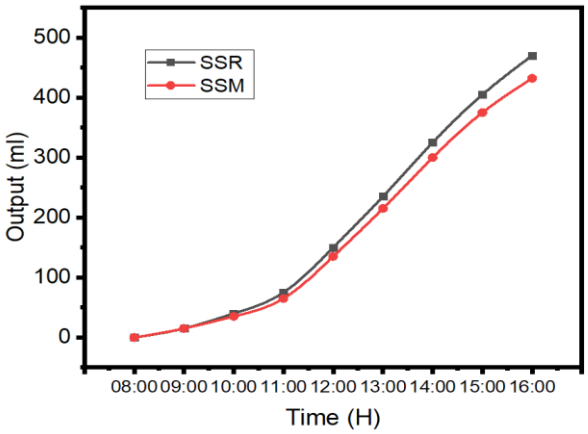

Figure 7. Accumulation output of pure water

IV. Conclusion

An experiment was done to test the effect of plastic fins on the performance of a solar still. the results show that:

- The temperature of the front side of the glass cover is the same.
- The water temperature of SSR is higher than SSM.
- The output of the Modify Solar Still SSM is lower than the Reference Solar Still SSR with an output of 8.8%.

It can be said that plastic fins are not a means of improvement in solar distillation.

Declaration

- The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper.
- The authors declare that this article has not been published before and is not in the process of being published in any other journal.
- The authors confirmed that the paper was free of plagiarism.

References

[1] S. Pahlavan, M. Jahangiri, A. Alidadi Shamsabadi, A. Khechekhouche, "Feasibility Study of Solar Water Heaters in Algeria, a Review, " Journal of Solar Energy Research, vol 3, pp.135-146. 2018.

[2] M. Ghodbane, B. Boumeddane, "Estimating solar radiation according to the semiempirical approach of Perrin de Brichambaut: application on several areas with the different climate in Algeria," International Journal of Eenergetica, vol.1, pp. 20-29. 2016. http://dx.doi.org/10.47238/ijeca.v1i1.12

[3] D. Benatiallah, A. Benatiallah, K. Bouchouicha, B. Nasri, "Estimation of clear sky global solar radiation in Algeria, " AIMS Energy, vol. 7, pp. 710-727. 2019.

[4] A. Khechekhouche, B. Benhaoua, MEH. Attia, Z. Driss, A. Manokar, "Polluted Groundwater Treatment in Southeastern Algeria by Solar Distillation," Algerian Journal of Environmental Science and Technology, vol. 6, 2020.

[5] K.K. Sadasivuni, H. Panchal, A. Awasthi, M., F.A. Essa, S. Shanmugan, M. Suresh, V. Priya, A. Khechekhouche, "Ground Water Treatment Using Solar Radiation-Vaporization & Condensation-Techniques by Solar Desalination system, " International Journal of Ambient Energy, 2020. https://doi.org/10.1080/01430750.2020.1772872

[6] H. Panchal, K.K. Sadasivuni, C. Prajapati, M. Khalid, F.A. Essa, S. Shanmugan, N. Pandya, M. Suresh, M. Israr, S. Dharaskar, A. Khechekhouche, "Productivity enhancement of solar still with thermoelectric modules from groundwater to produce potable water: A review, "Groundwater for Sustainable Development, vol. 11, pp. 100429. 2020. https://doi.org/10.1016/j.gsd.2020.100429

[7] A. Miloudi, A. Khechekhouche, I. Kermerchou, "Pollution groundwater treatment by solar stills with palm fibers, " JP Journal of Heat and Mass Transfer, vol 27, pp. 1-12. 2022.

[8] A. Laaraba, A. Khechekhouche, "Numerical Simulation of Natural Convection in the Air Gap of a Vertical Flat Plat Thermal Solar Collector with Partitions Attached to Its Glazing, " Indonesian Journal of Science & Technology, vol. 3, pp. 14-23, 2018. https://doi.org/10.17509/ijost.v3i2.12753

[9] M. Ghodbane, D. Benmenine, A. Khechekhouche, B. Boumeddane, "Brief on Solar Concentrators: Differences and Applications, " Instrumentation Mesure Métrologie, vol. 19, pp. 371-378, 2020. https://doi.org/10.18280/i2m.190507

[10] M. S. Meftah, B. Benhaoua, A. Khechekhouche, "Bottom collector isolation effect on the solar chimney performance," JP Journal of Heat and Mass Transfer, vol 26, pp. 27-40. 2022.

[11] A. Khechekhouche, N. Elsharif, I. Kermerchou, A. Sadoun,"Construction and performance evaluation of a conventional solar distiller," Heritage and Sustainable Development, vol. 1, pp. 72-77. 2019. DOI: 10.37868/hsd.v1i2.3

[12] M. Elgendi, M.Y.E. Selim, A. Aldhaheri, W. Alshehhi, H. Almarshoodi, A. Alhefeiti, "Design procedures for a passive pyramid solar still with an automatic feed water system, "Alexandria Engineering Journal (2021). https://doi.org/10.1016/j.aej.2021.12.002

[13] A. Khechekhouche, B. Boukhari, Z. Driss, N.E. Benhissen, "Seasonal effect on solar distillation in the El-Oued region of south-east Algeria, " International Journal of Energetica, vol. 2, pp. 42-45. 2017. http://dx.doi.org/10.47238/ijeca.v2i1.27

[14] Z.M. Omara, A.S. Abdullah, A.E. Kabeel, F.A. Essa, "The cooling techniques of the solar stills' glass covers – A review," Renewable and Sustainable Energy Reviews, vol.78, pp. 176-193, 2017. https://doi.org/10.1016/j.rser.2017.04.085

[15] A.E. Kabeel, Mohamed Abdelgaied, "Enhancement of pyramid-shaped solar stills performance using a high thermal conductivity absorber plate and cooling the glass cover, " Renewable Energy, vol. 146, pp. 769-775. 2020. https://doi.org/10.1016/j.renene.2019.07.020

[16] M.E.H. Attia, A.E. Kabeel, M. Abdelgaied, A. Bellila, "Optimization of the hemispherical solar distiller performance assisted by high thermal conductivity metal trays incorporated with reflective mirrors, " Environmental Science and Pollution Research. 2022. https://doi.org/10.1007/s11356-022-18708-y.

[17] B. Souyei, A. Khechekhouche, S. Meneceur, "Effect of comparison of a metal plate and a refractory plate on a sollar still, " JP Journal of Heat and Mass Transfer, vol 27, pp. 37-56. 2022. DOI: 10.17654/0973576322022

[18] R. Cherraye, B. Bouchekima, D. Bechki, H. Bouguettaia, A. Khechekhouche," The effect of tilt angle on solar still productivity at different seasons in arid conditions-south Algeria," International Journal of Ambient Energy. 2020. https://doi.org/10.1080/01430750.2020.1723689

[19] A. Khechekhouche, M. Manokar, R. Sathyamurthy, F. Essa, M. Sadeghzadeh, A. Issakhovm," Energy, exergy analysis, and optimizations of collector cover thickness of a solar still in El Oued climate, Algeria," International Journal of Photoenergy. Article ID 6668325, 2021. https://doi.org/10.1155/2021/6668325

[20] A. Khechekhouche, B. Benhaoua, A. M. Manokar, A. E. Kabeel, R. Sathyamurthy," Exploitation of an insulated air chamber as a glazed cover of a conventional solar still," Heat Transfer - Asian Research, vol. 48, pp. 1563-1574. 2019. https://doi.org/10.1002/htj.21446

[21] A. Khechekhouche, Z. Driss, B. Durakovic," Effect of heat flow via glazing on the productivity of a solar still, " International Journal of Energetica, vol. 4, pp. 54-57. 2019. http://dx.doi.org/10.47238/ijeca.v4i2.109

[22] A. Khechekhouche, B. Ben Haoua, Z. Driss,"Solar distillation between a simple and double-glazing," Revue de mécanique, vol. 2, 2017.

[23] P. Negi, R. Dobriyal, D.B. Singh, G.K. Badhotiya, "A review on passive and active solar still using phase change materials," Materials Today: Proceedings, vol. 46, pp. 10433-10438. 2021.

[24] J. Kateshia, V.J. Lakhera, " Analysis of solar still integrated with phase change material and pin fins as absorbing material, " Journal of Energy Storage, vol. 35, pp. 102292. 2021.

[25] A.K. Singh, D.B. Singh, V.K. Dwivedi, G.N. Tiwari, A. Gupta, "Water purification using solar still with/without nano-fluid: A review," Materials Today: Proceedings, vol. 21, pp. 1700-1706. 2020. https://doi.org/10.1016/j.matpr.2019.12.025

[26] T. Arunkumar, H.W. Lim, S.J. Lee,"A review on efficiently integrated passive distillation systems for active solar steam evaporation," Renewable and Sustainable Energy Reviews, vol. 155, pp. 111894. 2022. https://doi.org/10.1016/j.rser.2021.111894

[27] G. Mittal, An unsteady CFD modelling of a single slope solar still, Materials Today: Proceedings, vol. 46, pp. 10991-10995. 2021. DOI: 10.1016/j.matpr.2021.02.090

[28] D. Dsilva Winfred Rufuss, S. Arulvel, S. Iniyan, L. Suganthi, "Numerical study of titanium oxide nanoparticle enhanced energy storage material in solar desalination, Materials Today: Proceedings," vol. 43, pp. 805-808. 2021.

[29] O. Prakash, A. Ahmad, A. Kumar, S.M. Mozammil Hasnain, G. Kumar, "Comprehensive Analysis of Design Software Application in Solar Distillation Units, "Materials Science for Energy Technologies. 2022.

[30] H. Al-Madhhachi, G.F. Smaisim, "Experimental and numerical investigations with environmental impacts of affordable square pyramid solar still," Solar Energy, vol. 216, pp. 303-314. 2021. https://doi.org/10.1016/j.solener.2020.12.051

[31] A.E. Kabeel, M. Abdelgaied, A. Eisa, "Enhancing the performance of single basin solar still using high thermal conductivity sensible storage materials, " Journal of Cleaner Production, vol. 183, pp. 20-25. 2018. https://doi.org/10.1016/j.jclepro.2018.02.144

[32] M.E.A. Ouar, M.H. Sellami, S.E. Meddour, O.B. Mokrani, "Brackish water desalination using black granite as heat storage medium under arid climatic conditions, " Desalination and Water Treatment, vol. 225, pp. 149–155. 2021. DOI: 10.5004/dwt.2021.27204

[33] A. Khechekhouche, B. Benhaoua, M. Manokar, R. Sathyamurthy, A. Kabeel, Z. Driss," Sand dunes effect on the productivity of a single slope solar distiller," Heat and Mass Transfer Journal, vol. 56, pp. 1117-1126, 2020. https://doi.org/10.1007/s00231-019-02786-9 https://doi.org/10.1007/s00231-019-02786-9

[34] A. Sadoun, A. Khechekhouche, I. Kemerchou, M. Ghodbane, B. Souyei, "Impact of natural charcoal blocks on the solar still

output, " Heritage and Sustainable Development, vol. 4, pp.61-66, 2022. DOI: 10.37868/hsd.v4i1.80

[35] I. Kermerchou, I. Mahdjoubi, C. Kined, A. Khechekhouche, A. Bellila, G. E. Devora Isiordia. Palm Fibers Effect on the Performance of a Conventional Solar Still, ASEAN Journal For Science And Engineering In Materials, vol. 1, pp. 29-36, 2022.

[36] A. Bellila, A. Khechekhouche, I. Kermerchou, A. Sadoun, A. M. de Oliveira Siqueira, N. Smakdji," Aluminum Wastes Effect on Solar Distillation, " ASEAN Journal For Science And Engineering In Materials, vol 1. 2022.

[37] A. Khechekhouche, B. Benhaoua, A. Kabeel, M. Attia, W M. El-Maghlany," Improvement of solar distiller productivity by a black metallic plate of Zinc as a thermal storage material," Journal of Testing and Evaluation, vol. 49, 2019. DOI: 10.1520/JTE20190119