Enhancing Solar Still Efficiency: Optimal Water Depth and Wire Mesh-Pebble Structures

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Abstract

In underdeveloped countries, the shortage of clean drinking water is a major problem. One approach to tackle this issue has been to use solar energy for desalination, a process that turns saltwater into fresh water. This method utilizes solar thermal energy to evaporate water, separating the pure water from the salty water. However, traditional solar stills face challenges in producing sufficient water because of the limited heat transfer between the absorbing plate and the fluid used to extract energy. The research aims to improve the efficiency of solar stills for water desalination. In conventional solar stills, maintaining optimal water depth is a challenge. The study experimented with varying water depths (2 cm to 12 cm) in a modified solar still. The best result, with a maximum distillate output of 2050 ml/m^{2}day, was achieved at a 2 cm water depth. To enhance performance, wire mesh and pebbles were added to increase absorptivity, raising the temperature of saline water. This modification led to a significant improvement, with the modified solar still producing a maximum distillate of 2670 ml/m^{2}day. This research provides valuable insights into optimizing solar stills for better water yield and thermal efficiency.

Keywords: desalination, solar energy, solar still, water depth, wire-mesh, pebbles, fresh water production

1. Introduction

Fresh water is an essential resource for human survival, constituting approximately 60% of the human body. Without access to fresh water, humans cannot survive for more than a week, whereas they can endure for about a month without food. Thus, the availability of fresh water is paramount. Despite the vastness of water on Earth's surface, only a tiny fraction is fresh and potable. Of the total water on Earth, estimated at around 1,386 million cubic kilometers, merely 1% is suitable for drinking and other human uses. The majority, approximately 97%, exists in the form of saline oceans, rendering it unsuitable for consumption. Additionally, around 2% of water is locked in ice caps, further limiting accessible freshwater sources [1,2].

Solar energy is considered an excellent heating source, particularly in regions with severe freshwater scarcity [[3–6]. Solar desalination, especially through conventional solar stills, is a prominent and economical method, particularly in areas with abundant sunshine and scarce

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freshwater resources. Conventional solar stills are chosen for their simplicity, passive nature, affordability, and ease of maintenance. However, limitations such as low efficiency and production rates have prompted researchers to explore ways to enhance productivity, including the use of wick materials [7,8].

The process of solar water distillation, a technology that mimics the natural processes of heating, evaporation, and condensation to purify water, is a fascinating one. Sunlight passes through a transparent inclined cover, heating the water, which then evaporates and condenses on the inner surface. The resulting distilled water is collected in troughs for storage [9,10]. Despite the simplicity of solar desalination using solar stills, its low efficiency and production rate still need to be improved. Researchers have extensively explored ways to enhance the efficiency of solar stills. However, the overall cost tends to rise due to the high materials and additional attachment expenses. To address this, utilizing easily accessible and less expensive materials and adjusting operational parameters emerges as a practical solution. This approach aims to overcome cost challenges by relying on readily available resources and optimizing operational conditions, providing a more economical means to enhance solar still productivity.

Abdullah et al.'s [11] review highlights techniques to maintain minimal water depth in solar stills for desalination, addressing the critical need for freshwater, especially in underserved regions. They reveal diverse methods, like cords, stepped configurations, wicks, absorber shapes, and rotating parts, enhancing productivity by varying degrees, offering insights into thermal methods' impact, and suggesting avenues for further research. The study by Muthu Manokar A. et al. [12] compares pyramid solar still performance at varying water depths, showing higher efficiency and freshwater yield, particularly with insulation, emphasizing its crucial role in enhancing productivity. Mohit Bhargva and Avadhesh Yadav's [13] review highlights the importance of optimizing various parameters, particularly water depth, to enhance the productivity of solar stills and promote sustainable water distillation practices. Elango and Murugavel [14] present a novel approach utilizing glass for solar stills, demonstrating higher productivity in double basin setups regardless of insulation, with maximum yield observed at 1 cm water depth. Insulated double basin stills outperform single basin ones, showing 17.38% and 8.12% higher production at 1 cm depth. Yousef Al-Abed Allah Malik et al. [15] investigate pyramid solar still productivity, revealing basin depth's significant impact, with variations up to 40.6%, while fins boost production by 7.5% and higher inlet temperatures increase yields by 15.3% and 21.2% at 40°C and 50°C, respectively. AE Kabeel et al. [16] compare conventional, inclined, and integrated solar stills, highlighting enhanced productivity in the integrated configuration. They emphasize water depth and mass flow rate, showing CSS-ISS and ISS yield 46.23% and 18.87% more freshwater than CSS alone, with CSS-ISS improving water temperature by 20%. Sourabh Kumar Nougriaya et al. [17] highlight the importance of drinkable water scarcity and advocate for solar desalination as a cost-effective solution, particularly relevant in countries like India. Their review emphasizes the significance of water depth in enhancing productivity in solar stills, offering insights to optimize design for wider adoption of the technology. M.K. Phadatare and S.K. Verma [18] investigate the influence of water depth on heat and mass transfer in a single basin single slope plastic solar still, finding maximum distillate output at 2 cm depth. Results show varying efficiencies from 10% to 34%, indicating decreased productivity with increased basin water depth. Saif Salim Saif Al-Mezeini et al. [19] conducted experiments on a single slope solar still in Gulf countries, finding that a water depth of 4 cm yielded maximum productivity of 2.680 L/day, enhanced to 3.075 L/day with an external mirror, providing valuable insights for optimizing solar desalination in arid regions.

Emad M.S. El-Said et al. [20] introduced a porous packed media with vibrating steel wire mesh screens to enhance heat absorption and transfer in a tubular solar still, achieving a yield of 4.2 L/m^2, a 34% improvement over conventional design, with enhanced efficiencies and reduced cost of freshwater production. Hamdy Hassan et al. [21] experimented with single slope solar stills, revealing that the use of wire mesh, sand, and heat sink condenser significantly increased freshwater yield and efficiency, with MSS achieving up to 41.95% efficiency in summer, providing insights for climate-specific optimization. Hamdy Hassan et al. [22] conducted an experimental study on double-acting solar still with a tracked parabolic trough collector, finding that incorporating steel wire mesh and sand enhanced freshwater yield by up to 14.1% in summer and improved system efficiency, highlighting cost-effective improvements in solar desalination. Husham M. Ahmed and Ghaleb A. Ibrahim [23] explored the enhancement of basin-type solar stills by varying wick materials and layouts, revealing that the incorporation of light black cotton fabric in two different arrangements significantly improved productivity by 36.9% and 26.3%, offering insights for optimizing solar distillation performance. The incorporation of a mesh wire layout arrangement provides an additional effect by increasing the surface area of evaporation. R. Samuel Hansen, C. Surya Narayanan, and K. Kalidasa Murugavel [24] explored inclined solar still performance with varied wick materials and absorber plates, highlighting water coral fleece as the optimal material, achieving a peak distillate of 4.28 L/day with wire mesh-stepped absorber plates. Prakash Perumal [25] investigated the use of pebbles as sensible heat storage materials in single basin single slope solar stills, finding that smaller diameter pebbles, particularly 2 cm, yielded higher productivity, with a 27.27% increase compared to conventional stills, suggesting potential for enhanced performance and shorter payback periods. T. V. Arjunan [26] experimentally investigated solar stills with varied energy storage materials, identifying black granite gravels as more efficient and capable of storing excess heat to extend distillation into evening and night hours, offering the potential for improved solar still operations. T. V. Arjunan et al. [27] investigated solar distillation, revealing a 9.5% productivity boost when using pebbles as energy storage, showcasing their effectiveness in heat retention and release for enhanced solar still performance. Manoj Dubey and Dhananjay R. Mishra [28] aimed to improve the winter performance of double-slope solar stills, comparing conventional setups with modified versions incorporating black dye, pebbles, and iron chips. Results showed a 28.4% increase in distillate yield and notable enhancements in overall heat transfer coefficient and thermal efficiency, suggesting effective winter optimization strategies. M. Koilraj Gnanadason et al. [29] reviewed passive solar distillation systems and tested two solar stills in Nazareth, with modifications like black paint, pebbles, fins, and low pressure, showing increased efficiency and evaporation rate in the modified still compared to the atmospheric pressure variant. V. Velmurugan et al. [30] enhanced an ordinary basin-type solar still with fins and an effluent settling tank to produce potable water from industrial effluents, achieving increased productivity and a one-year payback period supported by theoretical and economic analyses. V. Velmurugan et al. [31] designed a stepped solar still and an effluent settling tank for textile effluent desalination, achieving a maximum 98% increase in productivity with enhancements like fins, sponge, and pebbles, supported by theoretical analysis.

This research paper presents a comprehensive experimental investigation into the performance of solar stills, focusing specifically on the impact of water depth and the integration of wire mesh with pebbles. While previous studies have explored various aspects of solar desalination, this work uniquely combines these factors to enhance absorptivity and increase distillate production. The study compares conventional solar stills with modified versions incorporating wire mesh and a combination of wire mesh with pebbles. The study provides valuable insights into the effectiveness of these modifications through detailed experimental analysis, including measurements of temperatures, solar radiation, humidity, and distillate yield. The findings contribute to advancing knowledge in the field of solar desalination and offer practical implications for addressing water scarcity challenges in arid regions.

2. Experimental Analysis of Solar Stills

A solar still experiment was carried out at Mewar University in Rajasthan, India. The still was made from 26-gauge galvanized steel sheets (0.46cm thick). It consisted of a galvanized iron box inside a wooden container, with the bottom and sides well-insulated using 50 cm thick sawdust to reduce heat loss. The inner box was constructed using PVC semi-cylinder pipes (0.75 inches or 19.05 cm), covered with a 3 cm thick glass tilted at a 30° angle to guide condensate into a collection channel. A black-painted galvanized iron basin (1 m x 0.5 m) with an effective area of 0.5 m^2 was utilized for improved absorption. To ensure water-tightness, the plates were welded and sealed with m-seal. Three holes were drilled for water inlet, condensed water outlet, and saline water discharge. PVC pipes were connected for airtightness, featuring valves for flow control. Water level indicators on both sides were included to maintain a consistent water depth. Post-construction, the solar still was coated with cellulose-based black paint, and insulation material (sawdust) was introduced between the wooden box and galvanized sheet.

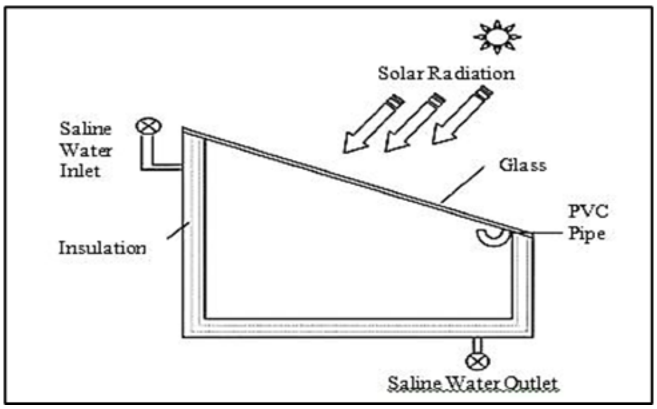

Figure 1: *Cross-section of the solar still*

Figure 2: *Front view of the solar still*

Thermocouples were strategically placed before fixing the glass cover to record temperatures, including the outside glass cover, saline water, and basin temperature. These temperatures were displayed on a digital indicator. Rubber bands were used to seal any small spaces between the glass cover and the still. The experiment considered potential measuring errors from instruments

Figure 3: *Side view of the solar still*

such as thermocouples, measuring cylinders, digital indicators, pyranometers, and anemometers used for temperature, distillate collection, solar intensity, and wind velocity measurements.The accuracies of various measuring instruments used in the experiments are provided in Table 1.

Table 1: *Accuracies of various measuring instruments*

Instruments	Accuracy	Range
Pyranometer	± 1 W/m^2	0 – 5000 W/m^2
Calibrated Flask	± 5 ml	0 – 500 ml
Anemometer	± 0.1 m/s	0 – 30 m/s
Thermocouple	± 0.1 °C	0 – 200 °C
Hygrometer	± 0.1%	0 – 100%

The solar still is positioned with its elongated side facing north-south, maximizing its efficiency. The technical specifications, as provided in Table 2, outline the specific features and dimensions of the solar still.

Table 2: *Technical specifications of the solar still*

Specifications	Dimensions
Length	1 m
Width	0.5 m
Base area	0.5 m^2
Cover inclination	30°
Glass area	0.678 m^2
High side wall depth	450 cm
Low side wall depth	160 cm

The saline water is used for experimentation. Table 3 provides the properties with value for saline water used.

Table 3: *Properties of saline water*

Properties	Values
pH	7.19
T (°C)	21.0
Ca (mg/l)	456.9
Salinity (g/l)	36.85
Total Hardness (ppm)	312.5
Permanent Hardness (ppm)	162.5
Temporary Hardness (ppm)	144
Dissolved oxygen (ppm)	10
Biological oxygen demand (ppm)	4.5
Total solid (ppm)	246350
Total suspended solid (ppm)	214900
Total dissolved solid (ppm)	31450

Figure 4: *Saline water sample*

3. Results and Discussions

Experiments were conducted from May 22 to May 29, 2023, measuring distilled water production between 08:00 and 19:00 hours. Various parameters like glass cover temperature, ambient temperature, saline water temperature, basin temperature, and ambient air humidity were recorded. The study comprised two main parts. In the first part (May 22 to May 27, 2023), experiments were conducted at different depths (2, 4, 6, 8, 10, and 12 cm). The second part (May 28 to May 29, 2023) involved modifications, such as introducing wire mesh and a combination of wire mesh and pebbles to improve absorptivity. Table 4 illustrates the effect of a 2 cm depth of saline water on the production of distilled water over the course of the day.

Table 4: *Experimental results on 22/05/2023; depth of water: 2 cm; total production: 2025 ml*

S. No.	Time (hr)	Ambient temp. (°C)	Glass temp (°C)	Water temp (°C)	Basin temp (°C)	Relative humidity (%)	Solar radiation (W/m^2)	Distillate (ml/m^2 hr)
1	8	35.7	35.3	33.3	34.3	40.8	376	0
2	9	36.9	38.2	42.4	47.4	39.7	536	0
3	10	38.4	44.5	49.8	66.1	22.8	679	0
4	11	40.2	48.1	57.0	70.5	20.3	782	80
5	12	41.6	49.9	58.9	80.3	17.9	824	190
6	13	42.7	51.7	60.3	86.2	16.9	786	320
7	14	43.4	52.3	58.7	84.3	15.4	649	350
8	15	43.7	51.6	53.8	78.4	12.2	508	335
9	16	44.5	49.1	48.5	64.3	11.2	326	300
10	17	42.8	45.3	43.7	49.7	11.7	248	270
11	18	41.3	40.8	39.0	43.9	11.2	96	120
12	19	38.2	37.4	35.9	39.4	11.3	7	60

The research investigated how the depth of water in a standard solar still influences its performance. Hourly measurements were collected, including ambient temperature, glass temperature, water temperature, basin temperature, relative humidity, wind velocity, solar radiation, and distillate production (ml/m^2hr).

Figure 5 shows that at 13:00 hours, the water temperature peaked at 60.3 °C, while the ambient air temperature was 51.6 °C. The glass temperature reached a maximum of 52.2 °C, and the basin temperature recorded the highest at 86.2 °C. This indicates that the solar still effectively increased the temperatures of water, glass, and the basin, especially around midday when sunlight is strongest.

In Figure 6, we see that the total distilled water yield was 2050 ml/m^2day, with a saline water depth of 2 cm. This indicates that the ideal time for maximum water production is in the afternoon. This is because during this period, both the water temperature and solar radiation are at their peak, resulting in higher productivity.

Table 5 shows how the amount of distilled water produced (ml/m^2hr) changes every hour at constant saline water depths of 2, 4, 6, 8, 10, and 12 cm.

The results reveal that the depth of the saline water has a major effect on the solar still's performance, indicating how varying depths affect temperature fluctuations and, as a result, the production of distilled water throughout the day.

Figure 7 compares the hourly distilled water values for a steady saline water depth of 2, 4, 6,

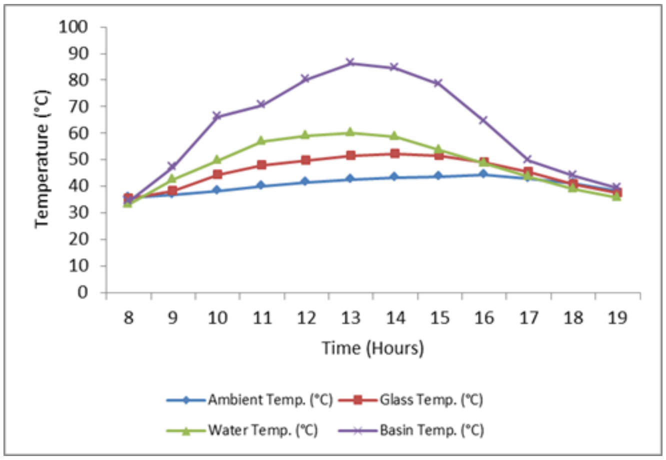

Figure 5: *Hourly variations of temperatures (22/05/2023)*

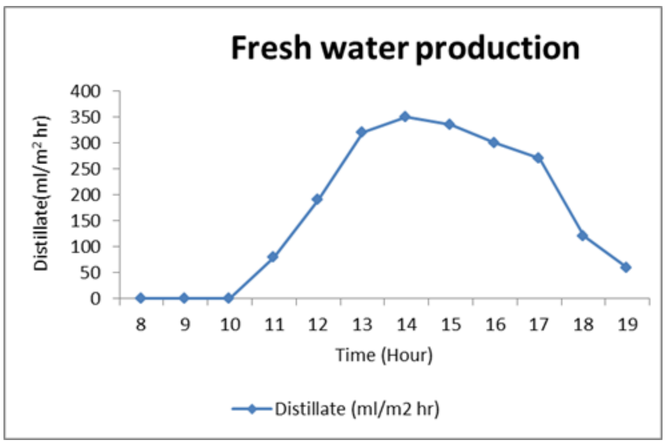

Figure 6: *Hourly variations of distilled water yield (22/05/2023)*

Table 5: *Comparison of experimental results for hourly variation of experimental distilled water yield; depth of water: 2, 4, 6, 8, 10 and 12 cm; maximum production: 2025 ml (2 cm)*

S. No.	Time (hr)	2 cm (22/5/23)	4 cm (25/5/23)	6 cm (23/5/23)	8 cm (27/5/23)	10 cm (24/5/23)	12 cm (26/5/23)
1	8	0	0	0	0	0	0
2	9	0	0	0	0	0	0
3	10	0	0	0	0	0	0
4	11	80	75	60	80	65	50
5	12	190	170	150	135	140	95
6	13	320	290	280	195	200	150
7	14	350	310	320	250	250	190
8	15	335	320	290	310	270	250
9	16	300	260	240	275	240	230
10	17	270	220	190	230	180	170
11	18	120	140	100	140	110	90
12	19	60	60	70	110	50	70

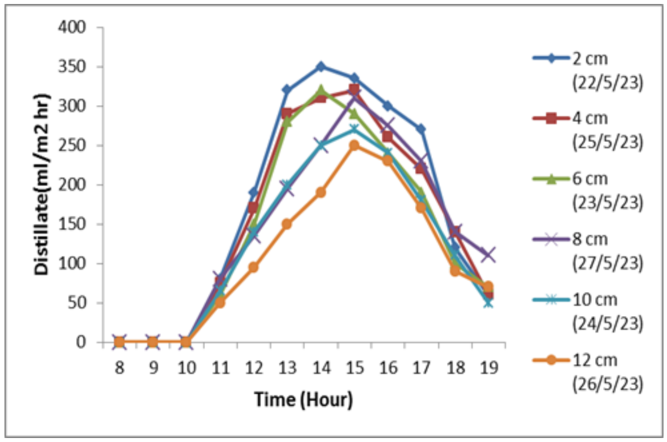

Figure 7: *Comparison of hourly variation of distilled water yield (ml/m^{2}hr)*

8, 10, and 12 cm. The water depth stayed constant throughout the day. The trend shows water production starting at zero in the morning, gradually rising, and reaching its highest point in the afternoon. In the figure, it's clear that the maximum distilled water yield is 2050 ml for a 2 cm saline water depth, observed on May 22, 2023. The peak fresh water production occurs in the afternoon, specifically around 14:00 hours, reaching approximately 350 ml.

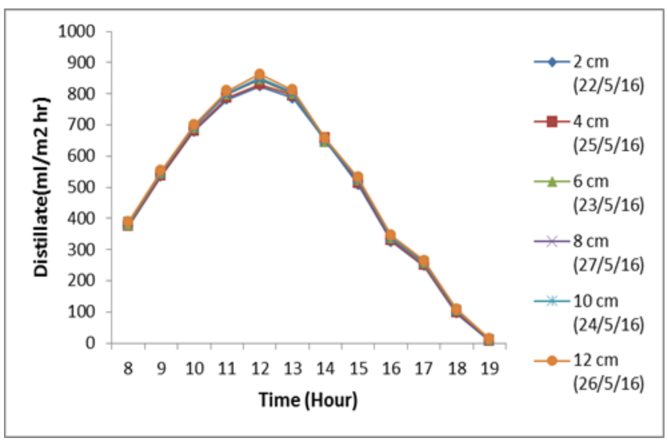

Figure 8: *Comparison of hourly variation of solar radiation (w/m^2) on different days*

Figure 8 shows how solar radiation changes from 8 am to 7 pm on different days. The graph indicates that the intensity of solar radiation remains almost the same throughout this period. The values are consistently close, suggesting a stable pattern.

On May 28, 2023, the experiment was conducted with a modified solar still using wire mesh in the basin, maintaining a constant depth of 2 cm for saline water throughout the entire day. The results are in Table 6, showing various parameters measured during this time.

Figure 9 displays the hourly variation of various measured temperatures. The observations indicate that the maximum water temperature was achieved between 12:00 to 14:00 hours, reaching approximately 65.7 °C, while the ambient air temperature was nearly 42.6 °C. Additionally, the maximum glass temperature and basin temperature were recorded at 46.3 °C and 88.4 °C, respectively. These findings underscore the solar still's capacity to elevate water, glass, and basin

Table 6: *Experimental results for modified solar still (Wire Mesh) 28/05/2023; depth of water: 2 cm (wire mesh); total production: 2450 ml*

S. No.	Time (hr)	Ambient temp. (°C)	Glass temp (°C)	Water temp (°C)	Basin temp (°C)	Relative humidity (%)	Solar radiation (W/m^2)	Distillate (ml/m^2 hr)
1	8	34.5	33.3	33.7	34.7	51.1	402	0
2	9	35.2	35.6	44.6	48.7	46.8	575	0
3	10	37.4	38.8	52.8	65.3	40.3	714	55
4	11	39.2	41.6	60.3	73.5	34.4	812	115
5	12	40.4	45.5	62.4	83.5	38.3	820	230
6	13	41.7	46.3	65.7	88.4	35.2	797	350
7	14	42.1	45.3	61.7	85.3	31.9	702	410
8	15	42.3	45.6	55.8	79.6	31.3	567	380
9	16	42.6	44.7	50.2	67.7	28.2	418	320
10	17	41.7	43.4	45.7	52.7	28.2	261	290
11	18	40.3	39.7	41.2	46.5	28.6	102	210
12	19	38.3	37.3	37.9	41.2	30.1	12	90

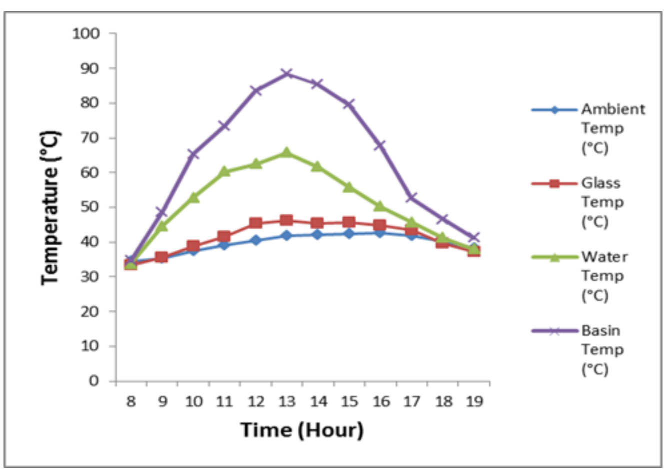

Figure 9: *Hourly variations of temperatures (28/05/2023)*

temperatures during the specified period, with peak values aligning with the maximum solar radiation and heat during midday hours.

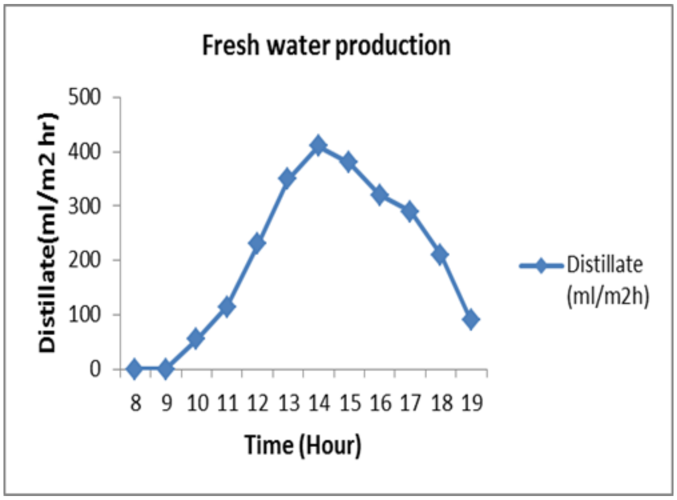

Figure 10: *Hourly variations of distilled water (28/05/2023)*

Figure 10 illustrates the fresh water yield from the modified solar still, specifically when using wire mesh in the basin. The production rate initiates slowly, attributed to the gradual warming of the modified solar still. The peak production rate is observed around 14:00 hours, after which it begins to decrease. The total fresh water yield obtained for the modified solar still was recorded at 2450 ml/m^2day, with a constant saline water depth of 2 cm. These results highlight the effectiveness of the modifications, showcasing an improvement in water yield compared to the conventional solar still.

On May 29, 2023, an experiment was carried out on the modified solar still using both wire mesh and pebbles in the basin. The saline water depth was kept constant at 2 cm throughout the entire day. Hourly readings were measured from 08:00 to 19:00 hours. The results are in Table 7, showing various parameters measured during this time.

Figure 11 illustrates the hourly variation of temperatures during the experiment conducted on May 29, 2023, using a modified solar still with both wire mesh and pebbles in the basin. The observations from the figure indicate that the maximum water temperature recorded was 69.7 °C, with the ambient air temperature reaching nearly 42.6 °C. Additionally, the maximum glass temperature and basin temperature were measured at 43.7 °C and 87.5 °C, respectively. These findings highlight the ability of the modified solar still, with the combination of wire mesh and pebbles, to achieve elevated temperatures during the specified period.

Figure 12 illustrates the fresh water yield of the modified solar still with both wire mesh and pebbles in the basin. The water production shows an increasing trend from the morning, reaching its maximum values in the mid-noon, and subsequently starts to decrease. The total water yield for this modified solar still was recorded at 2670 ml/m^2day, with a constant water depth of 2 cm. These results indicate the effectiveness of the modifications, particularly the combination of wire mesh and pebbles, in enhancing the overall water yield compared to the conventional solar still.

Table 8 provides a comparison of experiment results, showcasing the hourly variation of distilled water yield (ml/m^2hr) for different solar still setups. The comparison involves the conventional solar still, the modified solar still using wire mesh, and the modified solar still using both wire mesh and pebbles.

Table 7: *Experimental results for modified solar still (Wire Mesh and pebbles) 29/05/2023; depth of water: 2 cm (wire mesh); total production: 2670 ml*

S. No.	Time (hr)	Ambient temp. (°C)	Glass temp (°C)	Water temp (°C)	Basin temp (°C)	Relative humidity (%)	Solar radiation (W/m^2)	Distillate (ml/m^2 hr)
1	8	33.7	32.3	33.6	35.2	48.9	386	0
2	9	35.3	34.2	44.7	48.5	47.2	560	0
3	10	37.5	37.9	56.5	64.3	43.9	700	65
4	11	38.4	40.1	65.2	75.3	40.7	795	125
5	12	39.3	41.3	66.4	84.7	36.6	811	240
6	13	41.5	43.5	69.7	87.5	33.3	781	370
7	14	42.6	43.7	68.5	84.2	30.1	706	425
8	15	41.7	42.3	66.4	80.7	28.6	610	390
9	16	40.3	40.5	61.7	69.8	26.3	499	350
10	17	39.3	41.6	57.3	60.7	25.4	272	325
11	18	36.7	38.2	52.7	52.4	23.9	118	240
12	19	34.3	35.6	49.5	45.6	42.3	15	140

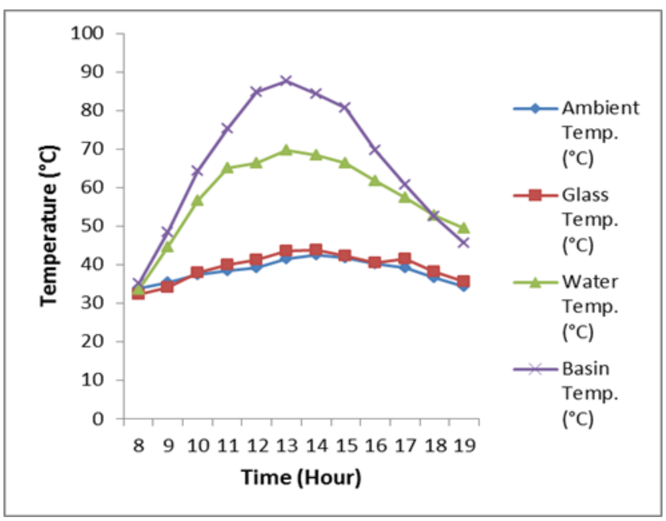

Figure 11: *Hourly variations of temperatures (31/05/2023)*

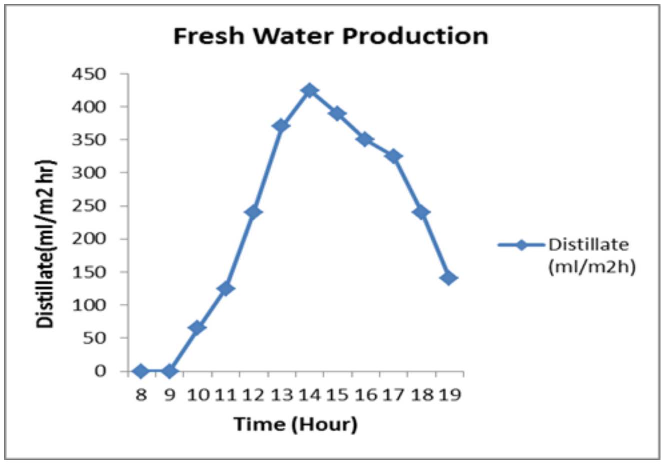

Figure 12: *Hourly variations of distilled water yield (31/05/2023)*

Table 8: *Comparison hourly variation of distilled water yield (ml/m^2hr) for different solar still setups*

S. No.	Time (hr)	Conventional still (22/05/2023)	Modified solar still with wire mesh (28/05/2023)	Modified solar still with pebbles (30/05/2023)	Modified solar still with wire mesh and pebbles (29/05/2023)
1	8	0	0	0	0
2	9	0	0	0	0
3	10	0	55	40	65
4	11	80	115	110	125
5	12	190	230	200	240
6	13	320	350	330	370
7	14	350	410	380	425
8	15	335	380	340	390
9	16	300	320	280	350
10	17	270	290	260	325
11	18	120	210	190	240
12	19	60	90	80	140

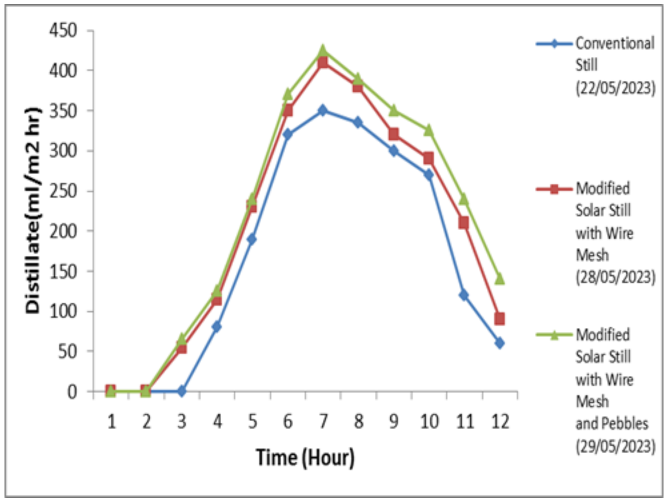

Figure 13: *Hourly variations of distilled water yield for different modified solar still*

From Figure 13, it is evident that the maximum productivity of distilled water yield is as follows:

- Conventional solar still (experiment on May 22): 2050 ml/m^{2}day
- Modified solar still with wire mesh (experiment on May 28): 2450 ml/m^{2}day
- Modified solar still with wire mesh and pebbles (experiment on May 29): 2670 ml/m^{2}day

These values were obtained at a constant depth of 2 cm of water. The peak production occurs in the afternoon around 14:00 hours, with the maximum amount of distillate recorded at approximately 350 ml for the conventional still, 410 ml for the modified solar still with wire mesh, and 425 ml for the modified solar still with wire mesh and pebbles. The highest amount of distillate obtained is with the modified solar still using wire mesh and pebbles on May 29, 2023, at 2670 ml/m^{2}day.

4. Conclusion

The research investigated the performance of both conventional and modified solar stills, employing various depths of 2, 4, 6, 8, 10, and 12 cm. The modified solar still incorporated the use of wire mesh and wire mesh with pebbles. Key conclusions drawn from the experiments are as follows:

- **Solar radiation impact**: The primary factor influencing the productivity of the solar still is solar radiation. Maximum productivity is achieved when the solar still receives the highest solar radiation.
- **Water depth influence**: The depth of water in the solar still is inversely related to its productivity. Maintaining a minimum depth in the solar still is challenging.
- **Use of wire mesh and pebbles**: The introduction of wire mesh and pebbles in the solar still serves to increase absorptivity, leading to higher saline water temperatures within the still. Consequently, this results in an increase in the overall productivity of the solar still.

The highest distilled water yield, 2050 ml/m^{2}day, was observed at 2 cm depth on May 22, 2023. The modified still, with wire mesh and pebbles, produced the maximum distillate of 2670 ml/m^{2}day on May 29, 2023. These results highlight the importance of modifications in improving solar still performance and productivity.

This research provides practical solutions for tackling water scarcity in underdeveloped regions by enhancing solar desalination systems. By incorporating wire mesh and pebbles into solar still designs, the study demonstrates a significant increase in distillate yield, reaching up to 2670 ml/m^{2}day. Emphasizing the importance of solar radiation and careful system calibration, the findings offer valuable insights for maximizing efficiency and productivity.

Implementing these strategies can lead to affordable and sustainable water supply solutions, benefiting vulnerable populations and improving water security in resource-constrained areas.

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