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# Novel Design of Double Slope Solar Distiller with Prismatic Absorber Basin, Linen Wicks, and Dual Parallel Spraying Nozzles: Experimental Investigation and Energic–Exergic-Economic Analyses

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**Abstract:** Increasing the evaporation zone inside the solar distiller (SD) is a pivotal method for augmenting its freshwater production. Hence, in this work, a newly designed prismatic absorber basin covered by linen wicks was utilized instead of the conventional flat absorber basin to increase the surface area of the vaporization zone in a double-slope solar distiller (DSSD). Meanwhile, for further enhancement of modified DSSD performance, dual parallel spraying nozzles are incorporated underneath the glass cover as a saltwater feed supply to minimize the thickness of the saltwater film on the wick, which enhances the heating process of the wick surface and, consequently, the evaporation and condensation processes are improved. Two double slope distillers, namely a double slope solar distiller with wick prismatic basin and dual parallel spraying nozzles (DSSD-WPB&DPSN) and a traditional double slope solar distiller (TDSSD), are made and tested in the outdoor summer conditions of Tanta, Egypt (31° E and 30.5° N). A comparative energic–exergic-economic analysis of the two proposed solar stills is also conducted, in terms of the cumulative distillation yield, daily energy efficiency, daily exergy efficiency, and cost per liter of distilled yield. The present results show that the cumulative distillation yield of the DSSD-WPB&DPSN was 8.20 kg/m$^2$·day, which is higher than that of the TDSSD by 49.64%. Furthermore, the energy and exergy efficiencies were increased by 48.51% and 118.10%, respectively, relative to TDSSD. Additionally, the life cost assessment reveals that the cost per liter of the distilled yield of the DSSD-WPB&DPSN is decreased by 11.13% compared to the TDSSD.

**Keywords:** double-slope solar distiller; prismatic absorber; linen wicks; spraying nozzles; energic–exergic analysis; life cost analysis



**Citation:** Zayed, M.E.; Kamal, A.; Diab, M.R.; Essa, F.A.; Muskens, O.L.; Fujii, M.; Elsheikh, A.H. Novel Design of Double Slope Solar Distiller with Prismatic Absorber Basin, Linen Wicks, and Dual Parallel Spraying Nozzles: Experimental Investigation and Energic–Exergic-Economic Analyses. *Water* **2023**, *15*, 610. https://doi.org/10.3390/w15030610

Academic Editors: Vasileios Bartzis and Ioannis Sarris

Received: 6 January 2023
Revised: 24 January 2023
Accepted: 31 January 2023
Published: 3 February 2023



## 1. Introduction

Freshwater is an essential priority for the existence of humans, animals, and plants. It may indicate the distinction between life and death, as well as the gap between wealth and poverty. Climate change and population growth have recently made the availability of clean water a major issue for individuals [1–3]. According to contemporary estimations of the United Nations and World Health Organization, around 900 million people worldwide lack access to high-quality drinkable water and about 2.6 billion lack adequate sanitation facilities [4]. By 2025, more than 70% of the world's population will have restricted access to freshwater [5]. These problems can be resolved by desalinating seawater [6].

There are several treatment procedures available to provide drinkable water to urban and rural populations on small and large scales [7,8]. However, no economical solution to deliver potable water is available for people living in dry places. The solar distiller remains one of the most effective desalination technologies, due to its zero-fuel cost and favorable environmental impacts [9]. Solar radiation is used to turn accessible saline or brackish water into clean water via a solar still [10]. The benefits of this approach are low maintenance costs, simplicity, and affordable manufacturing [11,12].

A solar still is simple to build with minimum maintenance requirements [13]. However, a traditional distiller has a low output yield [14]. Therefore, scientists have worked hard to increase the still's output yield by utilizing a wide range of modifications on solar distillers, such as using different shapes of glass cover for maximizing the solar radiation and condensation area; this was achieved through the design of single slope SS [15], double slope SS [16], triangle pyramid SS [17], tilt SS [18], pyramid SS [19], tubular SS [20], and hemispherical SS [21]. Another class of modifications aimed to enhance the evaporation rate, break the surface tension and lessen the water depth as much as possible, such as utilizing stepped SS [22], and by including rotating parts inside the SS [23]. Furthermore, research targeted the capillary effect property to enhance SS productivity via different types of rotating or static wicks [24–26]. Additionally, the productivity of SS was enhanced by internal or external reflectors [27], jute materials [28], phase change material (PCM) [29], thin film [30], and the use of nano-materials [31].

Numerous studies that investigated the performance of DSSD with or without wick showed the advantages of using double slope glass and its effect on capturing more solar radiation, increasing the evaporation and condensation rates, and improving freshwater collection. Elango and Murugavel [32] examined the influence of the thickness of water bulk in the basin on freshwater production for single and double basin double slope glass solar distillers. The results indicated that, for 1 cm water bulk thickness, double basin un-insulated and insulated distillers produced, respectively, 8.12% and 17.38% higher output than the single basin distiller. The efficacy of using the material for heat storage and an exterior reflector in enhancing the performance of a DSSD was studied by Gnanaraj and Velmurugan [33]. The heat-storing material in the distiller improved pure water production above the traditional distiller by 23.08%. However, the modified distiller with the reflector increased the output yield by 62.97%. Moreover, a DSSD with hollow fins that had square and circular cross-sections was investigated at various thicknesses of water bulk of 10, 20, and 30 mm [34]. For a 10 mm basin water depth, the highest output yield was produced. Moreover, the circular-fin distiller, with a daily energy efficiency of 26.86%, produced 43.8% more than the yield of a square-fin still. On the theoretical side, Dev et al. [35] used an innovative device to obtain the characteristic equations of a passive-type DSSD. For the passive type of DSSD, three different nanofluids were considered to establish an analytical description of the characteristic equation [36].

Utilizing wick materials of different types and configurations is one of the main current adjustments made to increase the rate of evaporation within SDs and, consequently, improve freshwater production [37,38]. Tully et al. [39] improved the drinkable water production of an active DSSD by employing a wick material, paraffin wax as an energy storage medium, a solid rectangular fin, and an external condenser. The supreme productivity ranged between 2.70 and 3.07 $L/m^2$/day for different SD designs. The energetic efficiency of the developed SD with an external condenser reached a high value of 39.74%, while it was only 30% for SD without a condenser. The use of an external condenser boosted productivity by about 10%. The daily efficiency of the developed SD was improved by about 22.33% compared with conventional SD. Moreover, the thermal and financial analyses of a stepped DSSD incorporated with linen wicks coated with carbon black powder were investigated by Sharshir et al. [40]. Utilizing linen wicks coated with carbon black powder in the modified still boosted the energy efficiency and freshwater production by 110.5% and 80.57%, respectively, as compared to the traditional distiller.

Given the promising developments made so far, there is an ongoing desire for new innovative methods to enhance the thermo-economic performance of desalination systems and reduce costs because of the problem of limited distilled yields. In the present paper, a novel design of an SD incorporating a prismatic absorber basin covered by linen wicks into a DSSD is presented. The main objective of this study is to improve the freshwater distillation rate of a novel design of a DSSD by utilizing a prismatic absorber basin covered by linen wicks to improve the freshwater distillation rate. For further enhancement of performance in the same modified DSSD design, dual parallel spraying nozzles are implemented below the top glass cover of the distiller to minimize the thickness of the saltwater film and augment the absorption of solar radiation, as well as enhance the evaporation and condensation rates. Overall, the novelty of this research paper can be summarized as follows:

1. A new double slope solar distiller with a wick prismatic basin and dual parallel spraying nozzles (DSSD-WPB&DPSN) is investigated for the first time and compared to the traditional double slope solar distiller (TDSSD).
2. Modified DSSD-WPB&DPSN and TDSSD are designed, manufactured, and examined under the same weather conditions of Tanta (31° E and 30.5° N), Egypt.
3. A comparative exergetic–energetic assessment of the two studied distillers is accomplished to explore the effects of the proposed applied modifications on the performance of the DSSD.
4. A cost analysis is carried out to assess the production cost per liter of freshwater obtained by the two cases of DSSD.

The applied modifications are anticipated to have important improvements in the exergo-economic, and energo-economic performance of the DSSD. In addition, the investigated scenarios of experiments had not been studied before on the DSSD.

## 2. Materials and Methods

### *2.1. Design and Experimentation of the System*

In this experimental research, two identical DSSDs are manufactured and examined. Figure 1 displays a 3D layout of the experimental setup, while a detailed pictorial view of the experimental system of the two proposed DSSDs is presented in Figure 2. The first SD is a traditional double slope solar distiller (TDSSD), while the second SD is a modified double slope solar distiller with a wick prismatic basin and dual parallel spraying nozzles (DSSD-WPB&DPSN). Each distiller has a square basin projected area of $0.50 \times 0.50$ m$^2$ and is manufactured from a 1.5 mm thick galvanized steel sheet. The TDSSD has a conventional flat absorber basin, whereas the second still (DSSD-WPB&DPSN) is incorporated with a prismatic absorber basin covered by linen wicks inside the distiller basin. The south and north sides of the wick prismatic absorber basin are tilted 30.5° with the horizontal, to which both are attached at a 36 cm height from the middle of the distiller. The top of each distiller is covered by a glazier of 3 mm thick in an identical 30.5° tilted double slope configuration. For the further enhancement of modified DSSD performance, a feed flow pipe distributor (5 mm diameter, 50 cm length, and containing six spraying nozzles with 2 mm diameter on each side) is linearly attached below the glass cover inline geometrical layout, as seen in Figure 3. The spraying nozzles atomize the seawater droplets of feed water supply over the two sides of the prismatic wick absorber basin, to minimize the saltwater film to augment the absorption of solar radiation and enhance the evaporation and condensation rates. The saltwater film over the wick prismatic basin is fed with a continuous feed supply at a fixed rate of 3.5 L/min utilizing the feed saltwater tank. Condensed distilled vapor within the glazier coverage is collected in a channel beneath the two sides of the cover and flows into a 1.0 L jar bottle. Moreover, for the two stills, the outer body and the sidewalls of the basin are isolated by a 5.0 cm rigid foam layer (thermal conductivity K = 0.022 W/°C.m) to decrease the heat losses to the surroundings. The inner sides of the basin are painted with a black coating, which absorbed maximum solar flux. In addition, each distiller is linked to a seawater feed tank (25 L) via branched pipelines to feed and conserve a fixed level of saltwater inside the two distillers of 2.0 cm thickness.

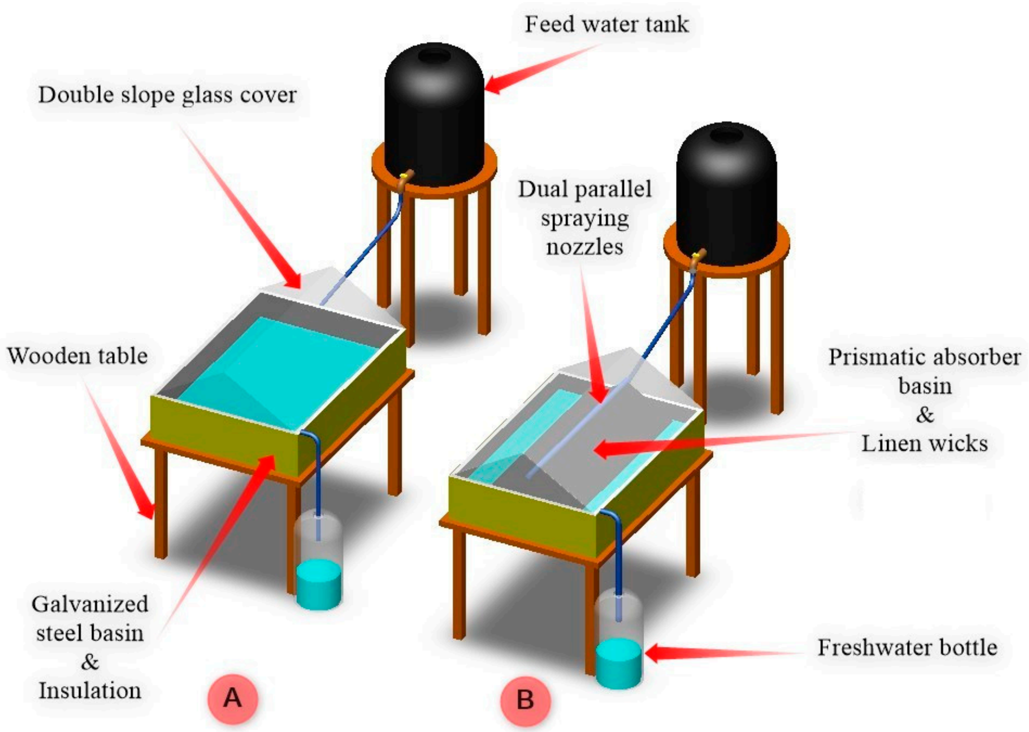


**Figure 1.** The layout of experimental test-rig of TDSSD (**A**) and DSSD-WPB&DPSN (**B**).

### 2.2. Experimental Procedure and Measurements

To analyze the effect of the new-designed wick prismatic absorber plus the utilized dual parallel spraying nozzles on the improvement of water distillation production of the DSSD, the TDSSD and the modified DSSD-WPB&DPSN were tested in the same outdoor climate of Tanta (31° E and 30.50° N), Egypt in July 2022 from 8:00 to 19:00. The saltwater depth inside the basin within the testing periods for the two DSSD is maintained at a fixed value of 2.0 cm. For each distillatory, the temperatures of atmospheric air, saltwater, absorber basin, and the inner and outer surface of the top glazier coverage, are measured in an hourly step utilizing k-type thermocouples. The water distillation production is measured via a graduated beaker every hour. Moreover, a digital vane anemometer and solar power meter are also employed to record the values of ambient speed and total solar irradiation. Technical characteristics of measuring tools utilized in the experiments are clearly listed in Table 1. According to the standard ranges and precisions of the measurement instruments demonstrated in Table 1 and the measured findings, the relative errors in the experimental results are computed by the procedure in [41–43]. Accordingly, the errors in freshwater accumulation rate and the energetic daily efficiency are equal to ±0.68% and ±1.26%, respectively.

**Table 1.** Technical characteristics of measuring tools.

| Measurement Device | Accuracy | Range | Error (%) |
|---|---|---|---|
| K-type thermocouples | ±0.10 °C | 0–100 °C | 0.197 |
| SR05 solarimeter | ±1 W/m$^2$ | (0–5000) W/m$^2$ | 0.462 |
| Testo 410i Vane anemometer | ±0.1 m/s | 0.4–30 m/s | 2.45 |
| Graduated beaker | ±5.0 mL | 0–500 mL | 0.260 |

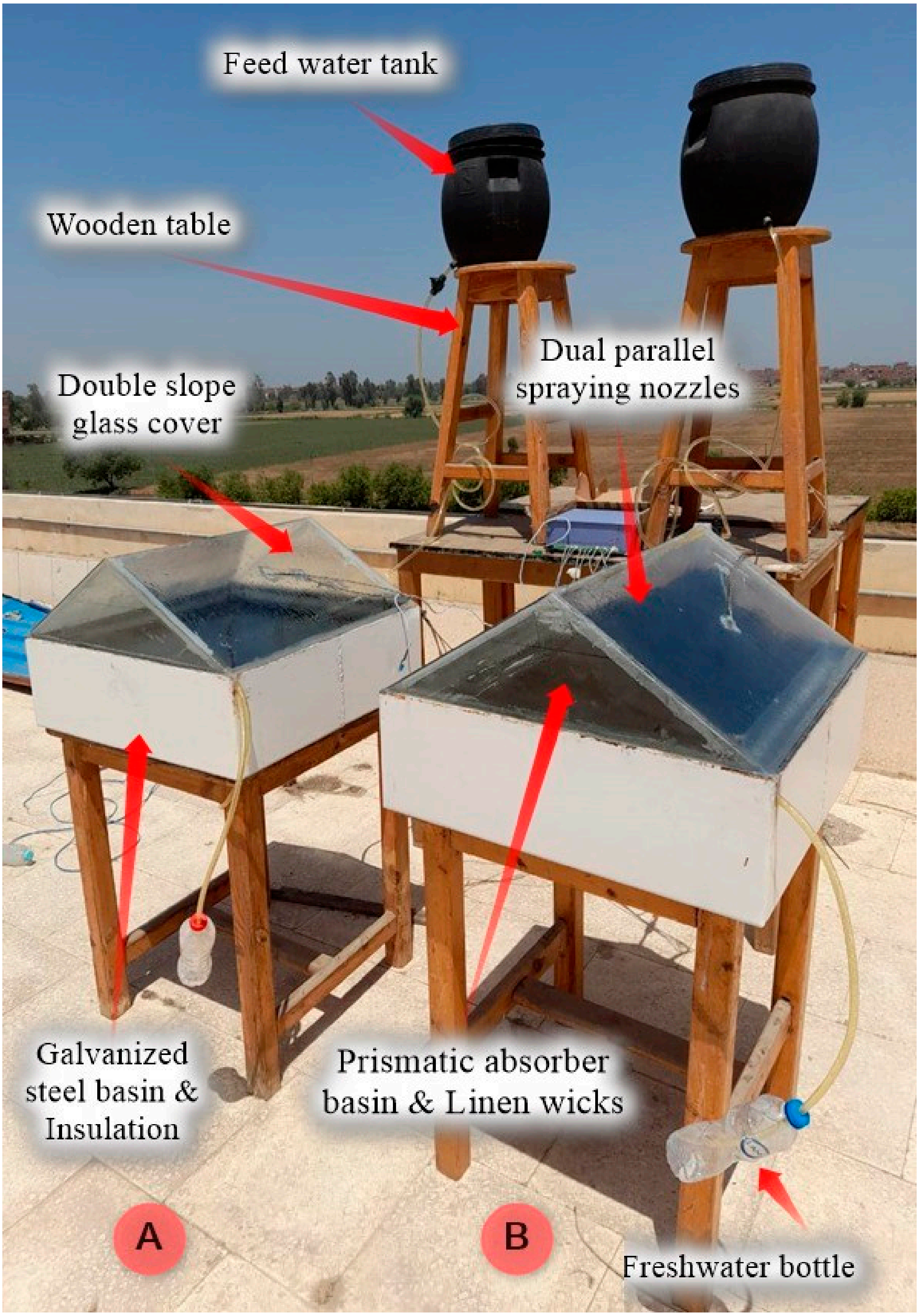


**Figure 2.** Photographic view of the test-rig of TDSSD (**A**) and DSSD-WPB&DPSN (**B**).

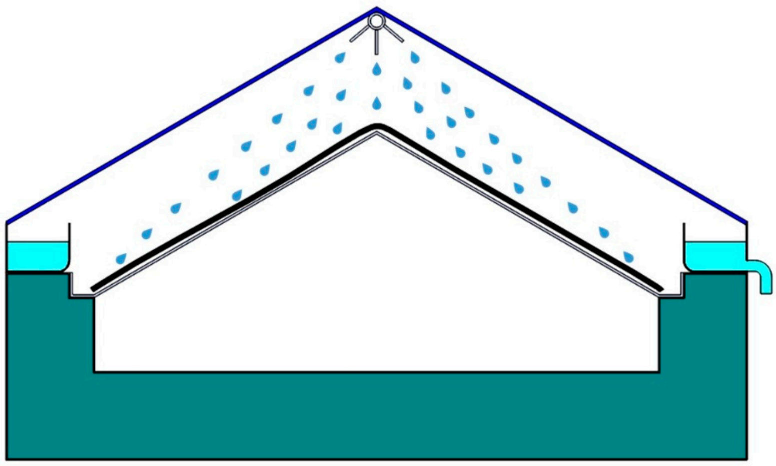

**Figure 3.** Geometric layout of the dual parallel spraying nozzles of seawater supply.

## 3. Results and Discussion

The integration of a modified DSSD with a wick prismatic absorber and dual parallel spraying nozzles was compared with the conventional double slope solar distiller under the same outdoor conditions of Tanta, in the north of Egypt. The pivotal goal of this work is to examine simultaneously the use of the wick prismatic absorber and dual parallel spraying nozzles in improving the energo-economic performance of double slope solar distilleries. Hence, a comparative exergic–energic-economic analysis of DSSD-WPB&DPSN and TDSSD has been carried out.

The variations of solar radiation intensity, ambient air speed, and ambient temperature during July 2022 are illustrated in Figure 4. The tests were begun by 8.00 and completed by 19:00 on the days of study. On an average basis, three trials were performed to confirm the correctness of the findings. Specifically, the obtained findings of 6 July 2022 were utilized for the analyses in this work. The mean values of solar radiation, ambient air speed, and atmospheric temperature were noticed as 541.5 W/m$^2$, 1.71 m/s, and 31.3 °C, respectively, while the maximal values of solar radiation, ambient air speed, and atmospheric temperature were recorded as 955 W/m$^2$, 2.70 m/s, and 33.5 °C, respectively.

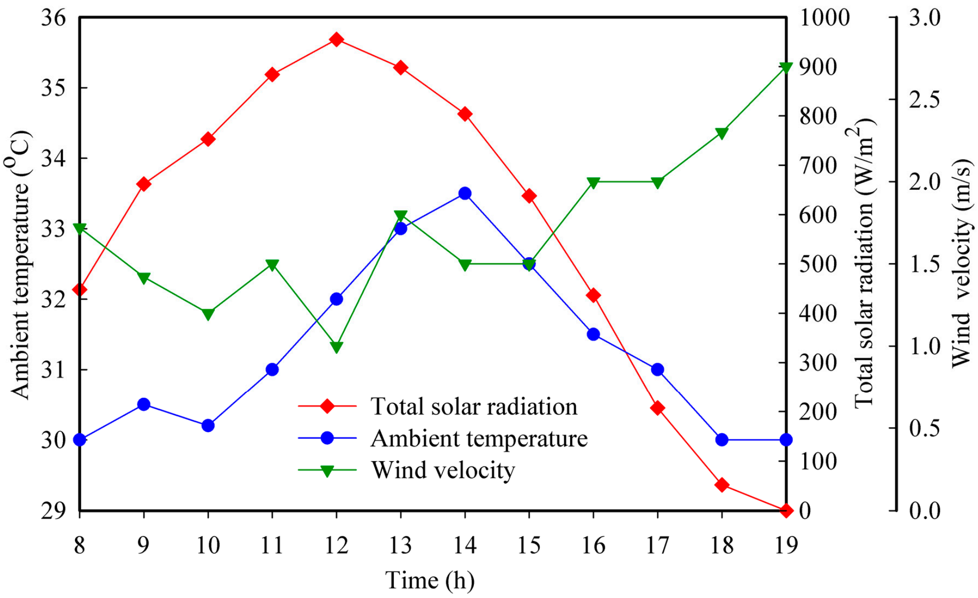


**Figure 4.** Time dependence: ambient temp, solar radiation, wind velocity.

Figure 5 presents the variations in the hourly saltwater, internal glass coverage, and external glass coverage temperatures for DSSD-WPB&DPSN and TDSSD. It is seen in Figure 5 that the saltwater basin and glass coverage temperatures of the DSSD-WPB&DPSN are much higher than that of the TDSSD. This increased temperature is attributed to the usage of a wick prismatic absorber basin, which increases the heat transferring area exposed to incident solar flux for the DSSD-WPB&DPSN as compared to the TDSSD. The wick prismatic absorber basin assists in accruing plenty of thermal energy from the falling solar flux, and thus increases the heat transfer rates to the saltwater in the distiller basin. Additionally, the utilization of dual parallel spaying nozzles helps in minimizing the saltwater film and augmenting the absorption of solar radiation, and enhancing the evaporation and condensation rates, and thus significantly increasing the saltwater temperatures of the DSSD-WPB&DPSN. It can be indicated that the average and maximal saltwater basin temperatures of the modified DSSD-WPB&DPSN are obtained to be 52 and 67 °C, respectively, while they are recorded to be 49 and 64 °C, for the TDSSD. Moreover, Figure 5 shows that the modified DSSD-WPB&DPSN yielded higher glazier coverage temperatures than TDSSD by about 0–1.5 °C. The increase in the coverage temperatures of the DSSD-WPB&DPSN is because of the larger obtained vaporization and condensation rates than those of the TDSSD thanks to the larger heat transfer area in the DSSD with a wick prismatic absorber basin.

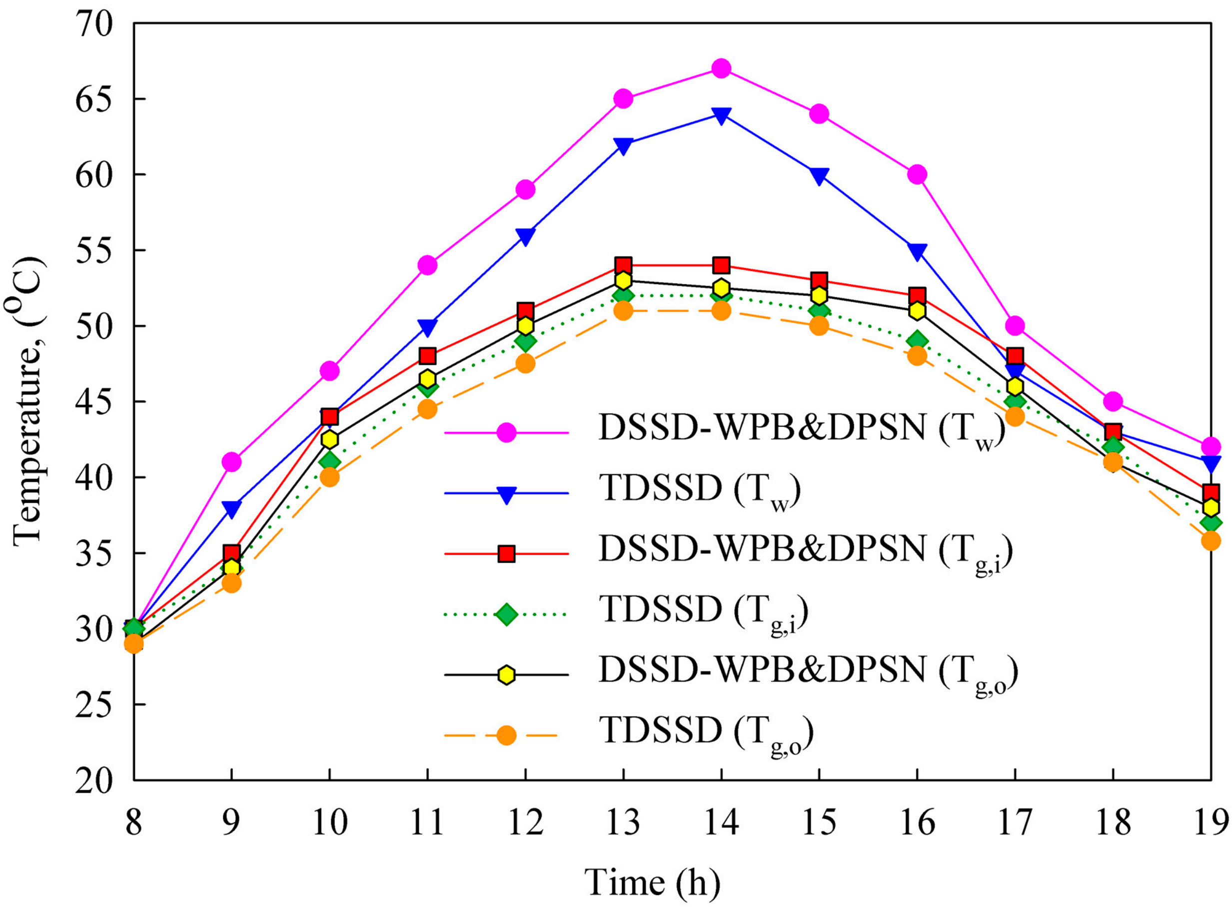


**Figure 5.** Time dependence: the hourly saltwater ($T_w$), internal glass coverage ($T_{g,i}$), and external glass coverage ($T_{g,o}$) temperatures for DSSD-WPB&DPSN and TDSSD.

The diurnal values of the hourly freshwater yield for DSSD-WPB&DPSN and TDSSD at a saline water depth of 2.0 cm are highlighted in Figure 6. The results assert that at all times the water distilled yields of DSSD-WPB&DPSN are much higher than those of TDSSD. This result can be directly attributed to the utilization of a wick prismatic absorber basin, which has significant thermal benefits and a larger evaporation area, which is the key reason for maintaining higher drinkable water productivities in the case of DSSD-WPB&DPSN compared with DSSD-WPB&DPSN. Additionally, the inclusion of linen wicks plays a role as a thermal moderator by further promoting the saltwater heating in the prismatic absorber basin via the heat energy transferred by convection and radiation from the pores of linen wicks. Furthermore, the implementation of spraying nozzles in the seawater feed supply helps in minimizing the saltwater film and augmenting the absorption of solar radiation, therefore enhancing the evaporation and condensation rates and thus significantly increasing the freshwater yields of the DSSD-WPB&DPSN. Figure 6 demonstrates that the distilled yield is low in the morning and increases gradually to reach the peak hourly distillation yield at 14:00 (1.196 and 0.884 kg/m$^2$.h for DSSD-WPB&DPSN and TDSSD, respectively), and thereafter it reduces gradually until the sunset time. It is inferred that the peak hourly distillate freshwater product of the DSSD-WPB&DPSN is enhanced by 35.3% compared to that of TDSSD, respectively.

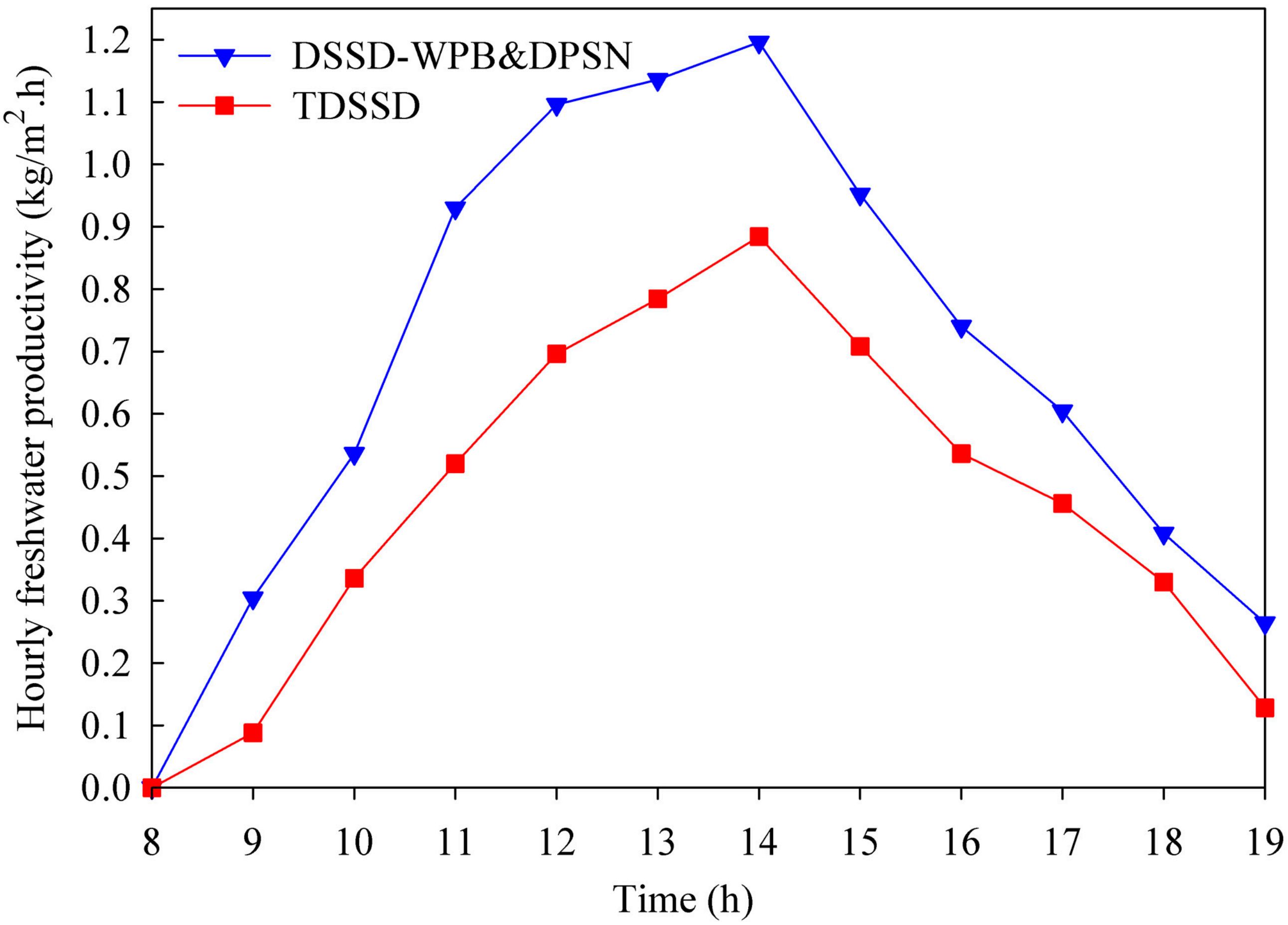


**Figure 6.** Time dependence: hourly distilled water yields for DSSD-WPB&DPSN and TDSSD.

The cumulative distillation yields for the new DSSD-WPB&DPSN and TDSSD from 8:00 to 18:00 are presented in Figure 7. The measured findings clearly indicate that the modified DSSD with wick prismatic absorber basin and internal spaying nozzles has higher cumulative distillation yield than that of the traditional DSSD one, for the same reasons previously explained. It is concluded that the overall cumulative distillation yields are collected as 8.20 kg/m$^2$ day for the DSSD-WPB&DPSN and 5.48 kg/day.m$^2$ for the TDSSD at a fixed saline water depth of 2.0 cm.

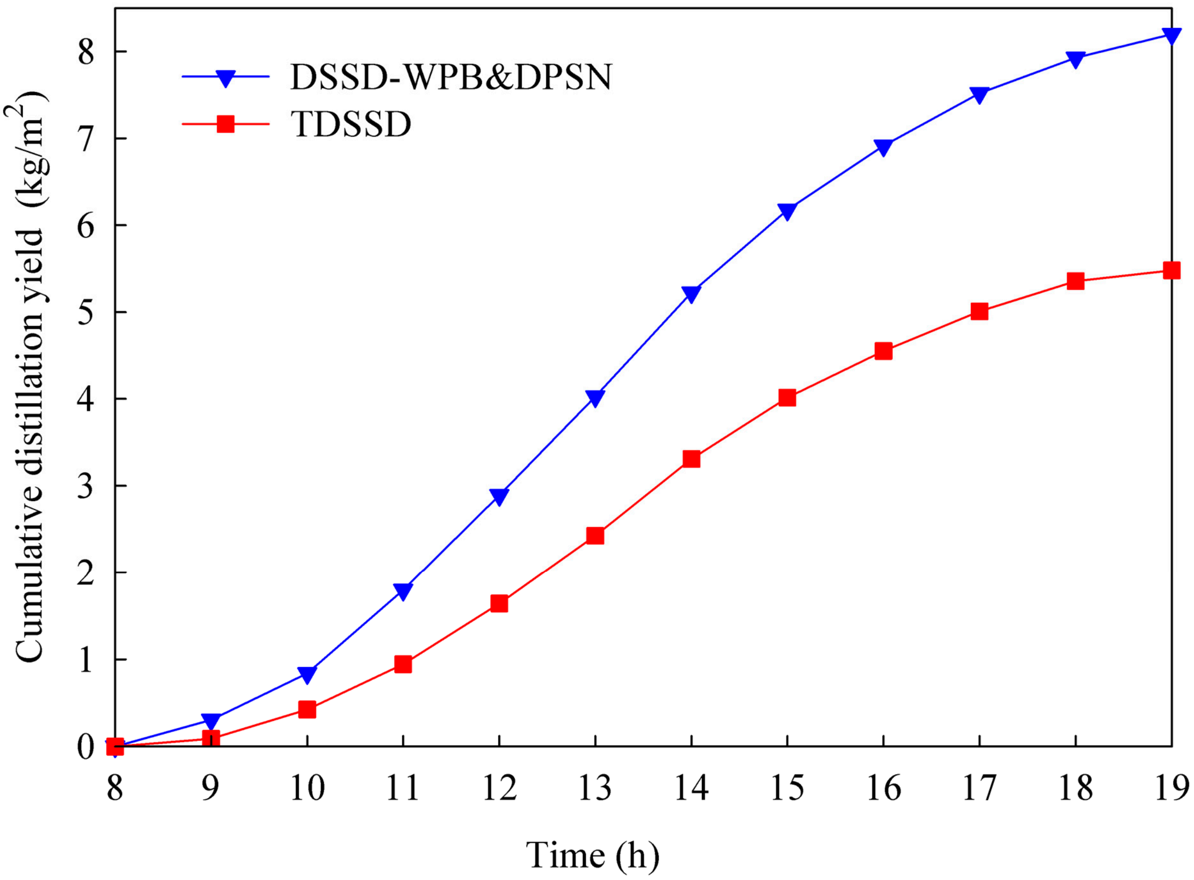


**Figure 7.** Time dependence: cumulative distillation yield for DSSD-WPB&DPSN and TDSSD.

The energetic–exergetic performance of the two examined DSSDs has been assessed and compared concerning the daily distillate yield, energetic daily efficiency, and exergetic daily efficiency of the DSSD. The energy daily efficacy of the still $\eta_{en}$ is a crucial performance indicator to identify the real amelioration in the production performance of SDs from the standpoint of the input available solar radiation received by the still. It relies on the summation of hourly distillation yields $\Sigma m_w$, the vaporization latent heat $h_l$, diurnal solar flux $\Sigma\, I_s(t)$, and the basin projected surface area $A_s$, as exemplified in Equation (1) [15]:

$$\eta = \frac{\sum h_l \times m_w}{\sum A_s \times I(t) \times 3600} \quad (1)$$

where the vaporization latent heating of the distilled vapor $h_l$ is exemplified based on the temperature of saline water $T_w$ [15]:

$$h_l = [2501.897 - 2.407\ T_w + 1.192 \times 10^{-3}\ T_w^2 - 1.596 \times 10^{-5}\ T_w^3] \times 10^3 \quad (2)$$

On the other hand, the diurnal exergy efficiency of the still $\eta_{ex,daily}$ represents the ratio between the entire plentiful exergy, $Ex_{,out}$, as a result of the evaporation rates of saltwater basin, and the aggregate input exergy from the sun incident on the SD, $Ex_{in}$, which can be expressed as [44]:

$$Ex_{in} = A_s\ \ I(t)\left[1 - \frac{4}{3}\left(\frac{T_a + 273}{T_s + 273}\right) + \frac{1}{3}\left(\frac{T_a + 273}{T_s + 273}\right)^4\right] \quad (3)$$

$$Ex_{out} = \frac{m_w h_l}{3600}\left[1 - \frac{(T_a + 273)}{(T_w + 273)}\right] \quad (4)$$

$$\eta_{ex,daily} = \frac{\sum Ex_{out}}{\sum Ex_{in}} \quad (5)$$

Here, $T_a$ and $T_w$ are the temperatures of ambient and saline water, respectively, whereas $T_s$ is the temperature of the sun, which is adapted as 5729 °C [44].

Figure 8 presents a comparison of the cumulative distillation yield, energy daily efficiency, and exergy daily efficiency of the DSSD-WPB&DPSN and TDSSD. The amelioration percentages in the cumulative distillation yield, energy daily efficiency, and exergy daily efficiency for the modified DSSD-WPB&DPSN compared to the TDSSD are demonstrated in Figure 9. It is deduced from Figure 9 that the DSSD-WPB&DPSN achieved an amelioration in the cumulative distillation yield of 49.64% (8.20 kg/m$^2$·day) over the TDSSD (5.48 kg/m$^2$·day) at a fixed seawater deepness of 2.0 cm. Moreover, it is also asserted that the energy and exergy daily efficiencies for the DSSD-WPB&DPSN are obtained as 59.6% and 4.10%, respectively, whereas the energy and exergy daily efficiencies are recorded to be 40.2% and 1.82% for the TDSSD, respectively. The latter finding proves that the double slope sunny distillers using the novel designed wick prismatic absorber basin and dual parallel spraying nozzles achieve 48.51% and 118.10% augmentation in the daily energy and exergy efficiencies than reference TDSSD, respectively, as seen in Figure 9. Conclusively, it can be inferred that the mutual utilization of those efficacious modifications (wick prismatic absorber basin and dual parallel spraying nozzles) can be regarded as an effective strategy for augmenting the freshwater distillation and energetic – exergetic performance of the DSSDs. In our future work, we will employ different machine learning models [45–47] to predict the yield of the suggested design of SS.

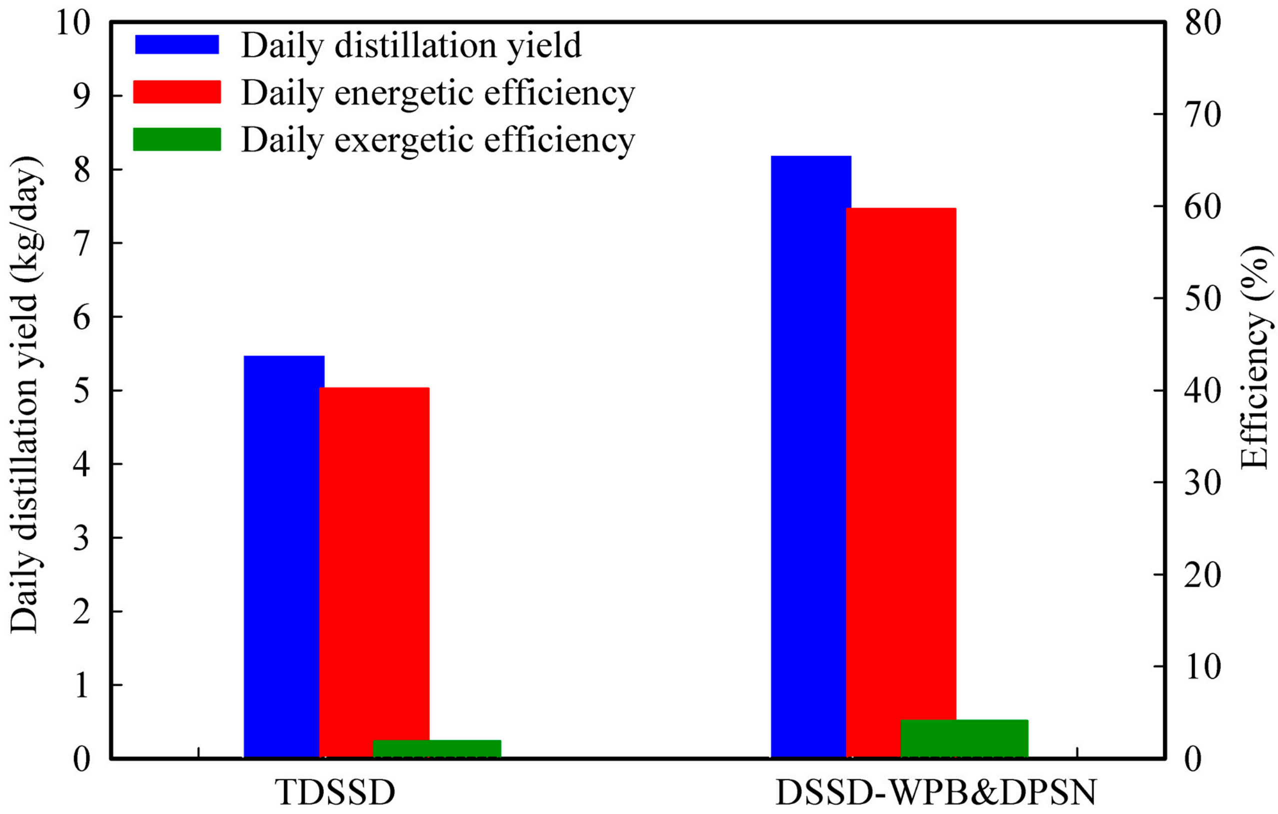


**Figure 8.** Comparison of the cumulative distillation yield, energy daily efficiency, and exergy daily efficiency of the DSSD-WPB&DPSN and TDSSD.

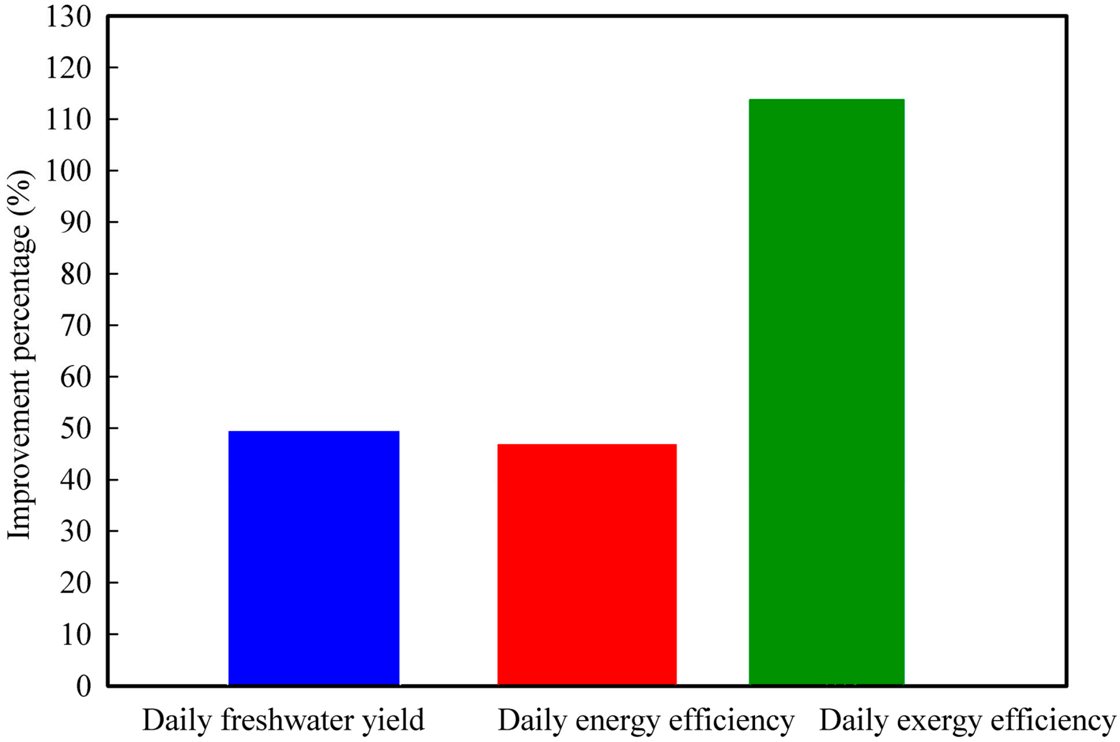


**Figure 9.** Amelioration percentages in the cumulative distillation yield, energy daily efficiency, and exergy daily efficiency for the modified DSSD-WPB&DPSN compared to the TDSSD.

## 4. Comparison between the Present Work and Other Previous Studies

To identify the significance of the usage of the new design of wick prismatic absorber basin and dual parallel spraying nozzles in enhancing the performance of the DSSD, a comparison between the findings of the present study with those of other relevant works published in double slope solar distillers has been highlighted in Table 2. The anticipated improvements in both water cumulative distillation yields exhibited an efficient performance with respect to the other related previous works.

**Table 2.** Comparative demonstration between the findings of the present study with those of other relevant works published in DSSDs.

| Ref. | SD Design | Modifications and Additives | Daily Yield ($kg/m^2\cdot day$) | Yield Increase (%) |
|---|---|---|---|---|
| [33] | DSSD | - With black granite storage material<br>- With external reflectors | 3.76<br>4.98 | 23.08<br>62.90 |
| [34] | DSSD | Circular hollow fins | 1.50 | 43.80 |
| [36] | DSSD | - Water + $Al_2O_3$ nanofluid<br>- Water + $TiO_2$ nanofluid<br>- Water + CuO nanofluid | 7.46<br>7.05<br>6.90 | 16.0<br>9.66<br>7.30 |
| [39] | DSSD | Rectangular fins + paraffin wax + wicks + exterior condenser | 2.82 | 13.12 |
| [48] | DSSD | Nano $LaCoO_3$/black paint | 5.40 | 40.20 |
| This study | DSSD | Wick prismatic absorber basin and dual parallel spraying nozzles | 8.20 | 49.64 |

## 5. Life Cost Analysis

In this sub-section, the life cost analysis of the two studied DSSDs has been described. The cumulative distillation yield of modified DSSD-WPB&DPSN and TDSSD are 8.20 and 5.48 kg/day.m$^2$, respectively. Table 3 is presented to evaluate the cost per liter of distillation yield (CLDY) by executing the sequential manner of Equations (6)–(11) [15]. The capitalized recovery index (CRI) is represented as given:

$$CRI = \frac{K\,(1+K)^t}{(1+K)^t - 1} \tag{6}$$

**Table 3.** Life cost analysis findings.

| Cost Parameter | TDSSD | DSSD-WPB&DPSN |
|---|---|---|
| Manufacturing and Materials (USD) | 80.0 | 80.0 |
| Wick prismatic absorber basin cost (USD) | - | 20 |
| Dual parallel spraying nozzles cost (USD) | - | 15 |
| Capitalized total cost, *P* (USD) | 80.0 | 115.00 |
| First annual cost, *FAC* (USD) | 14.1587 | 20.3531 |
| Annual maintenance cost, *AMC*, (USD) | 4.2476 | 6.1059 |
| Annual salvage value, *ASV* (USD) | 0.9117 | 1.3106 |
| Total yearly cost, *TYC* (USD) | 17.495 | 25.148 |
| Daily distillation yield (kg/$m^2$·d) | 5.4800 | 8.2000 |
| Annual distillation yield (kg/$m^2$·yr) | 1479.6 | 2214.0 |
| Cost of 1.0 L of distilled yield, CLDY (USD/kg) | 0.01820 | 0.01135 |

Here, $K$ is the annual discounting rate (12%) and $t$ is the life of the DSSD, which is adapted as ten years. The first annual cost ($FAC$) is [32]:

$$FAC = P \times CRF \tag{7}$$

Herein, $P$ is the total capitalized cost of the components of each DSSD. The yearly salvage value ($YSV$) is described as:

$$YSV = 0.20\,P \times \left[\frac{k}{(K+1)^t - 1}\right] \tag{8}$$

The annual maintenance cost ($AMC$) is considered as:

$$AMC = 0.15 \times YFC \tag{9}$$

The overall yearly cost ($OYC$) is summated as given:

$$OYC = FAC + AMC - YSV \tag{10}$$

Lastly, the cost per 1.0 L of distillation yield ($CLDY$) is exemplified as follows:

$$CLDY = \frac{OYC}{M_{w,yr}} = \frac{TYC}{M_{w,day} \times N} \tag{11}$$

Herein, $M_{w,day}$ is the daily distillation yield and $N$ points to no. of working days of the distiller per year, which is assumed to be 270 days to maintain reliable and actual cost results [34]. Table 3 figures out the findings of the life cost calculations of the proposed two DSSDs in this investigation. The financial analysis results indicated that the CLDY of the modified DSSD-WPB&DPSN and TDSSD are estimated as 0.01820 USD/kg and 0.01330 USD/kg, respectively, representing a reduction in the freshwater production cost of 11.13%.

## 6. Conclusions

In the current study, the impact of utilizing a novel designed prismatic absorber basin covered by linen wicks on the performance of a DSSD was experimentally assessed to augment freshwater distillation yield. Furthermore, dual parallel spraying nozzles were integrated below the glass cover of the saltwater feed supply to minimize the saltwater film for improving the evaporation and condensation rates. Two double slope distillers, namely a double slope solar distiller with wick prismatic basin and dual parallel spraying nozzles (DSSD-WPB&DPSN) and a traditional double slope solar distiller (TDSSD), were tested in the outdoor hot conditions of Tanta, Egypt. Moreover, a comparative evaluation based on energy, exergy, and economic analyses was performed between the proposed DSSD-WPB&DPSN and TDSSD. The study revealed satisfactory outcomes relative to TDSSD, which can be concluded as follows:

1. The utilization of a wick prismatic absorber basin remarkably augmented the cumulative distillation yield by enhancing the vaporization rates via providing an increased heat transfer zone in the basin. In addition, the implementation of dual parallel spraying nozzles for the seawater feed supply helps in minimizing the saltwater film and augmenting the absorption of solar radiation, and enhancing the evaporation and condensation rates, thus significantly increasing the freshwater yields of the DSSD.
2. The modified DSSD with a wick prismatic basin and dual parallel spraying nozzles (DSSD-WPB&DPSN) obtained an augmentation in the cumulative distillation yield by 49.64% (8.20 kg/day·m$^2$) over the TDSSD (5.48 kg/day·m$^2$) at a fixed saltwater deepness of 2.0 cm.
3. The diurnal energetic efficiency of the DSSD-WPB&DPSN was computed to be 59.60% compared to 40.20% for TDSSD, respectively, representing a 48.51% improvement in the energetic efficiency.
4. The daily exergetic efficiency of the DSSD-WPB&DPSN was obtained as 4.10% compared to 1.82% for TDSSD, respectively, representing 118.10% augmentation in the daily exergy efficacy.
5. The life cost assessment reveals that the cost per liter of the distilled yield of the DSSD-WPB&DPSN and TDSSD were estimated to be 0.01820 USD/kg and 0.01330 USD/kg, respectively, representing a reduction in the freshwater production cost of 11.13%.
6. It can be inferred that the wick prismatic absorber basin and dual parallel spraying nozzles can be regarded as an effective strategy for augmenting the freshwater distillation and energic, exergetic, and economic performances of the double-slope solar distillers.

**Author Contributions:** Data creation, Writing original draft, M.E.Z.; Conceptualization, Project administration, M.E.Z. and A.H.E.; Design and experiments preparation, A.K. and M.R.D.; Experimental work, M.E.Z. and A.K.; Validation and revision, F.A.E.; Consulting and review, O.L.M.; Resources and revision M.F.; Methodology, Formal analysis, Writing, Revised version A.H.E. All authors have read and agreed to the published version of the manuscript.

**Funding:** The work was supported by the Science & Technology In-novation Funding Authority, Ministry of Higher Education and Scientific Research, Egypt, (Youth research project; ID 43623).

**Data Availability Statement:** Data is contained within the article.

**Acknowledgments:** The authors thank the financial funding of this work supported by the Science & Technology Innovation Funding Authority, Ministry of Higher Education and Scientific Research, Egypt, (Youth research project; ID 43623).

**Conflicts of Interest:** The authors declare no conflict of interest.

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