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Yield augmentation by integrating jute wick in a single slope solar still: an experimental study

Akashdeep Negi[a], Lalit Ranakoti[a], Prabhakar Bhandari[b], Saurabh Aggarwal[c], Rajesh P. Verma[d], Ankur Singh Bist[e], Arun Uniyal[f], Shivasheesh Kaushik[g*], Nikhil Kanojia[h], Ayushman Srivastav[h]

[a]Department of Engineering, Graphic Era Deemed to be University, Dehradun 248 002, Uttarakhand, India
[b]Department of Mechanical Engineering, School of Engineering and Technology, K.R. Mangalam University, Gurugram, Haryana 122 103, India
[c]Department of Mechanical Engineering, Uttaranchal University, Dehradun 248 007, Uttarakhand, India
[d]Department of Aerospace Engineering, Graphic Era Deemed to be University, Dehradun 248 002, Uttarakhand, India
[e]Department of Computer Science and Engineering, Graphic Era Hill University, Bhimtal Campus, Bhimtal 263 136, Uttarakhand, India
[f]Department of Mechanical Engineering, COER University, Roorkee 247 667, Uttarakhand, India
[g]Department of Mechanical Engineering, Shivalik College of Engineering, Dehradun 248 007, India
[h]Department of Mechanical Engineering, UPES., Dehradun 248 007, India
*Corresponding author email: shivasheeshkecua@gmail.com

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Abstract

The availability of freshwater is a significant challenge in today's world, especially in arid and coastal regions. As a solution, purifying existing open water reservoirs or saline water could help bridge the gap between demand and supply. Solar distillation presents a promising method, requiring low initial investment and leaving no harmful environmental impact. However, limited yield due to the traditional design of a solar system is still a problem. Therefore, in the present study, the traditional design of the solar still, i.e. single slope solar still or conventional solar still (CSS) is modified with jute wick (MSS) at an inclination angle of 30º. The length-to-width ratio was kept at 3:1 to avoid shadows at the corners. The studies were conducted to assess how jute fibre as a wick, wind speed and solar intensity affected the CSS's distillate production. The total yield was found to be 2.69 and 3.208 kg/m^2 per day for CSS and MSS, respectively. Additionally, daily thermal efficiency was analysed to check the feasibility and practicability of the systems. It was evident that incorporating jute wick improves the thermal efficiency of CSS by 26.6%. These findings recommend MSS as a promising and economically viable solution for enhancing solar still performance.

Keywords: Energy; Solar distillation; Solar still; Tilted wick; Jute wick; Distillate yield

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1. Introduction

Needless to say, there is no life without fresh water. It is not only the water we drink, water is part of everything we do. Yet, it is increasingly becoming scary. Already, around 2/3rd of the total population faces water scarcity at least once a month. Islands and coastal areas, in particular areas, are at the forefront of climatic change due to global warming [1]. Therefore, in those places, droughts happen more frequently, and freshwater sources are drying up, resulting in critical day-zero situations (people have to stand in cue for the daily quota of water) in ma-

Nomenclature

A_{ge} – area of glass exposed, m^2
$IS_{(t)}$ – solar intensity, W/m^2
L_{vap} – latent heat of vaporisation, J/kg
$\dot{m}_p$ – hourly distillate yield, kg/h
T_w – temperature of water, K

Greek symbols

$\eta_{d(t)}$ – daily thermal efficiency of the system

Subscripts and Superscripts

ge – glass exposed
vap – vaporisation
w – water

Abbreviations and Acronyms

CSS – conventional solar still
MSS – modified solar still
SEM – scanning electron microscopy

jor cities of both developed and developing nations. So, the population depends on fresh waterfalls from nearby water sources, i.e. canals and groundwater. However, extensive use of these resources results in ecological unbalance. Generally, near coastal areas, the availability of fresh water is limited; moreover, their populations depend on nearby sources, i.e. transportation of fresh water, and ocean water if found purified [2]. The transported water is not economical and feasible in the long term. So, they need a place solution to combat the current scenario. According to the World Health Organization (WHO), the palatability of drinking water has been standardized in the form of total dissolved solids (TDS) [3]. Ocean water contains high TDS of more than 35 ppb (parts per billion). In this context, the TDS value of less than 300 ppm is highly considered for drinking water, while those between 300−600 ppm can be used for drinking water. However, a TDS value above 600 ppm is not considered for drinking purposes [4].

Various techniques such as nanofiltration [5], electrocoagulation [6], electro-oxidation [7], and reverse osmosis [8] are available to treat ocean water. However, due to sophisticated mechanisms and certain drawbacks, such as more energy consumption, these methods are limited to being used in nearby coastal areas [9]. Hence, an alternative low-cost technique named solar distillation can be used to treat saline water in nearby oceans. Solar distillation is a technique used to treat saline water or impure water with the help of solar radiation. It works on the principle of evaporation and condensation. During the process, the saline water is poured into the watershed, and sunlight that passes through the transparent covers and reaches the watershed water surface heats the water. The absorbed heat causes the water molecules to gain energy and transition from liquid to vapour through evaporation. During the process, the impurities, such as salts, bacteria, and other contaminants, are left behind in the wick. The vapour accumulates on the inner surface of the transparent cover due to temperature differences. This condensed water is collected in a separate container at the lowest point of the still. The evaporation and condensation process continues in a continuous cycle under available sunlight [10]. Wicks are materials with a high water-absorbing tendency due to capillary action such as sponges, cotton, jute fibre, khes cloth, polyester cloth, terry cloth, and so on [11]. The introduction of wick results in a higher evaporation rate, which increases the overall distillate of the solar still compared to the conventional one. Moreover, inclined wicks have better distillate output compared to horizontal wicks [12]. Literature [13] suggests the inclination of the wick should be equal to the latitude of the location to collect maximum solar radiation throughout the day. In order to store maximum solar radiation throughout the day, some special collectors with a roughened surface (such as W-contoured, taper-contoured and reverse taper-contoured turbulators) [14] can be used and for maintaining the energy in transferring medium, micro-channel [15], mini-channel [16], and heat pipe [17] or exchanger can be employed [17]. For instance, Munisamy et al. [18] experimented by inclining the tilted wick solar still at 30ºC. Terry cloth, jute cloth, polyester, and fur fabric cloth were used as the wick material. The maximum distillate was obtained for the fur fabric followed by jute, terry cloth, and polyester fabric. The author found that fur fabric cloth has high water absorbency while low capillary rise compared to jute cloth. Furthermore, Hansen et al. [19] tested the porosity, absorbency, capillary rise, and heat transfer coefficient of various wick materials for the distillate enhancement of the inclined solar still. The results revealed that the porosity of the wick material is an important area of assessment. The high porosity of the wick material has more voids that enable water vapour to move easily toward the condensing surface. In addition, [20] has tested the various parameters affecting the distillate yield of wick-type solar still, i.e. climatic, operational, and design parameters. Janarthanan et al. [21,22] have theoretically and experimentally tested the effect of floating tilted wick solar stills. Mahdi et al. [23] used charcoal pieces to reduce the thermal inertia of watershed-type solar still. The reduction in thermal inertia provided by the wet wick extends the contact time of watershed water with the wick to enhance the evaporation rate [24]. Furthermore, Fayaz et al. [25] experimentally tested the effect of inclination and flow rate over the wick. The author found an angle of 30º as the best for the latitude of the location and the optimum flow rate value was 0.20 $g/(m^2s)$. The flow rate of the watershed water was based on experimental testing and the wick should remain completely wet during the experimentation. Modi et al. [26] reported a significant improvement in the distillate yield of 23.71% by modifying conventional solar still (CSS) with jute wick.

A concise summary of results regarding the wick-based distillation is shown in Table 1. The literature review on the distillate yield of stills suggests that the inclination of the wick and materials used for the wick are the factors that influence the distillate yield. However, limited study has been conducted on the effect of the tilted wick inner part of the watershed. This creates

Table 1. Summary of distillate yield from solar stills with wick.

Solar still type	Wick material	Inclination or height	Observation	Reference
Individual watershed	khes cloth	30°	Maximum distillate yield: • CSS – 2.894 kg/m²/day • MSS with tilted wick and flat plate collector – 3.997 kg/m²/day	[13]
Double slope multi wick	black cotton cloth, jute cloth	10,13, 16, 19, 22, 25, 28,31, 34, 37 cm	Maximum productivity for 2 cm water depth: • reference still – 3020 l/day • black cotton cloth – 9012 l/day • jute wick – 7040 l/day	[27]
Inclined individual slope	jute wick	20°, 30°	Distillate enhancement compared to CSS: • jute wick with solar still – 62% • parabolic concentrator solar tracker + wick type solar still's efficiency – 276%	[28]
Individual slope	khes cloth	0, 15, 30, and 45°	Maximum distillate yield: • 0° – 3.1 kg/m²/day • 15° – 3.51 kg/m²/day • 30° – 3.60 kg/m²/day • 45° – 3.41 kg/m²/day	[28]
Individual slope	V-shaped floating jute cloth wick	24°	Winter: • daily productivity – 3.23 kg/m² Summer: • daily productivity – 6.2 kg/m²	[29]
Individual slope	jute cloth	13°	• Maximum daily yield in April – 4.57 kg/m² • Overall efficiency in the month of April – 46%	[30]
Inclined individual slope	jute cloth, terry cloth, polyester cloth, and fur fabric	30°	Productivity: • fur fabric cloth as wick – 3.63 l/day. • jute as wick – 3.39 l/day. • polyester cloth as wick - 2.56 l/day. • terry cloth as a wick – 2.85 l/day	[18]

a research gap in understanding the impact of the wick's tilt angle on the distillation process. Exploring the influence of the wick's inclination within the watershed is a crucial factor for several reasons. The tilt angle can affect the flow dynamic of heat transfer within the still. The combined effect of the low-cost jute wick material and its inclination has not been extensively studied. So, to fill this gap a low-cost jute fibre was used as a wick material of the watershed inner part to enhance the distillate yield of the solar still. The findings were not limited to the fact that a higher number of fins have always shown better performance than arrangements with lower number of fins.

A review of existing literature highlights that both the inclination of the wick and the material used significantly influence the distillate yield in solar stills. However, there is a noticeable lack of comprehensive research focusing on the use of jute material as a wick under a location latitude inclination. This gap limits our understanding of how the wick's tilt angle impacts the efficiency of the distillation process. The inclination angle plays a critical role in influencing heat transfer dynamics within the still. Despite the potential of low-cost jute material, its combined effect with varying inclinations on the performance of solar stills remains underexplored. To address this gap, this study utilizes an affordable jute fibre as the wick material and investigates its inclination within the basin to enhance distillate yield, offering a novel approach to improving solar still performance. Additionally, thermal and economic analyses were performed for better understanding.

2. Materials and methods

2.1. Fabrication of setup

The jute cloth was purchased domestically from a local shop. Raw image of the jute fiber and its microscopic images at 132× and 230× magnification are shown in Fig. 1. Upon closer examination through scanning electron microscopy (SEM) analysis, the jute fiber revealed a unique surface morphology characterized by its inherent roughness and fibrous structure. These features play a critical role in enhancing capillary action and improving water retention, both of which are crucial for the efficient functioning of the solar still. The porosity of the jute fibers, although visually identifiable from the SEM images, directly contributes to their water absorption capability. This property facilitates prolonged water retention within the wick, ensuring steady evaporation rates over time. In this study, a tilted wick inner part of the watershed solar still was constructed using stainless steel grade 304. The aspect area of the still, made of 24-gauge sheet, was 1.8 m × 0.59 m × 0.8 m. The upper part of the still was covered with 5 mm toughened glass sheet with a transmissivity of 90%. The glass was adjusted at an angle of 45° so that maximum radiation could be accumulated during the day. The low-cost jute fiber is used as a wick for the experimental study. A galvanized iron (GI) sheet that was 30° slanted under the location's latitude supported the inclined wick, Fig. 2(B). Prior to experimentation under the environmental conditions, the setup was tested with external radiation panels, Fig. 2(A).

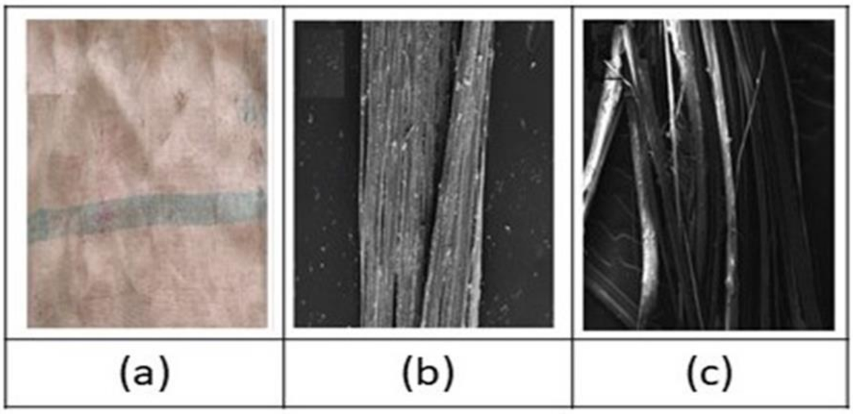

Fig. 1. Image of (a) jute fibre, and its SEM images: (b) at 132× magnification, (c) at 230× magnification.

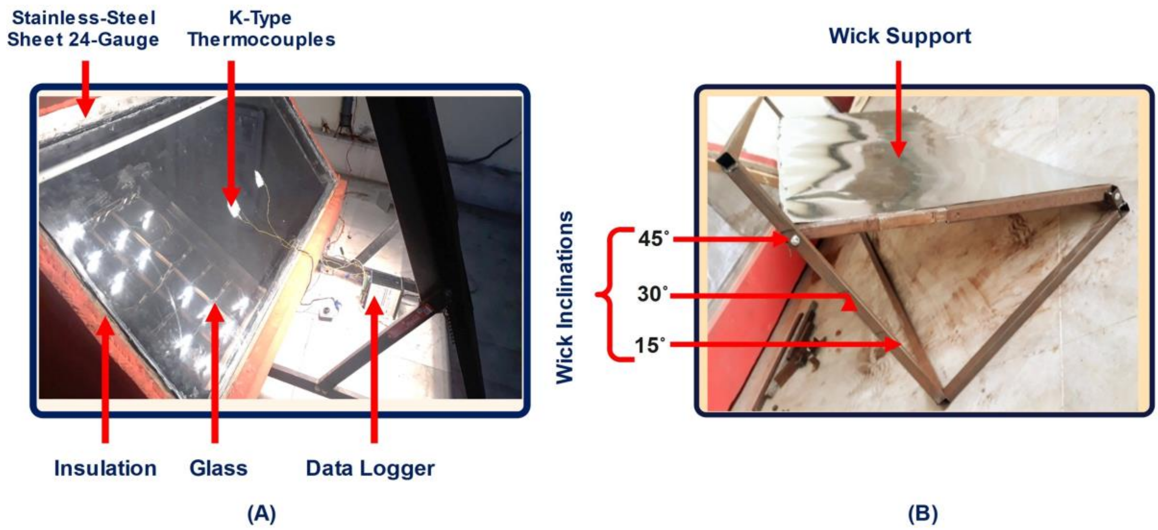

Fig. 2. Images of (A) experimental setup with external radiation panel and (B) wick adjusting stand.

2.2. Experiment procedure

The experiments were performed under the environmental conditions of Chandigarh University of Mohali, Punjab for the latitude of 30.7712° N, 76.5783° E. The experiments were carried out for 3 days in March 2020 and the best day results were disclosed in this study. The details on experimental setup are shown in Fig. 3. The solar still was oriented towards the South to obtain the maximum solar radiation throughout the day. Five K-type thermocouples were used to measure the temperature of different components of the still. The thermocouples were attached to a data logger which recorded the temperature data of the components during experiment time. Each day, the experiment was performed for the available period of solar intensity, i.e. for approximately10 hours, from 9:00 am to 7:00 pm, maintaining the level of the basin water at 3 cm. The distillate output from the setup was measured each hour using a weighing pan. The solar intensity was measured using a solarimeter, while an anemometer was used to measure the wind velocity during the day. The experiments were performed for two cases, viz.: (1) conventional solar still (CSS) and (2) modified solar still (MSS). The case of the modified solar still was the conventional solar still modified with a tilted jute wick. The experimentation on CSS was performed on 13 March 2020 while for MSS the experimentation was performed on 15 March 2020. Table 2 shows the range and accuracy of the instruments used during experimentation.

Table 2. Details of used instruments during experimentation.

Instruments	Range	Accuracy
Solarimeter	0–1500 W/m^2	±1 W/m^2
K-type thermocouples	±200°C	±0.1 m/s
Anemometer	0–30 m/s	±0.1°C
Weighing pan	0–5 kg	±0.001 g
Data logger	–	–

2.3. Thermal performance

Thermal efficiency is the ratio of output to input energy of the system. The output energy is defined as the energy required to evaporate the basin water and input energy is expressed in solar intensity. Moreover, thermal efficiency serves as a modest

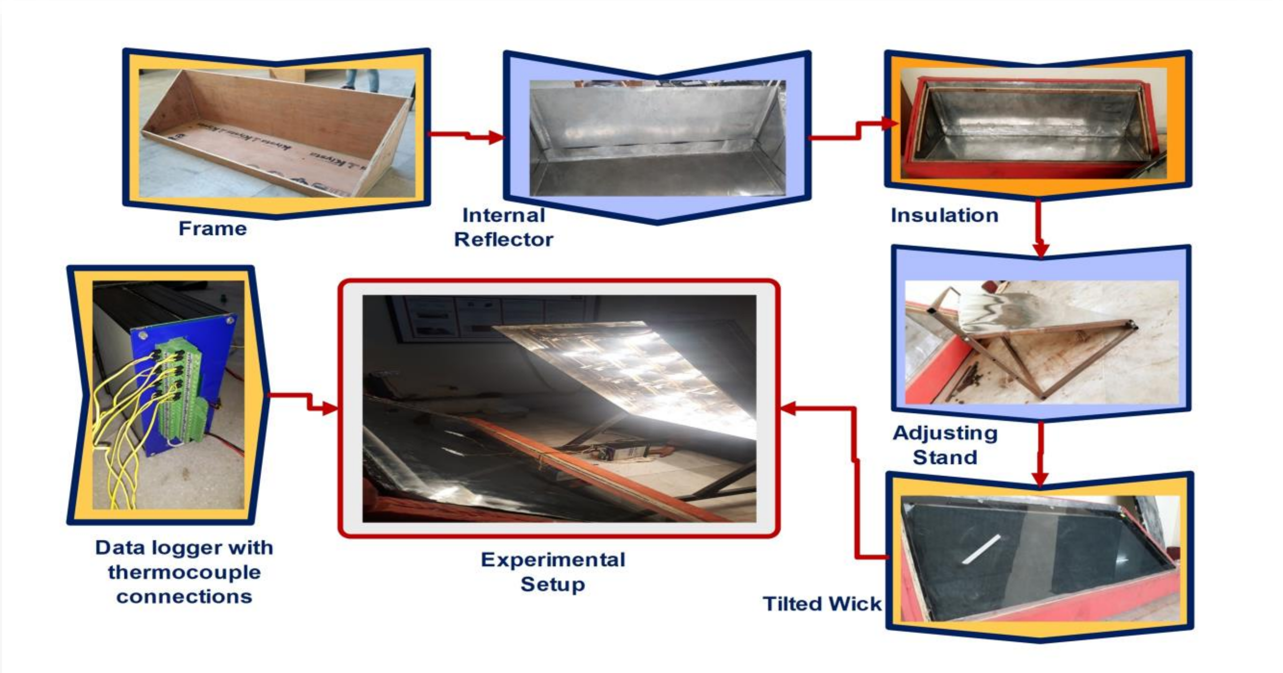

Fig. 3. Components of experimental setup.

measure to assess a distiller's capacity to harness the solar radiation available within its area. As such, it stands as a benchmark for comparing the thermal effectiveness between MSS and CSS.

The system's daily thermal efficiency varies with time and depends on the hourly distillate yield ($\dot{m}_p$), solar intensity ($IS_{(t)}$), latent heat of vaporization (L_{vap}), and the area of glass exposed (A_{ge}) to incident solar radiation. It can be calculated using the equation

$$\eta_{d(t)} = \frac{\sum \dot{m}_p L_{vap}}{3600 \sum IS_{(t)} A_{ge}}. \tag{1}$$

Additionally, the L_{vap} can be determined from the equation [31–32]

$$L_{vap} = 3.1615\times10^{6}\,(1 - 7.616\times10^{-4}\, T_w), \tag{2}$$

where T_w stands for the temperature of water.

3. Results and discussion

The effect of jute fibre as a wick on the distillate yield of the individual watershed slope solar still was investigated under actual climatic conditions. In the present study, the distillate yield of the modified solar still is evaluated. Moreover, the results of distillate yield obtained from MSS were compared with those obtained from CSS.

3.1. Variation of solar intensity and wind velocity

The solar intensity and wind velocity during the experimental days are shown in Fig. 4, respectively. The average radiations falling on the surface are approximately similar in the trend for the experimental days. Besides this, the wind velocity fluctuates throughout the experiment duration time for both days. The maximum solar intensity of approximately 1000 W/m^2 and 980 W/m^2 was estimated at 12:00 pm – 1:00 pm for CSS and MSS, respectively. After 1:00 pm the solar intensity decreases to 220 W/m^2 at 6:00 pm – 7:00 pm. Similarly, the wind velocity fluctuates throughout the day. It was low during the day, and increased during the off-shine hours, the wind velocity increased and was found to be maximum during the late hours of testing.

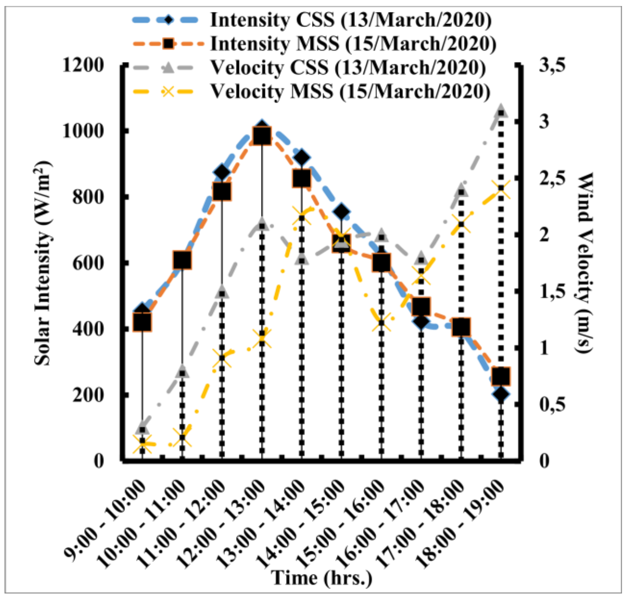

Fig. 4. Variation of solar intensity and wind velocity.

3.2. Variation of the component's temperature and productivity of the conventional solar still

The temperatures of CSS and MSS components are shown in Fig. 5. In the case of CSS, the glass and watershed water is directly exposed to solar radiation, while in the case of MSS the

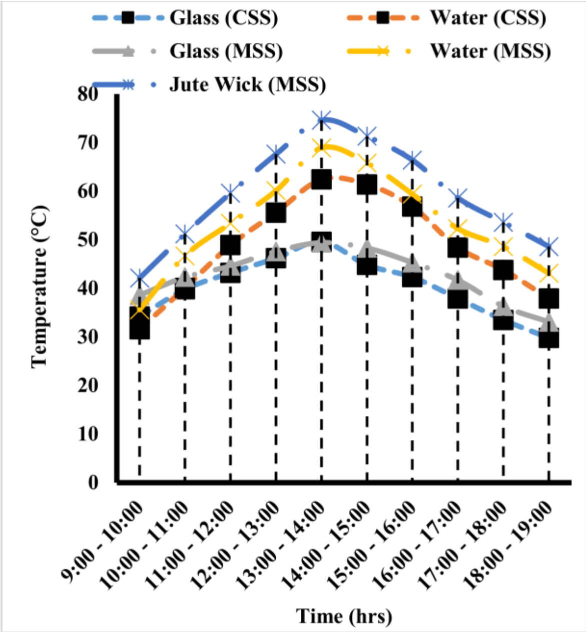

Fig. 5. Temperature variations of CSS and MSS components.

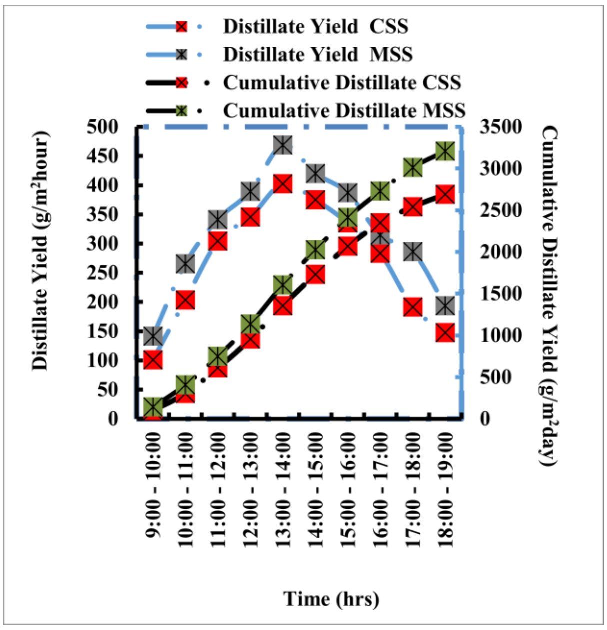

Fig. 6. Hourly and cumulative distillate yield of CSS and MSS.

glass and inclined jute wick are directly subjected to solar radiation. The watershed water of the MSS is not subjected to direct solar radiation due to the placement of the wick above the watershed. In the case of CSS, the glass and watershed temperature increases with increased solar radiation until 1:00 pm, after that the energy stored in the form of latent heat of the watershed water further elevates the temperature of water for the next hour. However, due to the direct incident radiation on the glass and the increased evaporation rate of the watershed water, the glass temperature surged but remained lower than the watershed temperature. This may be due to the wind velocity and heat loss to the surroundings.

3.3. Distillate yield of the CSS and MSS

The temperatures of CSS and MSS components are the distillate yield and accumulated yield of the CSS and MSS, shown in Fig. 6. The distillate yield strictly depends on the difference between watershed water and glass temperature in the case of CSS. However, in the MSS, the tilted wick temperature plays a vital role. It is directly proportional to the daily distillate yield obtained with MSS, which is 19.2% higher compared to CSS. The jute fibre as a wick has high capillary rise, which increases the surface area thermal inertia resulting in an increase in the evaporation rate. In the case of CSS, the maximum distillate yield of 402.3 g/m^2 was obtained between 1:00 and 2:00 p.m. during the maximum temperature difference between water and glass. Similarly, the maximum distillate output of MSS was achieved between 1:00 and 2:00 p.m. and was 468 g/m^2. Furthermore, the temperature of the wick played an important role in increasing the evaporation rate. Also, the cumulative yield of 2.69 kg/m^2/day and 3.208 kg/m^2/day was achieved for CSS and MSS, respectively.

3.4. Thermal performance of the CSS and MSS

Thermal performance is a vital parameter in evaluating the performance of the solar still. Therefore, it is utmost important to compare the daily thermal efficiency of the CSS and MSS. Figure 7 portrays the comparison in the daily thermal efficiency of the respected models. It can be clearly seen that, while introducing wick to CSS, it has higher surface area, and consequently a higher distillate yield that has severely influenced the daily efficiency of the system. Figure 7 shows comparative energy efficiency for both respective models. Higher daily efficiency of 41.29% was reported for MSS, while for CSS it was 32.61%.

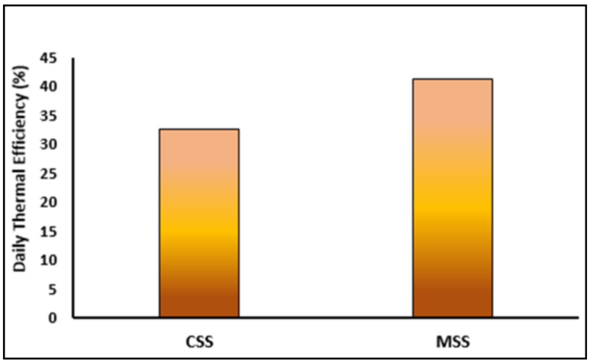

Fig. 7. Daily thermal efficiency of CSS and MSS.

4. Conclusions

The experimental investigation was performed by modifying the conventional solar still (CSS) with and without jute fibre wick at the latitude of the location. The experiments were performed on the actual environmental conditions. The following conclusions were made on the basis of experiments.

- The evaporation rate of the solar still is proportional to the solar intensity during the day.
- Jute fibre as a wick has significant benefits such as good capillary rise, low cost, and ease of availability.
- Yearly maintenance of watershed surface and glass can be helpful to increase the overall distillate yield of the still.
- The daily distillate yield obtained from MSS was 19.2% higher when compared to CSS.
- Properties such as capillary action, porosity, and wettability of the wicks should be an important assessment area and should be considered for future work.
- Investigating the effects of chemical or thermal treatments on jute fibre properties (e.g., hydrophilicity, durability) could further enhance its performance.
- Treating jute fibre with hydrophilic coatings or anti-bacterial agents can improve its longevity and performance in solar stills operating in diverse environmental conditions.
- A comprehensive environmental and economic life-cycle assessment of jute fibre-based systems is recommended to validate their sustainability and long-term viability.

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References

[1] Boretti, A., & Lorenzo, R. (2019). Reassessing the projections of the World Water Development Report. *npj Clean Water*, 2, 15. doi: 10.1038/s41545-019-0039-9

[2] Hoque, M.A., Scheelbeek, P.F.D., Vineis, P., Khan, A.E., Ahmed, K.M., & Butler, A.P. (2016). Drinking water vulnerability to climate change and alternatives for adaptation in coastal South and South East Asia. *Climatic Change*, 136, 247−263. doi: 10.1007/s10584-016-1617-1

[3] Dulaimi, A., Adham, G., & Younes, M.A. (2017). Assessment of potable water quality in Baghdad City, Iraq. *Air Soil and Water Research*, 10, 1−5. doi: 10.1177/1178622117733441

[4] Chabuk, A., Hammood, Z.A., Ansari, N.A., Abed, S.A., & Laue, J. (2021). Classification maps for TDS concentrations in the GIS along Euphrates River, Iraq. *Water, Air, and Soil Pollution*, 232, 317. doi: 10.1007/s11270-021-05236-7

[5] Diawara, C.K. (2008). Nanofiltration process efficiency in water desalination. *Separation and Purification Reviews*, 37(3), 302–324. doi: 10.1080/15422110802228770

[6] Al-Raad, A.A., Hanafiah, M.M., Naje, A.S., Ajeel, M.A., Basheer, A.O., Aljayashi, T.A., & Toriman, M.E. (2019). Treatment of saline water using electrocoagulation with combined electrical connection of electrodes. *Processes*, 7(5), 242. doi: 10.3390/pr7050242

[7] Heikki, S., Bhatnagar, A., & Sillanpää, M. (2015). Recent developments of electro-oxidation in water treatment − A review. *Journal of Electroanalytical Chemistry*, 754, 46−56. doi: 10.1016/j.jelechem.2015.06.016

[8] Thomas, M.M., Ghaffour, N., Dehwah, A.H.A., Rachman, R., Maliva, R.G., & Amy, G. (2013). Subsurface intakes for seawater reverse osmosis facilities: Capacity limitation, water quality improvement, and economics. *Desalination*, 322, 37−51. doi: 10.1016/j.desal.2013.04.021

[9] Lauren, G.F., Lawler, D.F., Freeman, B.D., Marrot, B., & Moulin, P. (2009). Reverse osmosis desalination: Water sources, technology, and today's challenges. *Water Research*, 43(9), 2317−2348. doi: 10.1016/j.watres.2009.03.010

[10] Akashdeep, N., Dhindsa, G.S., & Satbir, S.S. (2020). Performance enhancement of solar still using heat storage medium and nanoparticles. *International Journal of Advance Science and Technology*, 29(10s), 5508−5513.

[11] Hongjie, W., Wang, H., Jin, X., Zhou, H., Wang, H., Wang, W., Ruan, F., Feng, Q., & Lin, T. (2023). Tuning in-plane wicking properties of hydrophilic fibrous membranes using hydrophobic fibrous cover layers. *Advanced Materials Interfaces*, 10(1), 2200741. doi: 10.1002/admi.202200741

[12] Al-Karaghouli, A.A., & Minasian, A.N. (1995). A floating-wick type solar still. *Renewable Energy*, 6(1), 77−79. doi: 10.1016/0960-1481(94)00047-A

[13] Akashdeep, N., Dhindsa, G.S., & Satbir, S.S. (2022). Experimental investigation on individual watershed tilted wick solar still integrated with flat plate collector. *Materials Today: Proceedings*, 48(5), 1439−1446. doi: 10.1016/j.matpr.2021.09.210

[14] Ghildyal, A., Bisht, V.S., Bhandari, P., Thapliyal, S., Kaushik, S., Ranakoti, L., Bangari, R.S., Srivastav, A., Kanojia, N., & Paul, A.R. (2024). A comparative numerical evaluation of solar air heater performance having W-contoured, taper-contoured and reverse taper-contoured turbulators. *Archives of Thermodynamics*, 45(4), 189–196. doi: 10.24425/ather.2024.152008

[15] Bhandari, P., Sharma, V., Ranakoti, L., Bisht, V.,S., Lila, M., K., Kaushik, S., Kanojia, N., Srivastava, A., Kumar, B., Kumar, S.R., Kumar, M., & Paul, A.R. (2024). Numerical investigation of increasing-decreasing stepped micro pin fin heat sink having various arrangements. *Archives of Thermodynamics*, 45(4), 37–44. doi: 10.24425/ather.2024.151995

[16] Kaushik, S., Mehta, J.S., Singh, S., Mahar, V.S., Srivastav, A., Kanoji, N., Kumar, R., Vashisth, S., Karki, S.S., Kumar, A., Bhandari, P., & Singh, D.S. (2024). Comparative study of thermal criteria and fluid-flow criteria in micro and mini channel design constrains with or without insert made of aluminum material. *International Journal of Integrated Engineering*, 16(6), 31−45. doi: 10.30880/ijie.2024.16.06.004

[17] Kaushik, S., Mahar, V.S., Singh, S., Kshetri, R., Kumar, B., Mehta, J.S., Paul, A.R., Kumar, S., Vashisth, S., Pundir, R.S., & Kumar, A. (2024). Comparative experimental analysis of fluid flow in a concentric tube exchanger having semi hollow cylindrical macro inserts with nanofluid and base fluid. *Archives of Thermodynamics*, 45(2), 205–212. doi: 10.24425/ather.2024.150866

[18] Munisamy, T.K., Mohan, A., & Veeramanikandan, M. (2019). Experimental investigation of tilted wick solar still using fabrics. *Australian Journal of Mechanical Engineering*, 17(3), 185–190. doi: 10.1080/14484846.2017.1334306

[19] Hansen, R., Samuel, C., Narayanan, S., & Murugavel, K.K. (2015). Performance analysis on inclined solar still with different new wick materials and wire mesh. *Desalination*, 358, 1−8. doi: 10.1016/j.desal.2014.12.006

[20] Yeh, H.M., & Chen, L.C. (1986). The effects of climatic, design, and operational parameters on the performance of wick-type solar distillers. *Energy Conversion and Management*, 26(2), 175−180. doi: 10.1016/0196-8904(86)90052-X

[21] Janarthanan, B., Chandrasekaran, J., & Kumar, S. (2005).

Evaporative heat loss and heat transfer for open-and closed-cycle systems of a floating tilted wick solar still. *Desalination*, 180(1-3), 291−305. doi: 10.1016/j.desal.2005.01.010

[22] Janarthanan, B., Chandrasekaran, J., & Kumar, S. (2006). Performance of floating cum tilted-wick type solar still with the effect of water flowing over the glass cover. *Desalination*, 190(1-3), 51−62. doi: 10.1016/j.desal.2005.08.005

[23] Mahdi, J.T., Smith, B.E., & Sharif, A.O. (2011). An experimental wick-type solar still system: Design and construction. *Desalination*, 267(2-3), 233−238. doi: 10.1016/j.desal.2010.09.032

[24] Sharshir, S.W., Joseph, A., Kandeal, A.W., & Hussien, A.A. (2022). Performance improvement of tubular solar still using nano-coated hanging wick thin film, ultrasonic atomizers, and cover cooling. *Sustainable Energy Technologies and Assessments,* 52(B), 102127. doi: 10.1016/j.seta.2022.102127

[25] Fayaz, Z., Dhindsa, G.S., & Sokhal, G.S. (2022). Experimental study of solar still having variable slope tilted wick in the watershed to enhance its daily yield. *Materials Today: Proceedings*, 48(5), 1421−1426. doi: 10.1016/j.matpr.2021.09.195

[26] Modi, K.V., & Modi, J.G. (2020). Influence of wick pile of jute cloth on distillate yield of double-basin single-slope solar still: theoretical and experimental study. *Solar Energy*, 205, 512−530. doi: 10.1016/j.solener.2020.05.086

[27] Pal, P., Yadav, P., Dev, R., & Singh, D. (2017). Performance analysis of modified watershed type double slope multi-wick solar still. *Desalination*, 422, 68−82. doi: 10.1016/j.desal.2017.08.009

[28] Jobrane, M., Kopmeier, A., Kahn, A., Cauchie, H.M., Kharroubi, A., & Penny, C. (2022). Theoretical and experimental investigation on a novel design of wick type solar still for sustainable freshwater production. *Applied Thermal Engineering*, 200, 117648. doi: 10.1016/j.applthermaleng.2021.117648

[29] Agrawal, A., & Rana, R.S. (2019). Theoretical and experimental performance evaluation of individual-slope individual-watershed solar still with multiple V-shaped floating wicks. *Heliyon*, 5(4), e01525. doi: 10.1016/j.heliyon.2019.e01525

[30] Shubhajyothi, H., Ganesh, R., Manikandan, V., & Bhavani, T. (2021). Performance evaluation of a tilted wick type solar still by using the concept of solar fraction. *Materials Today: Proceedings*, 37(2), 1112−1132. doi: 10.1016/j.matpr.2020.06.345

[31] El-Sebaii, A.A., Ramadan, M.R.I., Aboul-Enein, S., & Salem, N. (2008). Thermal performance of a single-basin solar still integrated with a shallow solar pond. *Energy Conversion and Management*, 49(10), 2839–2848. doi: 10.1016/j.enconman.2008.03.002

[32] Sahota, L., & Tiwari, G.N. (2016). Effect of Al2O3 nanoparticles on the performance of passive double slope solar still. *Solar Energy*, 130, 260–272. doi: 10.1016/j.solener.2016.02.018