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REVIEW ARTICLE

Augmentation of distillate output of solar still with help of evacuated tubes: A Review

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ABSTRACT

Potable water is essential for human existence. In addition, the quantity of potable water is limited. On the other hand, saline water is available, but it is not considered potable. Solar energy is utilized to convert saline water into potable water through a process called solar desalination. Solar stills are devices used to convert saline water into potable water using solar energy; however, the quantity of potable water produced is low. This review paper shows the use of evacuated tubes to increase the water temperature and hence increase the potable water from solar stills. Various researchers have worked on solar stills with evacuated tubes, as discussed in this review. The study concluded that evacuated tubes are among the most crucial components for increasing the amount of drinkable water produced by solar stills.

Keywords: Solar still; Evacuated tubes; Distillate yield; water temperature; Energy efficiency

1. Introduction

A significant challenge facing India is the scarcity of water resources. Every human being fundamentally depends on water [1-4]. In numerous states, the situation has become so dire that groundwater has nearly vanished, forcing residents in several areas to rely on alternative water sources [5-7]. Additionally, water is the most squandered natural resource due to its misuse. Despite being the most vital element of our existence, water does not receive the priority it deserves. In previous years, individuals structured their lives in a manner that allowed for a greater appreciation of the value of water. Water also was the birthplace and death ground for numerous civilisations too [8-10].

Solar energy is abundantly available and does not require any charge for its use it [11-13]. Solar energy can be harnessed to convert seawater into potable water, a process known as solar desalination [14][15]. Solar desalination makes use of several methods, among which solar stills are among the most affordable and reasonably priced choices [16-18]. Solar stills produce an insufficient quantity of distilled water, rendering them inadequate for supplying potable water for domestic and industrial applications. Numerous researchers have explored various methods to enhance the yield of solar distillates [19-21].

Based on several studies, Kalogirou [22] reviewed solar desalination systems. He reviewed several types of desalination technologies, their benefits, and distillate yields. They also provided many criteria applicable to research on solar desalination systems. Tiwari et al. [23] investigated solar stills to enhance the thermal efficiency of the stills and the impact of water depth on distillate yield. They found that the lower water depth inside the solar still produced more distillate yield than the higher water depth. Tiwari and Sahota [24] investigated developments in passive solar still technology. They want to see the effect of various parameters on distillate yield. They found that the use of the integrated heating systems can enhance distillate yield.

To examine the possibilities of humidification and dehumidification (HDH) systems, Ghaffour et al. [25] highlighted their scalability and energy economy of the solar desalination system. After analysing several HDH cycle designs, their review finds that these systems are appropriate for distributed desalination in dry areas. Fath et al. [26] carried out an overview of solar-assisted multi-effect desalination (MED) systems to check their feasibility for the desalination system. This study investigated the integration of multi-effect distillation (MED) technology with solar thermal collectors, highlighting the potential of solar energy to improve the economic feasibility of large-scale desalination plants. Sharon and Reddy [27] investigated the development of hybrid solar desalination systems that combine solar energy with other renewable sources. They concluded that places with changing solar radiation, exhibiting hybrid systems, offer better dependability and efficiency compared with the conventional solar still. Rajesh and Narayana [28] investigated the effect of water depth on solar stills. They found that lower water depths enhanced the evaporation surface temperature. Therefore, they found that improving the distillate yield is possible. To improve the condensation efficiency in solar stills, Al-Hinai et al. [29] investigated glass cover cooling of the conventional solar still and compared it with and without glass cover cooling effect. Their experimental results show that lowering the temperature of the glass surface increases water condensation and enhances distillate yield as compared with the conventional solar still. Abdullah et al. [30] showed that glass cover active cooling improves distillate yield due to the supply of hot water through the active system incorporation. They suggested that the Water circulation and air convection, among other cooling techniques, helped to decrease the glass cover temperature, thereby improving condensation rates to enhance distillate yield. Murugavel et al. [31] demonstrated that thermal energy absorption was improved by combining flat-plate collectors with solar stills. They received the water temperature and the distillate yield enhancement. Their study exhibited that the efficiency as well as distillate yield of solar still systems is significantly improved with flat-plate collectors due to the supply of hot water to the basin. Using flat-plate collectors, Fath et al. [32] investigated solar stills with and without the use of Flat plate collectors. They concluded that the additional thermal energy collected from the collectors improved the evaporation rates. Kumar and Tiwari [33] investigated the effect of water depth on solar stills to check the feasibility of obtaining higher distillate yield. They found that lower depths produced higher temperatures and faster rates of evaporation. Therefore, due to higher water temperature and faster evaporation rate, a higher distillate yield was obtained as compared with the conventional solar still. Kalogirou et al. [34] investigated ways for reducing the glass cover of solar stills, particularly forced air and water flow systems. They compared both systems and found the best system for the enhancement of distillate yield and condensation of water in the solar still. El-Sebaii and Faidah [35] experimentally examined solar still glass cover cooling methods to check their effect and compared them with the conventional solar still. The results showed that by lowering the dew point temperature, the condensation rate was improved. Therefore, the distillate yields from the glass cover were increased compared with the conventional solar still. Reviewing flat plate collectors used with solar stills, Murugavel and Chockalingam [36] found that attachment of the solar collectors to the solar still augments the thermal efficiency of the stills.

The distillate production of solar stills depends critically on water depth and temperature. Rising water temperatures were favourably connected with the rate of vapour generation, so increasing the distillate output. The operation of solar stills depends critically on the interaction of water depth and temperature since a reduced depth boosts effective heat transmission and so raises evaporation rates. Hot water from evacuated tubes can be used in a solar still, therefore raising the water temperature and enhancing distillation yield. Research on the usage of solar stills coupled with evacuated tubes to increase the distillate yield is presented in this review article.

2. About the evacuated tubes

Figure 1. Evacuated tubes collector [37]

Evacuated tubes collector (See **Figure 1**.) is designed to minimise heat losses and enhance efficiency over other collectors. Each tube of the evacuated tube collector comprises two concentric glass tubes. A concentric glass tube, called an inner glass absorber tube, and an outer protective glass tube. The spaces between these tubes are subsequently evacuated of air to work as an insulator. This vacuum reduces conduction and convection losses in the evacuated tube collector. Therefore, they enhance the system's efficiency in capturing and storing solar heat to perform water/air heating purposes. The absorber tube features a selective coating that works for solar energy absorption. It then converts it into thermal energy and uses it as a heat transfer fluid, typically water or air.

3. Single slope solar still with evacuated tubes

The hot water in the basin of the solar still is supplied by evacuated tubes. Hot water necessitates a reduced amount of heat for the process of evaporation and thereby enhance distillate yield. A single-slope solar still integrated with evacuated tubes serves to increase the distillate yield by optimizing heat absorption and enhancing the overall efficiency of the solar still.

The thermal efficiency of a single-slope solar still integrated with evacuated tubes was investigated by Kumar and Tiwari [38]. Evacuated tubes facilitate the pre-heating of water before to its entry into the still, therefore enhancing the rate of evaporation. The study demonstrated a significant 40-50% superiority in distillate production when compared to a traditional still lacking evacuated tubes.

Tanaka and Nakatake, Y. [39] conducted an experimental investigation involving the integration of evacuated tubes with a single-slope solar still. This study examines the effects of varying solar intensities and water depths on the output of the still. The yield of distilled water increased by 30-35% with the use of evacuated tubes under varying solar intensity conditions.

Sharshir et al. [40] had carried out thermoeconomic analysis to evaluate the cost-effectiveness and thermal efficiency of solar stills. They considered solar stills both with and without evacuated tubes during their experimentations. They found that the use of evacuated tubes enhanced efficiency and distillate yield but also increase initial investment. They also found that that, there was a reduction in long-term operational costs of the solar still with the evacuated tubes.

El-Sebaii and Al-Hazmi [41] had conducted numerical modeling to forecast the efficacy of a single-slope solar still with evacuated tubes. They considered various climate conditions during their research work. Numerical results demonstrated a 20-40% enhancement in distillate yield using evacuated tubes considering areas of experiments with higher solar intensity. The model concluded that evacuated tubes significantly enhance heat transfer to water, resulting in increased evaporation rates too.

Kalidasa et al. [42] examined the use of evacuated tube-enhanced solar stills in remote or off-grid regions in their research investigations. They have used the areas for the research work having restriction of water as well as electricity both. During their research work, they found that, the solar still utilizing evacuated tubes serves as a sustainable and dependable source of supplying freshwater. They concluded that, solar still with the evacuated tubes considered as good solution of places where less availability of freshwater as well as electricity.

Badran and Abu-Khader [43] had a comparative analysis to evaluate the efficiency differences between conventional solar stills with and without use of the evacuated tubes. The solar still utilizing evacuated tubes demonstrated excellent performance compared to the conventional one. They obtained enhancement of 35-45% compared with the conventional one.

Al-Harahsheh and Abu-Arabi [44] has investigated the efficiency as well as distillate yield of a single-slope solar still integrated with evacuated tubes under varying weather conditions. The evacuated tubes serve to pre-heat the water prior to its entry into the solar still to enhance distillate yield. They obtained distillate yield improvement of 45% compared with conventional one. It is concluded that the use of evacuated tubes that enabled the system to sustain higher temperatures and distillate yield.

Fathy and El-Agouz [45] had examined the application of evacuated tubes with nanofluids to improve the thermal efficiency and distillate yield of a single-slope solar still. Their research indicated a remarkable enhancement of up to 60% in freshwater yield when employing nanofluids use in evacuated tubes during experimentations.

Zhang et al. [46] investigated the remarkable impact of evacuated tubes and external reflectors on distillate yield as well as efficiency of solar still. They found that the integration of evacuated tubes and reflectors enhanced distillate yield by 60% during the afternoon when solar intensity remains higher compared with other time of experiments. The reflectors redirected sunlight to the evacuated tubes and thereby, enhancing solar energy absorption and improving evaporation and condensation rates of solar still.

Kabeel and Omara [47] investigated experimental analysis of solar stills integrated with evacuated tubes during climate conditions of Egypt. They investigated the use of various energy storage materials in solar still coupled with evacuated tubes. They received 40% enhancement of distillate yield with use of energy storage material and evacuated tubes. They also obtained the distillate yield during the evening hours due to heat capacity of water as well as energy storage materials.

Jain and Tiwari [48] had used Computational Fluid Dynamics (CFD) to analyze and compare the thermal performance of a single-slope solar still. They used solar still with and without use of evacuated tubes during the CFD work and experimental work too. Their research indicated a 30% enhancement in efficiency due to use of the evacuated tubes with the solar still. They also compared the CFD simulation results with the experimental work and found good agreement between the results.

Eltawil and Elsayed [49] employed artificial neural networks (ANN) to optimize the design parameters of a solar still integrated with evacuated tubes to achieve maximum efficiency. The study demonstrated that by optimizing parameters including water depth, tube angle, and insulation, the ANN model achieved a 45% enhancement in yield relative to traditional designs.

Qasem and Farag [50] had analyzed the economic viability of use of evacuated tubes with solar still in a place where there is a scarecity of potable water as well as electricity. They obtained enhancement of distillate yield of 50% higher with coupled solar still. They also found that the initial cost of the solar still with evacuated tubes higher but for the long tem distillate output remains higher in solar still coupled with evacuated tubes.

Kalogirou and Nassar [51] investigated the efficacy of a hybrid solar still integrated with evacuated tubes and reflectors to enhance heat absorption. The incorporation of reflectors enhanced solar radiation input by 20%, resulting in a 55% increase in distillate output. Evacuated tubes were the main contributors to the temperature increase, whereas reflectors improved the total heat absorption.

The design of a single-slope solar still that was combined with evacuated tubes was optimized by Khanna and Mishra [52] through the utilization of artificial intelligence (AI) techniques. An increase of 55% in water production was achieved as a result of the optimization that was based on artificial intelligence. This optimization proposed changes in the tilt angle, number of evacuated tubes, and water depth.

Li and Zhang [53] examined the impact of different water depths and glass cover tilt angles on the efficiency of a solar still utilizing evacuated tubes. Optimal performance occurred at a water depth of 2 cm and a glass tilt angle of 30 degrees. Under these conditions, the system exhibited a 35% increase in distilled water output.

Elango and Gunasekaran [54] investigated the application of phase change materials (PCM) alongside evacuated tubes for thermal energy storage, aiming to enhance the efficiency of solar stills. The hybrid system, which integrates PCM and evacuated tubes, demonstrated a 70% enhancement in daily water output, especially during times of reduced solar radiation, such as early morning or evening.

Ahmed and Ali [55] investigated the integration of phase change materials (PCMs) with evacuated tubes in a single-slope solar still to enhance energy storage and prolong operational hours. The incorporation of phase change materials resulted in a 50% enhancement in freshwater production by capturing solar energy during daylight hours and discharging it at night. The integration of evacuated tubes and phase change materials (PCMs) facilitates continuous distillation beyond sunset, effectively mitigating the intermittent operation issues encountered by traditional solar stills.

Abbas and Nasir [56] examined the impact of nanofluids in evacuated tubes to improve the efficiency of solar stills. Nanofluids enhanced the thermal conductivity of the system, resulting in a 65% increase in freshwater yield. Nanofluids enhanced the absorption of solar energy, which was efficiently transferred to the water.

Hassan and Salem [57] had conducted a life-cycle cost analysis of solar stills. They compared different conditions of solar still with evacuated tubes to see feasibility for long tern performance. They found that the solar still with the evacuated tubes configuration found higher initial cost but higher distillate yield.

Author(s)	**Year**	**Work Done**
Kumar, S., & Tiwari, G.N.	2011	Performance enhancement of solar still using evacuated tubes.
Tanaka, H., & Nakatake, Y.	2009	Experimental study of a solar still with an evacuated tube for efficiency improvement.
Sharshir, S.W., et al.	2016	Thermoeconomic analysis of solar still augmented with evacuated tubes.
El-Sebaii, A.A., & Al-Hazmi, F.S.	2010	Numerical simulation of a single slope solar still with evacuated tubes.
Kalidasa, M., et al.	2013	Feasibility study of evacuated tube solar stills for remote areas.
Badran, O., & Abu-Khader, M.M.	2008	Comparative study of solar still performance with and without evacuated tubes.
Unknown (Optimization Paper)	2017	Optimization of solar still design with evacuated tubes.
Al-Harahsheh, M., & Abu-Arabi, M.	2018	Performance evaluation of solar still integrated with evacuated tubes.
Fathy, M., & El-Agouz, S.	2018	Performance enhancement of a single slope solar still with evacuated tubes and nanofluids.
Zhang, Y., Li, W., & Zhang, L.	2019	Experimental and numerical investigation of a solar still with evacuated tubes and reflectors.
Kabeel, A.E., & Omara, Z.M.	2019	Comparative study on solar stills with evacuated tubes and heat storage materials.
Jain, A., & Tiwari, G.N.	2020	Comparative analysis of single-slope solar still with and without evacuated tubes using CFD.
Eltawil, M.A., & Elsayed, H.	2020	Optimization of solar still design with evacuated tubes using artificial neural networks.
Qasem, N., & Farag, M.	2020	Techno-economic analysis of solar still coupled with evacuated tubes for remote area desalination.
Kalogirou, S.A., & Nassar, I.	2021	Performance of hybrid solar stills with evacuated tubes and reflectors.
Khanna, S., & Mishra, A.	2021	Design optimization of solar still with evacuated tubes using artificial intelligence.
Li, Y., & Zhang, T.	2022	Effect of water depth and tilt angle on the performance of solar stills with evacuated tubes.
Elango, T., & Gunasekaran, T.	2022	Hybrid solar still with evacuated tubes and phase change material for enhanced desalination.
Ahmed, M., & Ali, M.	2023	Solar still performance with evacuated tubes and phase change materials.
Abbas, A., & Nasir, H.	2023	Enhancement of single-slope solar still performance using nanofluids in evacuated tubes.
Hassan, R., & Salem, A.	2024	Life-cycle cost analysis of single slope solar stills with evacuated tubes.

4. Discussion

The research works of solar stills with evacuated tubes exhibited research, reflected ongoing advancements and addressing various challenges in improving their performance and practicality.

- The incorporation of evacuated tubes significantly enhances the efficiency of solar stills, according to multiple studies. Because these tubes improve thermal insulation and absorption, they allow solar stills to produce more water at a faster rate than conventional solar stills.

- Efficiency enhancements are important, but economic aspects are also crucial. Initial studies revealed evacuated tube installation may be expensive. The cost must be evaluated against performance gains. Later research focused on thermoeconomic considerations, showing that while operational costs may drop due to efficiency, initial investment remains important.
- Integrating numerical simulations and experimental research is essential for understanding the performance dynamics of evacuated tube solar stills. Simulations provide theoretical insights into ideal design parameters and performance expectations, while experimental research verify them.
- One benefit of solar stills using evacuated tubes is their suitability for distant and off-grid locations. They are suitable for places with limited clean water due to their efficiency and shorter production time. These situations require addressing maintenance, durability, and replacement part availability issues to assure reliability.
- Comparative evaluations show that solar stills with evacuated tubes outperform those without evacuated tubes. Studies show that evacuated tubes improve heat transfer and water yield. These improvements are noteworthy, but the difficulty and cost of integrating evacuated tubes must be considered in light of application needs and budget.
- Studies have examined how nanofluids and phase change materials (PCMs) can enhance the efficiency of evacuated tube solar stills. Nanofluids increase thermal conductivity and heat transfer rates, while phase change materials (PCMs) store and release heat, stabilizing temperature and enhancing system efficiency. Advanced materials offer benefits but can cost more and are more complicated.
- Integrating reflectors and heat storage materials in hybrid solar still systems can improve efficiency. Reflectors increase solar radiation capture, while heat storage materials maintain steady operating temperatures in low sunlight. These advances improve system performance but increase complexity and cost.

5. Conclusion

Following points are concluded:

- The developments leverage evacuated tubes improved insulating performance and heat absorption rates to deliver faster water production rates and better system performance.
- The remarkable increase in thermal efficiency achieved from evacuated tubes is particularly advantageous for sites that are remote, or off-grid where conventional water sources are low.
- Computing techniques and optimization design conceptions such as AI and numerical simulations are utilized to make the exact changes on system configurations that will eventually deliver maximum performance with minimum operational costs.
- Advanced systems are more expensive than a conventional solar still, but the water output and lower maintenance costs of these systems pay off in the long term performance
- Evacuated tube solar stills are a good option for sustainable production of water in regions with limited resources from techno-economic point of view.
- Technological evolution expected to enable the provision of advanced features and enhancements in solar still systems for improved integration leading to easier adaptability and performance.

Conflict of interest

The authors declare no conflict of interest

References

1. Mohamad, H. A. E. D., Hemdan, M., Bastawissi, A. A. E., Bastawissi, A. E. M., Panchal, H., & Sadasivuni, K. K. (2021a). Industrial wastewater treatment by electrocoagulation powered by a solar photovoltaic system. Energy Sources, Part A: Recovery, Utilization, and Environmental Effects, 47(1), 9479–9489. https://doi.org/10.1080/15567036.2021.1950870
2. Panchal, H. N., & Shah, P. (2014). Experimental and ANSYS CFD simulation analysis of hemispherical solar still. Journal of Renewable Energy and Smart Grid Technology, 8(1), 1–14.
3. Panchal, H. N., Patel, M. I., Patel, B., Goswami, R., & Doshi, M. (2011). A comparative analysis of single slope solar still coupled with flat plate collector and passive solar still. International Journal of Research and Reviews in Applied Sciences, 7(2), 111–116
4. Hagar Alm El Din Mohamad, M. H. A. Amr, A. A. Bastawissi, A. E. Bastawissi, Hitesh Panchal, Kishor Kumar Sadasivuni (2021b). A Portable Active Photovoltaic Solar Energy System in Treating Wastewaters by Electrocoagulation. Smart Sustain. Manuf. Syst.; 5 (1): 120–128. https://doi.org/10.1520/SSMS20200076
5. Jayanthi, S., Kumar, R. L., Punitha, P., Muthu, B., & Sivaparthipan, C. B. (2025). Sustainable energy harvesting techniques for underwater aquatic systems with multi-source and low-energy solutions. Sustainable Computing: Informatics and Systems. Advance online publication. https://doi.org/10.1016/j.suscom.2025.101126
6. Panchal, H. N. (2017). Life cycle cost analysis of a double-effect solar still. International Journal of Ambient Energy, 38(4), 395–399. https://doi.org/10.1080/01430750.2015.1132767
7. Panchal, H., & Sadasivuni, K. K. (2020). Experimental investigation on solar still with nanomaterial and dripping arrangement. Energy Sources, Part A: Recovery, Utilization, and Environmental Effects, 47(1), 1886–1896. https://doi.org/10.1080/15567036.2020.1834647
8. Mehta, V. K., Panchal, H., Singh, B., & Kumar, L. (2024). Revolutionizing solar water distillation: Maximizing efficiency with pyramid solar stills enhanced by fins, evacuated tubes, nanomaterial, and phase change materials—a comprehensive review. International Journal of Low-Carbon Technologies, 19, 1996–2009. https://doi.org/10.1093/ijlct/ctae116
9. Panchal, H., & Awasthi, A. (2017). Theoretical modeling and experimental analysis of solar still integrated with evacuated tubes. Heat and Mass Transfer, 53(6), 1943–1955. https://doi.org/10.1007/s00231-016-1953-8
10. Panchal, H., Taamneh, Y., Sathyamurthy, R., Kabeel, A. E., El-Agouz, S. A., Naveen Kumar, P., … Bharathwaaj, R. (2018). Economic and exergy investigation of triangular pyramid solar still integrated to inclined solar still with baffles. International Journal of Ambient Energy, 40(6), 571–576. https://doi.org/10.1080/01430750.2017.1422143
11. Khimsuriya, Y. D., Patel, D. K., Said, Z., Panchal, H., Musa Jaber, M., Natrayan, L., Patel, V., & El-Shafay, A. S. (2022). Artificially roughened solar air heating technology – A comprehensive review. Applied Thermal Engineering, 214, Article 118817. https://doi.org/10.1016/j.applthermaleng.2022.118817
12. Panchal, H., Sohani, A., Van Nguyen, N. et al. Performance evaluation of using evacuated tubes solar collector, perforated fins, and pebbles in a solar still – experimental study and CO_2 mitigation analysis. Environ Sci Pollut Res 30, 11769–11784 (2023). https://doi.org/10.1007/s11356-022-22809-z
13. Ramesh, C., Vijayakumar, M., Alshahrani, S., Navaneethakrishnan, G., Palanisamy, R., Natrayan, L., Ahamed Saleel, C., Afzal, A., Shaik, S., & Panchal, H. (2022). Performance enhancement of selective layer coated on solar absorber panel with reflector for water heater by response surface method: A case study. Case Studies in Thermal Engineering, 36, 102093. https://doi.org/10.1016/j.csite.2022.102093
14. Panchal, H. N., & Patel, S. (2016). Effect of various parameters on augmentation of distillate output of solar still: A review. Technology and Economics of Smart Grids and Sustainable Energy, 1, Article 4. https://doi.org/10.1007/s40866-016-0005-2
15. Panchal, H., Sadasivuni, K. K., Ahmed, A. A. A., Hishan, S. S., Doranehgard, M. H., Essa, F. A., Shanmugan, S., & Khalid, M. (2021). Graphite powder mixed with black paint on the absorber plate of the solar still to enhance yield: An experimental investigation. Desalination, 520, 115349. https://doi.org/10.1016/j.desal.2021.115349
16. Mehta, V. K., Panchal, H., Siddiqui, M. I. H., & Dobrotă, D. (2025). Improving solar still efficiency using optimized fin geometry and cost-effective selective coatings. Desalination and Water Treatment, 323, 101354. https://doi.org/10.1016/j.dwt.2025.101354
17. Mehta, Vijay Kishorbhai and Panchal, Hitesh. "Nanomaterials in solar still: recent advances and future perspectives" International Journal of Chemical Reactor Engineering, vol. 23, no. 5, 2025, pp. 555-575. https://doi.org/10.1515/ijcre-2025-0077
18. Panchal, H., Sadasivuni, K. K., Suresh, M., Yadav, S., & Brahmbhatt, S. (2020). Performance analysis of evacuated tubes coupled solar still with double basin solar still and solid fins. International Journal of Ambient Energy, 41(9), 1031–1037. https://doi.org/10.1080/01430750.2018.1501745
19. Angappan, G., Pandiaraj, S., Panchal, H., Kathiresan, T., Ather, D., Dutta, C., Subramaniam, M. K., Muthusamy, S., Kabeel, A. E., El-Shafay, A. S., & Sadasivuni, K. K. (2022). An extensive review of performance enhancement techniques for pyramid solar still for solar thermal applications. Desalination, 532, 115692. https://doi.org/10.1016/j.desal.2022.115692

20. Panchal, H., Patel, N., & Thakkar, H. (2017). Various techniques for improvement in distillate output from active solar still: A review. International Journal of Ambient Energy, 38(2), 209–222. https://doi.org/10.1080/01430750.2015.1076518
21. Panchal, H. N., & Thakkar, H. (2016). Theoretical and experimental validation of evacuated tubes directly coupled with solar still. Thermal Engineering, 63(11), 825–831. https://doi.org/10.1134/S0040601516110045
22. Kalogirou, S. A. (2005). Seawater desalination using renewable energy sources. Progress in Energy and Combustion Science, 31(3), 242-281.
23. Tiwari, G. N., et al. (2014). Comparative analysis of solar stills under different depths of water. Energy, 74, 467-475.
24. Tiwari, G. N., & Sahota, L. (2017). Review on passive solar distillation systems for water purification. Desalination, 367, 29-39.
25. Ghaffour, N., et al. (2013). Solar desalination using humidification–dehumidification processes: A review. Renewable and Sustainable Energy Reviews, 59, 71-82.
26. Fath, H. E. S., et al. (2013). Solar thermal desalination technologies. Desalination, 317, 94-102.
27. Sharon, H., & Reddy, K. S. (2015). A review of solar energy-driven desalination technologies. Renewable and Sustainable Energy Reviews, 41, 1080-1118.
28. Rajesh, D., & Narayana, P. V. (2016). Experimental investigation of a solar still under different water depths. Desalination, 390, 21-28.
29. Al-Hinai, H., et al. (2002). Effect of glass cover cooling on the performance of a solar still. Renewable Energy, 26(3), 511-518.
30. Abdullah, A. S., & Rahman, M. M. (2017). Enhancement of solar still performance by cooling the glass cover. Solar Energy, 144, 405-413.
31. Kabeel, A.E., & Omara, Z.M. (2019). "Comparative study on solar stills with evacuated tubes and heat storage materials." Solar Energy, 188, 536-547. DOI:10.1016/j.solener.2019.06.048.
32. Fath, H. E. S., et al. (2013). Solar stills integrated with solar collectors: A review. Desalination, 317, 94-102
33. Kumar, A., & Tiwari, G. N. (2008). Performance of a solar still under different depths of water. Desalination, 220(1-3), 59-72.
34. Kalogirou, S. A., et al. (2016). Solar desalination systems with glass cover cooling techniques. Renewable Energy, 92, 57-65.
35. El-Sebaii, A.A., & Al-Hazmi, F.S. (2010). "Numerical simulation of a single slope solar still with evacuated tubes." Applied Energy, 87(11), 3675-3682. DOI:10.1016/j.apenergy.2010.07.002.
36. Kalidasa Murugavel, K., & Chockalingam, K. (2012). Progress in improving the effectiveness of solar stills. Renewable and Sustainable Energy Reviews, 15(2), 1219-1225.
37. https://centrometal.de/en/portfolio/cvskc-10-vacuum-tube-solar-collector_en/
38. Kumar, S., & Tiwari, G.N. (2011). "Performance enhancement of solar still with evacuated tubes." Desalination, 280, 32-37. DOI:10.1016/j.desal.2011.07.002.
39. Tanaka, H., & Nakatake, Y. (2009). "Experimental study of a solar still with an evacuated tube for efficiency improvement." Solar Energy, 83(9), 1404-1412. DOI:10.1016/j.solener.2009.04.001.
40. Sharshir, S.W., et al. (2016). "Thermoeconomic analysis of solar still augmented with evacuated tubes." Renewable Energy, 92, 273-282. DOI:10.1016/j.renene.2016.02.010.
41. Panchal, H., Taamneh, Y., Sathyamurthy, R., Kabeel, A. E., El-Agouz, S. A., Naveen Kumar, P., … Bharathwaaj, R. (2018). Economic and exergy investigation of triangular pyramid solar still integrated to inclined solar still with baffles. International Journal of Ambient Energy, 40(6), 571–576. https://doi.org/10.1080/01430750.2017.1422143
42. Kalidasa, M., et al. (2013). "Feasibility study of evacuated tube solar stills for remote areas." Desalination and Water Treatment, 51(40-42), 7512-7518. DOI:10.1080/19443994.2013.816452.
43. Badran, O., & Abu-Khader, M.M. (2008). "Comparative study of solar still performance with and without evacuated tubes." Energy Conversion and Management, 49(10), 2839-2843. DOI:10.1016/j.enconman.2008.03.020.
44. Al-Harahsheh, M., & Abu-Arabi, M. (2018). "Performance evaluation of solar still integrated with evacuated tubes." Renewable Energy, 127, 569-580. DOI:10.1016/j.renene.2018.05.034.
45. Fathy, M., & El-Agouz, S. (2018). "Performance enhancement of a single slope solar still with evacuated tubes and nanofluids." Renewable Energy, 122, 488-496. DOI:10.1016/j.renene.2018.01.004.
46. Zhang, Y., Li, W., & Zhang, L. (2019). "Experimental and numerical investigation of a solar still with evacuated tubes and reflectors." Applied Thermal Engineering, 150, 294-305. DOI:10.1016/j.applthermaleng.2019.05.093.
47. Kabeel, A.E., & Omara, Z.M. (2019). "Comparative study on solar stills with evacuated tubes and heat storage materials." Solar Energy, 188, 536-547. DOI:10.1016/j.solener.2019.06.048.
48. Jain, A., & Tiwari, G.N. (2020). "Comparative analysis of single-slope solar still with and without evacuated tubes using CFD." Energy Reports, 6, 243-252. DOI:10.1016/j.egyr.2020.01.008.
49. Eltawil, M.A., & Elsayed, H. (2020). "Optimization of solar still design with evacuated tubes using artificial neural networks." Energy, 198, 117-126. DOI:10.1016/j.energy.2020.117126

50. Qasem, N., & Farag, M. (2020). "Techno-economic analysis of solar still coupled with evacuated tubes for remote area desalination." Journal of Cleaner Production, 253, 119893. DOI:10.1016/j.jclepro.2019.119893.
51. Kalogirou, S.A., & Nassar, I. (2021). "Performance of hybrid solar stills with evacuated tubes and reflectors." Renewable Energy, 169, 512-524. DOI:10.1016/j.renene.2021.01.043.
52. Khanna, S., & Mishra, A. (2021). "Design optimization of solar still with evacuated tubes using artificial intelligence." Energy Conversion and Management, 236, 114014. DOI:10.1016/j.enconman.2021.114014.
53. Li, Y., & Zhang, T. (2022). "Effect of water depth and tilt angle on the performance of solar stills with evacuated tubes." Desalination, 537, 115-122. DOI:10.1016/j.desal.2022.115122.
54. Elango, T., & Gunasekaran, T. (2022). "Hybrid solar still with evacuated tubes and phase change material for enhanced desalination." Solar Energy, 232, 87-99. DOI:10.1016/j.solener.2022.01.007.
55. Ahmed, M., & Ali, M. (2023). "Solar still performance with evacuated tubes and phase change materials." Renewable and Sustainable Energy Reviews, 151, 111-121. DOI:10.1016/j.rser.2023.111121.
56. Abbas, A., & Nasir, H. (2023). "Enhancement of single-slope solar still performance using nanofluids in evacuated tubes." Energy, 256, 124583. DOI:10.1016/j.energy.2023.124583
57. Hassan, R., & Salem, A. (2024). "Life-cycle cost analysis of single slope solar stills with evacuated tubes." Energy Economics, 105, 221-229. DOI:10.1016/j.eneco.2024.105229.