A Cheap Automatic Solar Water Distiller

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ABSTRACT

The main objective of this study is to design and develop an efficient and cheaper solar-still, which can be used in Tsunami affected areas. The work reported here is concentrated on a solar still which would work automatically utilizing the capillary action of materials to pump water from reservoirs. Experiments were conducted to find the best wick material to use in the solar-still by considering the vertical absorption ability and the inclined transferability of various wick samples. The most efficient tilt angle was found by measuring the distillated output for different angles. The temperature variation of the cover glass plate, wick material and the atmosphere were also monitored in order to find the optimal time period of the day in which the solar-still can be used. Various water samples including Tsunami affected areas were purified and the conductivity, turbidity and pH values of the samples were measured before and after distillations in order to check whether the distillated water has achieved drinkable standards or not.

The handloom material used for wick had the best performance for vertical absorption ability since the wick has raised the water level up to 28 cm within the first hour. The same handloom material was found to be the best for inclined transferability as well as it showed 257 ml of water transfer for 36 degrees inclination. The most efficient tilt angle was found to be about 8.5^{o} for the fabricated solar-still. The efficiencies of the wick solar-still and the basin solar-still were calculated to be 33.8 % and 26.4 % respectively by considering the distillated output corresponding to the most efficient tilt angle. The optimal time period of the day was found to be 11.00 a.m. to 2.00 p.m. due to the maximum temperature gradient, between wick material (56 ºC) and the cover glass plate (42.8 ºC). The distilled water on analysis showed drinkable standards in turbidity, conductivity and pH values. The distilled output was found to improve when the wick was placed parallel to the cover glass plate than in the usual horizontal position.

1. INTRODUCTION

Solar energy has been the energy resource, most preferential by the general public for increased development and it could supply the majority of our energy needs. The solar energy has been used for many years in obtaining potable water by distillation from contaminated or brackish supplies. Solar distillation is a proven technology for water disinfections. Solar-still has proven to be highly effective in cleaning up water supplies to provide safe drinking water [1]. Concentrating collector, tilted multiple trays, tilted wick material and basin are the four major types of commonly used solar stills. Most commercial stills and water purification systems require electrical or other fossil fueled power sources but solar distillation technology produces the same safe quality drinking water as other distillation technologies [2]. The most important aspect in solar distillation is the removal of salts, heavy metals, microbiological organisms, pathogens and also this is a proven method to remove arsenic.

The major objective of the study was to design and to develop an efficient and cheaper wick type solar still which can be used in Tsunami affected areas. Various wick materials were tested and it was observed that handloom material give better results. The still-efficiencies were compared with respect to the best tilt angle since the model developed can be used either as a basin solar-still or a wick material solar-still. Various water samples were distilled and analyzed.

2. EXPERIMENTAL

The best wick material to be used in the solar-still was selected by checking the vertical absorption ability and the inclined transferability of ten wick samples such as handloom material, lamp wick, jute, wool etc. The solar still developed is shown in the figure 01 and the schematic diagram is shown in Figure 02. Wooden structure of the still was covered by Aluminum sheets and the top was covered by a transparent glass to reduce water vapour leakage, resulting in an air tight shallow basin which is blackened to improve the absorption of solar radiation.

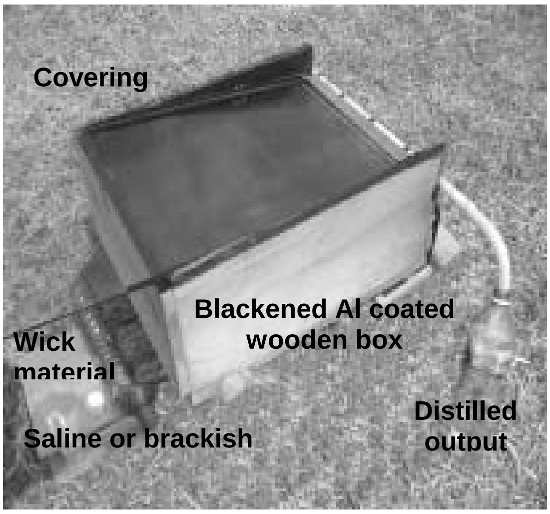

Figure 01:
Developed wick material Solar-Still

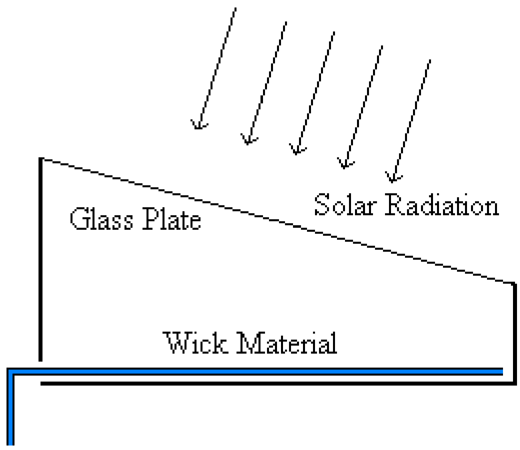

Figure 02: The Schematic illustration of Wick Material Solar-Still

Effective area, and weight of the solar-still and the covering glass thickness were 0.18 m^2, 7 kg, 0.5 cm respectively. The performance of the fabricated solar-still was tested by varying the tilt angle. Similar tests were conducted for the basin type solar-still in order to compare the efficiencies.

Still was kept in an open area, inclined to south – north to absorb solar radiation in an efficient way during the day time. Then, the output volume for different tilt angles was measured to compare the efficiency between the two types of solar stills. The temperature variation of the still was measured in order to optimize the performance. Various water samples were distilled and the conductivity, turbidity and pH values of the samples were measured before feeding and after distillation. Then, wick material was placed in parallel with the glass plate and the distilled output was monitored in order to observe any improvement of the performance.

3. RESULTS & DISCUSSION

According to the wick material tests, best-performed material for vertical absorption ability was the handloom material (thick sheet material) since it has raised the water level up to 28 cm within the first hour. Figure 03 gives the maximum vertical absorbed heights for well-performed five materials. Besides that the handloom material was found to be the best-material for inclined transferability as well as it transferred 257 ml for 36 degree inclination. Figure 04 gives the transferred volume as a function of tilt angle for well-performed five materials.

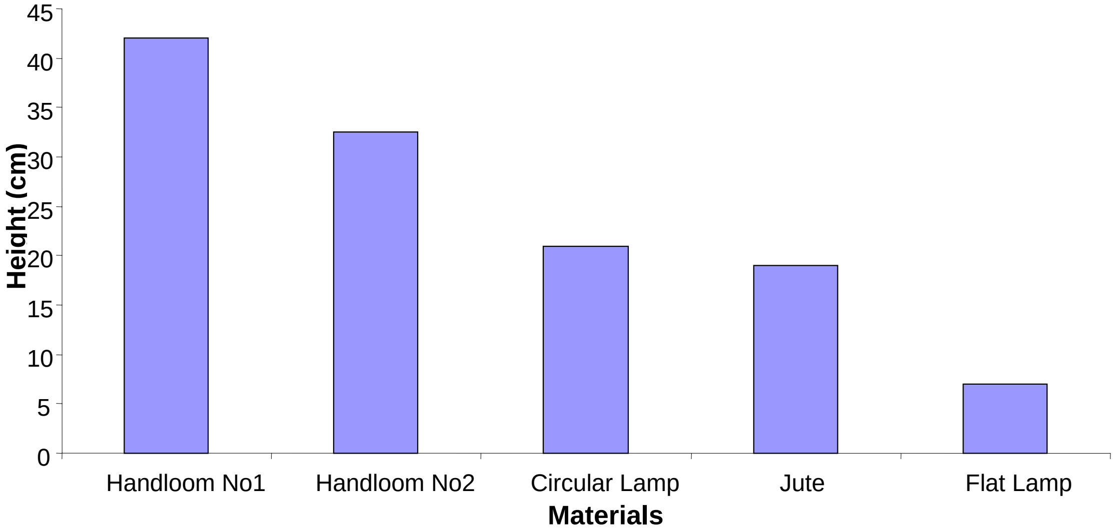

Figure 03: Maximum vertical absorbed heights for various materials

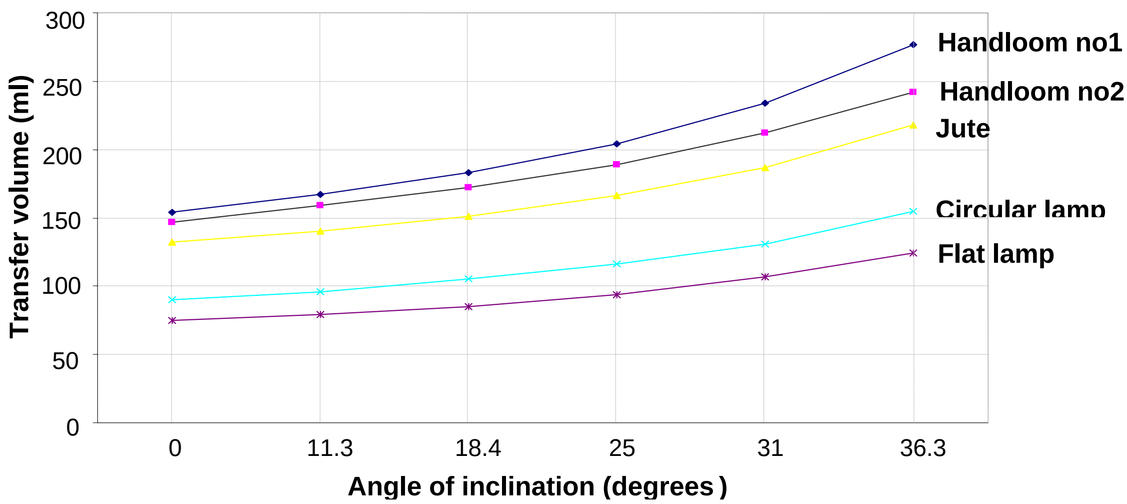

Figure 04: Transferred volume for different angles for various materials

Best efficiencies of our solar still and the commonly used basin solar still were 33.8 % and 26.4 % respectively. Although sufficient evaporation and condensation take place, the output volume was very low for lower tilt angles since the angle was insufficient for all the water drops to glide down to the collecting channel and hence some water drops fall back to the wick material or to the basin. Table 01 gives the output volume for various tilt angles and figure 05 gives the same result in a graphical form the optimum angle at which more distillation occurs was found to be about 8.5^{o}. When the tilt angle exceeds this value, output volume was found to decrease due to the increase in the air spacing between the glass plate and the wick material causing insufficient condensation of water vapour.

Table 01: Distilled output volume for different tilt angles, for both stills

Tilt angle(deg)	Basin solar still(ml)	Wick material solar still(ml)
1.72	9.8	14.3
2.86	28.7	31.7
4.00	43.2	48.9
5.14	54.7	67.3
6.28	73.8	92.5
7.41	84.6	103.9
8.53	123.5	157.8
9.65	85.2	105.4
10.79	75.4	100.7

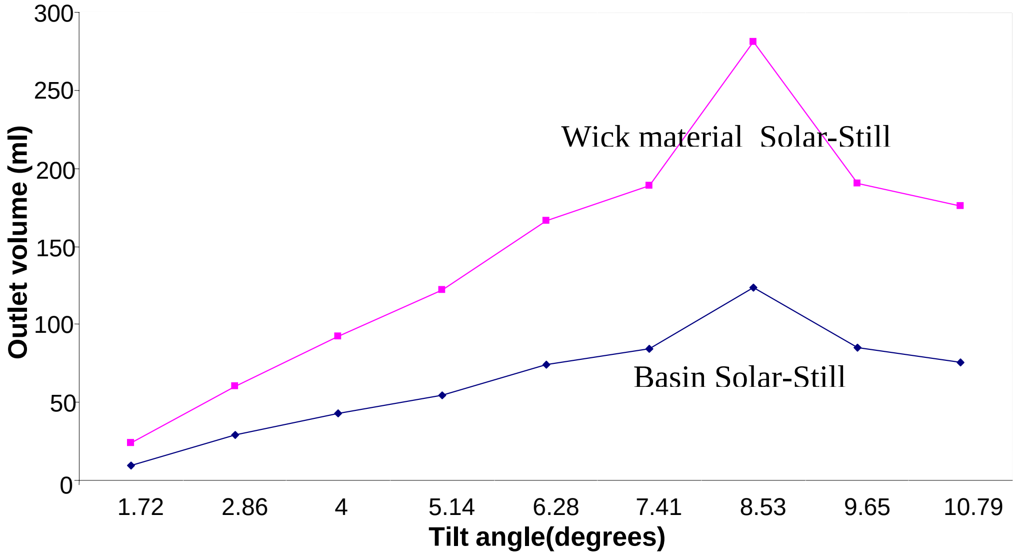

Figure 05: Outlet volume for different tilt angles, for both stills

The period for obtaining maximum output of distilled water was found to be 11.00 a.m. to 2.00 pm due to the maximum temperature gradient, between wick material (56 ºC) and the glass plate (42.8 ºC). During the period from 6.00 a.m. to 2.00 p.m., the temperature of the entire system continuously increased due to the exposure to solar radiation. However, in the late afternoon, the temperature started to decrease but the decrease was not very significant due to the trapped IR radiation as the solar still acts as a green house.

Various water samples were distilled and analyzed before and after feeding into the still. The turbidity, conductivity and pH values of all the water tested were found to reach the drinkable standards. When the wick material was placed in parallel with the glass plate the output volume was measured to be 168.2 ml whereas this volume was only 157.8 ml when the wick was placed horizontally indicating that the former arrangement is more efficient.

All the tests were conducted with same bright, sunny conditions to avoid the deviations due to the variation of solar radiation. In general, solar-stills are mostly suited to operate in equatorial countries due to the availability of solar radiation through out the year. Efficiency variation of the still, due to climate changes is a significant problem. To avoid salt building on the wick material, perfect maintenance is necessary. Condensed water drops act as lenses and concentrate solar radiation to the wick material and hence, cloth burning dots will appear and durability of the wick material will be reduced. Utilizing solar energy is the major advantage of the still and auto water pumping ability of the wick material is also an advantage. The absences of movable parts, more economical and environmental friendly nature are the other advantages of the new model.

4. CONCLUSIONS

Of the various cheap materials tested the handloom material was found to raise water efficiently. Basin and wick type solar stills were designed and constructed employing this handloom material to raise water from the reservoir and their performances were compared. Tests have shown that the wick type solar-still is more efficient having an optimum performance at the tilt angle of 8.5^{o}. The distilled amount can be improved by having the wick parallel to the cover glass plate rather than in the usual horizontal position.

REFERENCES

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