Enhancement of Conventional Solar Still Productivity by Modifying with The Tilted Wick at Different Angles and Black Painted Basin: An experimental & Economic Approach

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Research Article

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Enhancement of Conventional Solar Still Productivity by Modifying with The Tilted Wick at Different Angles and Black Painted Basin: An experimental & Economic Approach

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Abstract

Solar still is the emerging technique to distilled water at places where there is a huge scarcity of drinking water. The current investigation deals with the productivity enhancement of distilled yield of conventional solar still (CSS) to obtain decontaminated fresh water. Experiments were conducted by modifying CSS for five different cases viz: (a). Conventional solar still without the wick, (b). Conventional solar still with the tilted wick at 15°, 30°, and 45° (c). Black painted basin conventional solar still (BPBCSS) with the tilted wick at 30°. All experiments were performed on the month of March for approximate same climatic condition. From the preliminary investigation, the flow rate of basin water on the wick was kept fixat 0.2g/m².sec in such a way that the wick remained completely wet. The overall daily productivity of the cases was found to be 3.802kg/m², 3.925kg/m², 4.25kg/m², 4.102kg/m², and 4.372 kg/m² for CSS without the wick, CSS with the tilted wick at 15°, CSS with the tilted wick at 30°, CSS with the tilted wick at 45°, and BPBCSS with the tilted wick at 30° respectively. For BPCSS, the cost of the obtained yield distillate was found to be ₹1.38 per Liter, making it more affordable than CSS.

Keywords: Conventional Solar Still, Tilted Wick Solar Still, Absorptivity, Day Distillate, Economic analysis.

1. Introduction

Pure water is a necessity of human beings, but countries, especially UAE, Jordan, Egypt, India, etc., are facing an immense shortage of pure drinking water, particularly the places where rivers are distant (Nandi et al 2019). The habitant of those places has a high dependency on well, canals, or ocean water if found purified. The water content of the well and canal is drinkable but is
extremely less as compared to ocean water (Koschikowski et al 2003). Moreover, the population density near the ocean is high and keep on increasing since the start of globalization leading to higher demand for purified and drinking water (D'Odorico et al 2018). The availability of drinking water near the ocean is mainly carried out by transportation from nearby resources or can be accomplished by purifying the ocean water. The transported water is not cost-effective and thus there is a need for an in-place solution for the purification of water. There are various water purification methods used to treat impure water such as boiling, filtration, reverse osmosis, solar desalination (Flendrig et al 2009, Epimakhov et al 2004, Venkatesha et al 2020, Sobsey et al 2008, and Vk et al 2009 and many more. Among these, Solar distillation has the potential to desalinate coastal areas’ saline water without affecting the ecosystem. The performance enhancement of solar desalination, especially solar still is gaining the attention of researchers due to its simplicity, environment-friendly, and cost-effective.

The solar still device is used to purify saline or impure water with the help of solar energy. The pictorial representation of the Single slope solar still was shown in Figure 1. It works on the principle of evaporation and condensation (El-Sebaii et al 2008). The impure water is poured into the basin and the radiations are passed through glass (placed at the top of the still) to the basin surface, which increases the temperature of the basin water. The still is well insulated to prevent
thermal losses (Modi et al 2022), The rise of water temperature leads to the evaporation of basin impure water which gets condensed over the inner glass surface by releasing its latent heat and drops down through the glass surface to distillate channel. An illustration of a complete diagram of the solar still is shown in Figure 1. Many researchers have contributed to enhancing solar still performance by the modifying design of the stills, varying the depth of basin water, (Ashok and Rana 2019, Tarawneh et al 2007, Flendrig et al 2009, Epimakhov et al 2004), introducing external attachments like flat plate collector (Negi et al 2021, Subramanian et al 2020, Madiouli et al 2019), evacuated collector, different types of wick materials, the inclination of wicks (Fayaz et al 2022), using heat storage mediums and by introducing Nanoparticles (Negi et al 2020) to increase the productivity of the solar stills. For instance, (Fayaz et al 2022), performed an experiment on solar still by introducing the tilted Khes cloth wick inside the basin at different angles. The best optimum productivity was found according to the latitude of the location at 30° tilted wick inclination. The latitude of the location helps to achieve maximum solar intensity on the wick. The result shows daily distillate enhancement by 37.17% of Modified Solar Still (MSS) when compared to Conventional Solar Still (CSS). (Tanaka 2017) performed a theoretical investigation over vertical multi-effect solar still with a sponge-based tilted wick for better productivity. (Bisht et al. 2020) performed an experiment in which floating black die cotton wick and the solar pond were introduced to increase the productivity of CSS. The day distillate of MSS was enhanced by 53.55% compared to CSS. (Jobrane et al 2021) performed theoretical as well as an experimental procedure to increase freshwater productivity of porous wick-type solar still by introducing forced condensation. The results show an enhancement of 32% distillate output of MSS compared to CSS. (Ahmed et al. 2021) performed an experiment in which a black cotton wick was introduced to inclined solar still. The efficiency of the inclined solar still was found to be 139.12% compared to the solar still without a wick. (Lee et al. 2021) performed experimentation in which a multi-effect diffusion solar distiller with a free wick plate was used. The results show better productivity by 7% when compared to conventional solar distillers. (Essa et al. 2021) conducted an experiment on convex-shaped absorber tubular solar still (TSS) with jute wick and nanocomposites. The distillate output for the MSS was found to be 114.2% more compared to CSS. (Modi and Modi 2020) carried out theoretical as well as experimental work in DBSSSSS in which jute as a wick was introduced. The
maximum productivity of MSS with a wick was found to be 23.71% more compared to still without a wick. (Agarwal and Rana 2019) performed an investigation on solar still with multiple floating black jute wicks. The evaporative surface area of the MSS was 26% larger compared to CSS.

Investigation on solar stills shows reflectors, condenser, porous absorbing material, water depth, solar intensity, ambient temperature, insulation material, wick material, and fin can be used to increase the productivity of the still at a low cost (Narayanan et al 2020, Bhargava 2021). However, from the above literature, it was confirmed that wick plays an important role in the enhancement of distillate output of the solar still by increasing the surface area for evaporation.

(Riahi et al. 2015) done experiment on triangular-shaped solar still. While compared to CSS, the productivity of the still was enhanced by 101% with a black-painted basin. (Saktivel et al. 2022) performed experiments by adding various color die into the basin. Maximum efficiency and distillate found with the black die was 49.36% and 3.49g/m².day. The distillate produced for the black die was 21% higher when compared to colorless water. (Riahi and Zakaria 2019) experiment on a passive-type solar still by applying black paint to the basin. The results show a 36.25% increase in day distillate for the PSS by applying black paint to the basin compared to PSS without black paint. (Gnanadason and Senthilkumar 2011) done experiment on SBSS by providing a vacuum and black painted basin. The result shows a 30% increase in distillate productivity when compared to CSS. (Ashok and Rana 2019) performed experiment on solar still with black painted and charcoal basin. The results show a 17.41% increase in productivity with a black-painted basin compared to CSS.

By evaluating the above literature, it can be remarked that both wick and black paint inside the basin enhances the distillate output of the still, but according to the best knowledge of the author, no work was reported on the black-painted basin and tilted wick simultaneously inside the basin of the conventional solar still. Hence, in order to fill this gap, an experimental investigation was performed on CSS by modifying it with black paint and a tilted wick inside the basin. The day productivity of the MSS is increased with the help of a tilted wick inside the basin while night productivity was increased by storing heat inside the black-painted stainless-steel (304) basin that simultaneously acts as an internal reflector.
2. Experimental Setup

In the present study, an experimental work was performed for five cases as shown in Table 1 by modifying CSS viz: 1. CSS without the wick 2. CSS with the tilted wick at 15°, 30°, and 45° 3. BPBCSS with the tilted wick at 30°. The block diagram and dimensions of experimental setup are shown in figure 2 and Table 2 respectively. The length to width ratio of stills were kept 3:1 to avoid shadow on the corners of the stills. The inclination of the glass was kept at 45°, so that maximum solar radiation falls over the glass throughout the day and moreover, the basin water depth was kept at 3 cm. A galvanized iron sheet was used to support the wick. Khes cloth [15] with the black permanent die of 7×3 feet² was used as wick cloth. The setup was supported by a wooden frame, which was well insulated by 3-inch foam at the sides and 4-inch foam at back and bottom of the still. The insidereflectors and basin were made of stainless-steel grade 304 of 26-gauge thickness. A water pump with a fan regulator was adjusted at 0.2 g/m². sec flow rate of basin water at tilted wick to keep wick completely wet. The anemometer, solarimeter, and K-Type thermocouples were used for taking account of wind speed, solar intensity, and the temperature of different parts respectively as shown in Table 3.

Experimentation was carried out for clear climatic condition in March 2021 at Chandigarh University, Mohali at latitude of 30.7698°N and longitude of 76.5756°E for alternate days [15], [18]. The experiment starts sharp at 8 am and run till 6 pm for the same day with an average solar intensity range of 20-24 MJ/m². Before experimentation the preliminary investigation was done on the setup for 2 days under the external radiation panel as shown in figure 3.
Figure 2. Schematic Diagram of Proposed Solar Still (a) Conventional solar still without wick (b) Conventional solar still with the tilted wick at 15°, 30°, and 45° (c) Black painted basin conventional solar still with the tilted wick at 30°

Table 1 Experimental Cases:

<table>
<thead>
<tr>
<th>Cases</th>
<th>Date</th>
<th>Modifications on Conventional Solar Still</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15/03/2021</td>
<td>Conventional Solar Still without Wick</td>
</tr>
<tr>
<td>2</td>
<td>17/03/2021</td>
<td>Conventional Solar Still with Wick at 15°</td>
</tr>
<tr>
<td>3</td>
<td>19/03/2021</td>
<td>Conventional Solar Still with Wick at 30°</td>
</tr>
<tr>
<td>4</td>
<td>21/03/2021</td>
<td>Conventional Solar Still with Wick at 45°</td>
</tr>
<tr>
<td>5</td>
<td>23/03/2021</td>
<td>Black Painted basin Conventional Solar Still with Wick at 30°</td>
</tr>
</tbody>
</table>

Table 2 Dimensions of Experimental Setup

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of Still</td>
<td>1.84m</td>
</tr>
<tr>
<td>Width of Still</td>
<td>0.58m</td>
</tr>
<tr>
<td>Height of Still</td>
<td>0.79m</td>
</tr>
<tr>
<td>Water Basin Height</td>
<td>0.1m</td>
</tr>
<tr>
<td>Water Depth</td>
<td>0.03m</td>
</tr>
<tr>
<td>Glass Thickness</td>
<td>5mm</td>
</tr>
<tr>
<td>Wick</td>
<td>Khes cloth</td>
</tr>
</tbody>
</table>

Table 3 Instruments Used

<table>
<thead>
<tr>
<th>Instruments</th>
<th>Parameters</th>
<th>Error</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solarimeter</td>
<td>Solar Radiation</td>
<td>±1W/m²</td>
<td>0-1500W/m²</td>
</tr>
<tr>
<td>Anemometer</td>
<td>Wind Velocity</td>
<td>±0.1m/s</td>
<td>0-10m/s</td>
</tr>
<tr>
<td>Thermocouple</td>
<td>Temperature</td>
<td>±0.1°C</td>
<td>-200°C - +200°C</td>
</tr>
<tr>
<td>Weighing Pan</td>
<td>Distillate Weight</td>
<td>±0.001g</td>
<td>Up to 1kg</td>
</tr>
</tbody>
</table>

Additional data logger was used to record data over the period of time.
3. Results & Discussions

Fig 4, Fig 5, and Fig 6 show the variation in weather parameters such as ambient temperature ($T_a$), wind velocity ($v$) and solar intensity (IS) for experimental days. It can be observed from Fig 4 that ambient temperature ($T_a$) for CSS, was high throughout the day compared to other cases, while lowest for the CSS with tilted wick at 15°. However, the wind velocity ($v$) fluctuates throughout the period of experiment for all days as shown in Fig 5, although, it contributes in decreasing glass temperature and helps to increase the overall yield. Moreover, at early morning high ‘$v$’ decreases overall setup temperature that results in low distillate yield in early morning. However, the distillate yield increases as the day passes due to high solar intensity (IS) and found maximum around 12:00 – 2:00 pm. ‘IS’ varies throughout the day, it follows roughly similar path for all experimental days. The ‘$v$’ was independent of the variation in ‘$T_a$’, moreover the ‘IS’ increases as the day passes and found to be maximum for particularly CSS without wick. The maximum ‘IS’ being found at mid-noon for all the respected days around 12:00 – 2:00 pm.
Fig. 4 Variation of Ambient Temperature

Fig. 5 Variation of Wind Velocity
3.1. CSS without the Wick

Variation of component’s temperature of CSS without wick was shown in Fig 7. It can be seen from graph that the temperature of outer glass (T_{go}), inner glass (T_{gi}), water (T_{w}), and basin (T_{b}) increases as the solar intensity increases. Initially ‘T_{go}’ was high, but with the increment in wind velocity convection increases, which results in decrease of ‘T_{go}’ and remains below ‘T_{w}’. However, after 10:30 am the ‘T_{w}’ increases gradually as the ‘IS’ increases and remains high through-out the day compared to others. The directly exposed water basin under the radiations receive maximum thermal energy from the sun and the basin which increases T_{w} of the CSS. The hourly distillate productivity of CSS without wick inside the basin is shown in Fig 8. It can be clearly observed from the graph that productivity of the still increases as the ‘T_{w}’ – ‘T_{g}’ increases [12]. The overall daily cumulative productivity of CSS without wick was found to be 3.802kg/m² day. Peak hourly productivity of 347.86 g was found around 2:00 - 3:00 pm. The ‘IS’ and ‘v’ plays a vital role in enhancing productivity of still. The maximum IS contributed in enhancement of the evaporation rate, however, increase in ‘v’ increases the condensation rate of the still.
3.2 CSS with the Wick at 15°

Fig 9 shows the component’s temperature of CSS with the Wick at 15°. It can be clearly observed from the graph that the tilted wick temperature ($T_{tw}$) was high compared to other components it was seemed that ‘IS’ was directly incident on the wick which increases the ‘$T_{tw}$’. The ‘$T_{w}$’ was not
high when compared CSS without wick due to the placement of the wick over the basin. The basin water was not directly exposed to sun instead of that water poured into the wick with the help of a water pump in such a manner that excess water from the pump to the tilted wick drops down to the basin. It can be observed from Fig 10 that the distillate output was directly proportional to ‘$T_{tw}$’, the daily distillate yield increases with increase in temperature of ‘$T_{tw}$’. The cumulative distillate was found to be 3.925kg/m² day, while peak hourly productivity of 356.4g was found around 2:00 – 3:00 pm. The diurnal and nocturnal distillate obtained for the experimental day was found to be 2.27 kg/m² and 1.66 kg/m² respectively.

![Fig 9 Component’s Temperature of Conventional Solar Still with Wick at 15°](image)

![](image)

**Fig 9 Component’s Temperature of Conventional Solar Still with Wick at 15°**

![Fig 10 Distillate Output of Conventional Solar Still with Wick at 15°](image)

![](image)

**Fig 10 Distillate Output of Conventional Solar Still with Wick at 15°**

3.3 CSS with the Tilted Wick at 30°

Fig 11 shows the component’s temperature of CSS with the tilted wick at 30°. The ‘$T_{tw}$’ predominates entire experimental hours through-out day. The angle adjusted of the wick was approximately equal to the latitude of location which helps to transfer maximum possible radiation
The fluctuation in ‘v’ lowers ‘T_{go}’ and remain below the ‘T_{tw}’. The maximum ‘T_{tw}’ of 76.2°C was achieved around 2:00-3:00pm, respectively, also the distillate output for the experimental case is shown in Fig 12. The Graph shows linear increase in the distillate productivity up to 1:00pm, after that productivity fluctuated and drops after 4:00pm with a sharp dip. The tilted wick helps to evaporate water faster by providing the large surface area and extra thermal heat by GI-wick support [15]. The maximum distillate of 390.1 g was found around 1:00 – 2:00pm due to increase in ‘T_{tw}’ compared to ‘T_{gi}’. However, the night productivity curve was approximately similar to the CSS with the tilted wick at 30°. The cumulative daily yield for the case was found to be 4.25 kg/m² while night productivity was found to be 1.69 kg/m².

The component’s temperature of CSS with the tilted wick at 45° is shown in Fig 13. The ‘T_{tw}’ was high for entire hours through-out day. ‘T_{go}’ drops after 11:00 am due to the fluctuation in ‘v’ and increase in convective losses. The maximum ‘T_{tw}’ of 70.1°C was found around 2:00pm-3:00pm,
respectively. The distillate output for the case is shown in Fig 14, moreover, the graph shows linear increase in the distillate productivity up to 1:00pm similar to Fig 10 and after that productivity fluctuated and decrease after 5:00pm. The tilted wick helps to evaporate water faster by providing the large surface area and extra thermal heat by black painted wick support. The maximum distillate of 380.06g was found around 1:00pm – 2:00pm while the night productivity curve was approximately similar to the CSS with the tilted wick at 30°. The total yield obtained for CSS with tilted wick at 45° was 4.1 kg/m² while night productivity was found to be 1.48 kg/m².

![Component’s Temperature of Conventional Solar Still with Wick at 45°](image13.png)

**Fig 13** Component’s Temperature of Conventional Solar Still with Wick at 45°

![Distillate Output of Conventional Solar Still with Wick at 45°](image14.png)

**Fig 14** Distillate Output of Conventional Solar Still with Wick at 45°

1.5 BPBCSS and Tilted Wick at 30°

After experimentation for all the different inclination cases of the wick inside CSS the best results were obtained at 30° inclination of wick. At 30° the ‘$T_{tw}$’ and distillate output was found to be the maximum due to latitude of the location, which transfer maximum possible radiation on the tilted wick during the day, and store heat inside the basin. In order to increase the absorptivity of the
still, the black painted basin was placed inside CSS with the wick at 30˚. The component’s
temperature of CSS with the black painted basin and tilted wick at 30˚ was shown in Fig 15. The
‘T_w’ compared to other cases was maximum for this case. The ‘T_w’ was low compared to the tilted
wick due to placement of the wick, it was placed over the basin, that results in absorption of more
solar radiation by the tilted wick rather than basin water. The excess circulating water drops down
to basin from wick and increases the ‘T_w’. Fig 16 shows the day productivity of the BPCSS with
tilted wick at 30˚. The graph shows rapid increase in productivity up to 1:00pm, after that the
productivity decreases slowly up to 3:00pm. The rapid drop in productivity can be shown after 3:00
pm, but due to energy stored inside the basin during day and black painted basin the night
productivity increased compared to all other cases, resulting in increase in overall output. The
maximum daily obtained yield was 4.38 kg/m².day while the night productivity was found to be
1.79 kg/m² respectively.

Fig. 15 Component’s Temperature of Black Painted Basin Conventional Solar Still with Wick at
30˚

Fig 16 Distillate Output of Black Painted Basin Conventional Solar Still with Wick at 30˚

1.4 Distillate Comparison of the Cases

The distillate comparison of the CSS and MSS is shown in Fig 17. This can be verified from the
graph that highest distillate output during day and night was found for BPBCSS with the tilted
wick at 30˚. The black paint and inclination of tilted wick according to latitude of location helps to
achieve higher distillate yield compared to other cases. The day distillate of the BPCSS with tilted wick shows 14.9% improvement in diurnal yield while the nocturnal distillate for BPCSS with tilted wick shows 13.8% improvement when compared to CSS and found highest distillate among all the cases.

Fig 17 Distillate comparison of the CSS & MSS

4. Economic Analysis

The economic analysis of CSS without wick and BPBCSS with tilted wick at 30° is calculated in this section [39], [40]. All the expenditure during the experimentation was shown in Table 3. Moreover, the present study was compared with previous studies as shown in Table 4. Although, present study seemed an economical way to treat impure water with the help of BPBCSS with tilted wick compared to CSS.

Equation 1 shows Annual Fixed Cost (AFC) of the setup:

\[ AFC = CRF \times \text{Initial Investment} \]  

(1)

Capital Recovery factor (CRF) is computed by using Eq. 2 where ‘n’ denotes total life of still and considered to be 20 years as stainless-steel sheet is used as the basin of the still for both TWSS and BPBCSS with tilted wick at 30° and ‘i’ denotes rate of interest and considered 10%.

\[ CRF = \frac{(1+i)^n}{((1+i)^n-1)} \]  

(2)

The Annual Maintenance Cost and Annual Salve Value is equated by using Eq. 3&4
AMC = 0.15 × AFC \hspace{1cm} (3)

ASV = S × SFF \hspace{1cm} (4)

Where ‘S’ = 20% of Initial Investment and SFF denotes Sink Fund Factor which is given by Eq. 5.

\[
SFF = \frac{i}{(1+i)^n-1} \hspace{1cm} (5)
\]

Annual Cost and Cost of fresh water is given by Eq. 6 & 7.

\[
AC = AFC + AMC - ASV \hspace{1cm} (6)
\]

\[
CPL = \frac{\text{Annual Cost}}{\text{Total Annual Yield}} \hspace{1cm} (7)
\]

Net pay back period for the still was calculated by using Eq. 8

\[
NPBP = \frac{\ln\left[\frac{CF}{CF-(AFC \times i)}\right]}{\ln(1+i)} \hspace{1cm} (8)
\]

Table 3 Cost Analysis for TWSS and BPBCSS with tilted wick at 30°

<table>
<thead>
<tr>
<th>Still</th>
<th>CSS</th>
<th>BPBCSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Distillate Output (kg/m²)</td>
<td>3.802 kg/m²</td>
<td>4.372 kg/m²</td>
</tr>
<tr>
<td>Fabrication Cost (INR)</td>
<td>10000</td>
<td>12000</td>
</tr>
<tr>
<td>Expected Life (Year)</td>
<td>20 Year</td>
<td>20 Year</td>
</tr>
<tr>
<td>Operating Days per Year</td>
<td>300 days</td>
<td>300 days</td>
</tr>
<tr>
<td>CPL water (INR)</td>
<td>1.51/Kg</td>
<td>1.38/Kg</td>
</tr>
<tr>
<td>PBP (days)</td>
<td>104 days</td>
<td>91 days</td>
</tr>
</tbody>
</table>

Table 4 Comparison of previous work on the tilted wick solar still with present work
<table>
<thead>
<tr>
<th>Author / Ref</th>
<th>Year</th>
<th>Location</th>
<th>Modification</th>
<th>Wick Type</th>
<th>Total Yield (g/m²·day)</th>
<th>CPL</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.E. Kabeel [35]</td>
<td>2009</td>
<td>Tanta City, Egypt</td>
<td>Concave absorber Solar Still with wick</td>
<td>Jute</td>
<td>4.1 L/m²·day</td>
<td>0.065$</td>
</tr>
<tr>
<td>Alaian et al. [36]</td>
<td>2015</td>
<td>Egypt</td>
<td>Single Slope Solar Still with the pin finned wick</td>
<td>-</td>
<td>4195 g/m²·day</td>
<td>-</td>
</tr>
<tr>
<td>Munisamy et al. [37]</td>
<td>2017</td>
<td>Tamil Nadu, India</td>
<td>Solar Still inclined at 30° with wick</td>
<td>Fur Fabric</td>
<td>3630 g/m²·day</td>
<td>2.12 ₹</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Terry Cloth</td>
<td>2851 g/m²·day</td>
<td>2.87 ₹</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Jute</td>
<td>3393 g/m²·day</td>
<td>2.35 ₹</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Polyester Cloth</td>
<td>2559 g/m²·day</td>
<td>3.15 ₹</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Jute</td>
<td>0.942 L/m²·day</td>
<td>3.40 ₹</td>
</tr>
<tr>
<td>Modi et al. [10]</td>
<td>2020</td>
<td>Gujrat, India</td>
<td>Double Basin Single Slope Solar Still with the wick pile</td>
<td>Khes Cloth</td>
<td>3600 g/m²·day</td>
<td>-</td>
</tr>
<tr>
<td>Fayaz et al. [18]</td>
<td>2021</td>
<td>Chandigarh, India</td>
<td>Tilted Wick Solar still at 30°</td>
<td>Khes Cloth</td>
<td>3850 g/m²·day</td>
<td>0.028$</td>
</tr>
<tr>
<td>Younes et al. [38]</td>
<td>2021</td>
<td>Al Kharj, Saudi Arabia</td>
<td>Corrugated absorber Wick Solar Still</td>
<td>Black Cotton Cloth</td>
<td>4250 g/m²·day</td>
<td>0.023$</td>
</tr>
<tr>
<td>Modi et al. [26]</td>
<td>2022</td>
<td>Gujrat, India</td>
<td>Double Basin Single Slope Solar Still with the circular wick fins</td>
<td>Black Jute cloth</td>
<td>4.2313 L/m²·day</td>
<td>1.74 ₹</td>
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<td>Present Study</td>
<td>-</td>
<td>Chandigarh, India</td>
<td>Khes Cloth Tilted Wick inside the black painted basin</td>
<td>Khes Cloth</td>
<td>4372 g/m²·day</td>
<td>1.38 ₹</td>
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</table>
Conclusions

1. The wick increases the evaporation rate of the basin water by increasing surface area and hence, increases daily productivity of the MSS.

2. The wick should be placed according to latitude of the location to transfer maximum possible solar radiation to the wick.

3. The solar intensity (IS) helps to increase the evaporation rate while wind velocity (v) increases condensation rate by lowering glass temperature and thus an important factor for distillate enhancement of the still.

4. Black paint increases absorptivity of the basin but was less effective in case of tilted wick inside the basin as the basin does not receive direct solar radiations.

5. The day productivity of CSS, CSS with tilted wick at 15°, 30°, 45° and BPBCSS with tilted wick at 30° was found to be 3.802 kg/m², 3.925 kg/m², 4.25 kg/m², 4.102 kg/m², and 4.372 kg/m² respectively.

6. The CPL obtained for BPBCSS with tilted wick at 30° was 1.38 Rs/Kg with PBP of 91 days while in case of CSS the CPL was 1.51 Rs/Kg with PBP of 104 days.

Future Scopes

1. Nano Technology can be added to the setup to enhance the productivity of still.

2. The night productivity of the still was low compared to day productivity and can be enhanced by storing heat during day time. It can be used via sensible heat storage medium or latent heat storage medium.

Nomenclature & Subscripts

CSS = Conventional Solar Still
MSS = Modified Solar Still
AFC = Annual Fixed Cost
SFF = Sink Fund Factor
IS = Solar Intensity
\(T_a\) = Ambient Temperature
\(T_{go}\) = Temperature of Outer Side of Glass
\(T_{tw}\) = Temperature of Tilted Wick
BPBCSS = Black Painted Basin Conventional Solar Still
DBSSSS = Double Basin Single Slope Solar Still
CRF = Capital Recovery Factor
NPBP = Net Pay Back Period
v = Wind velocity
\[ T_i = \text{Temperature of Inner Side of Glass} \]

\[ T_w = \text{Temperature of Water} \]

**Declarations**

- **Ethical Approval**
  Not applicable

- **Consent to Participate**
  Not applicable

- **Consent to Publish**
  Not applicable

- **Authors Contributions**

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<th>No.</th>
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<td>1</td>
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- **Competing Interests**
  No competing interests

- **Availability of data and materials**
  Not applicable

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312  **References**


M. K. Gnanadason and P. Senthilkumar, “DESIGN AND PERFORMANCE ANALYSIS OF A VACUUM SINGLE BASIN SOLAR STILL”.


