EFFECT OF GLASS THICKNESS ON SOLAR STILL PERFORMANCE

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ABSTRACT

In this research paper, a conventional basin solar still for production of domestic drinking water using Bauchi climatic conditions (10.23°N, 9.84°E) is evaluated. The single glass cover basin solar still has a collector area of 0.9m^2 and water holding capacity of 20 litres. Performance evaluation of the system using two identical size glass cover thickness of 4mm and 6mm in the Harmattan period shows that 4mm glass cover thickness increases the distillate water output, basin water temperature as well as efficiency of the solar still compared to 6mm glass cover thickness. The model produces 1.60 and 1.55 litres of pure water from brackish water using the 4mm and 6mm glass cover thicknesses respectively.

Keywords: Basin Solar still, Distillate Output, Glass Cover Thickness, Harmattan.

INTRODUCTION

The use of conventional energy for water purification is expensive and has environmental concerns. Water is the basic necessity for human along with food and air. Solar energy is one of the energy resources, most preferential by the general public for increased development because of its availability and environmental friendliness and is capable of supplying 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 (Ihalawela and Careem, 2007).

The use of solar stills has been proven to remove pathogens, heavy metals and reduce salinity and thus, a point-of-use technology for water purification. Despite its relatively cheapness of this simple technology in providing potable water, its shortcoming is that of having on average only 30% efficient and require $2m^2$ to provide for one person's daily needs. The solar stills have often been used in the tropics where there is abundant supply of solar energy (Spiegler, 1977).

Essentially, the solar still consists of a black-lined shallow basin of saline water enclosed by a transparent glazing cover that allows solar radiation passes through the transparent glazing cover and is absorbed by the brine and the black basin liner. The system is tilted appropriately. This radiation is changed to heat by absorption, which serves to warm the brine. The warm brine partly evaporates and humidifies the air above the surface, thereby reducing the density of the air and causing it to circulate upward (Marwah and Abdul, 2013).

The moving air comes in contact with inner surface of the relatively cool transparent cover, and part of the humidity condenses thereon. The liquid condensate forms a film and flows to the base of the cover, from where it drips into the condensate trough and is conducted to the outside of the enclosure. The cooled air returns to the surface of the warm water to repeat the process of humidification. The circulation of air is thus due entirely to free convection (Velmurugan *et al.,* (2006), Zeinab and Ashraf, 2007).

Many adaptations have been made to the solar still design to improve the efficiency, however not so much attention has been given to mirror reflection. This study investigates the effect of glass thickness on the performance of a conventional solar still for the production of potable drinking water.

MATERIALS AND METHODS

The solar still developed is shown in Figure 1 and the sketch of the frame is shown in Figure 2. The expected daily amount of distilled water is 2.05 litres base on the average solar intensity of Bauchi state (550W/m^2), overall efficiency of 30% and aperture area of the solar still. The outside wooden structure of the solar still is painted dark brown proper wood preservation. 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 as recommended by (Akash and Nayfeh (2000), Al-Hinai *et al.*, (2002) and Al-Hayek and Badran, 2004. The bottom part of solar still is proper insulated using 50mm saw-dust thickness to prevent back heat transfer losses. To minimise leakages between the glazing top and the solar still, a rubber gasket is provided. The water distillate output from the solar still was collected through a channel that was fixed at the end of small vertical side of basin and a plastic pipe then provided to drain distillate water to a container graduated as a measuring jar. Effective area of the solar-still and the covering glass thickness were 0.9m^2 and 0.4 cm respectively. The system performance of the fabricated solar-still was tested in the month of December, 2016 in Bauchi state. The solar still was kept in an open area, inclined to the collector tilt of Bauchi to absorb maximum solar radiation during the day time from 9am to 5pm. The temperature variation of the water in the solar still basin, ambient temperature and volume of water condensate collected were measured for five consecutive days and the

average results presented.

Figure 1: The Solar Still

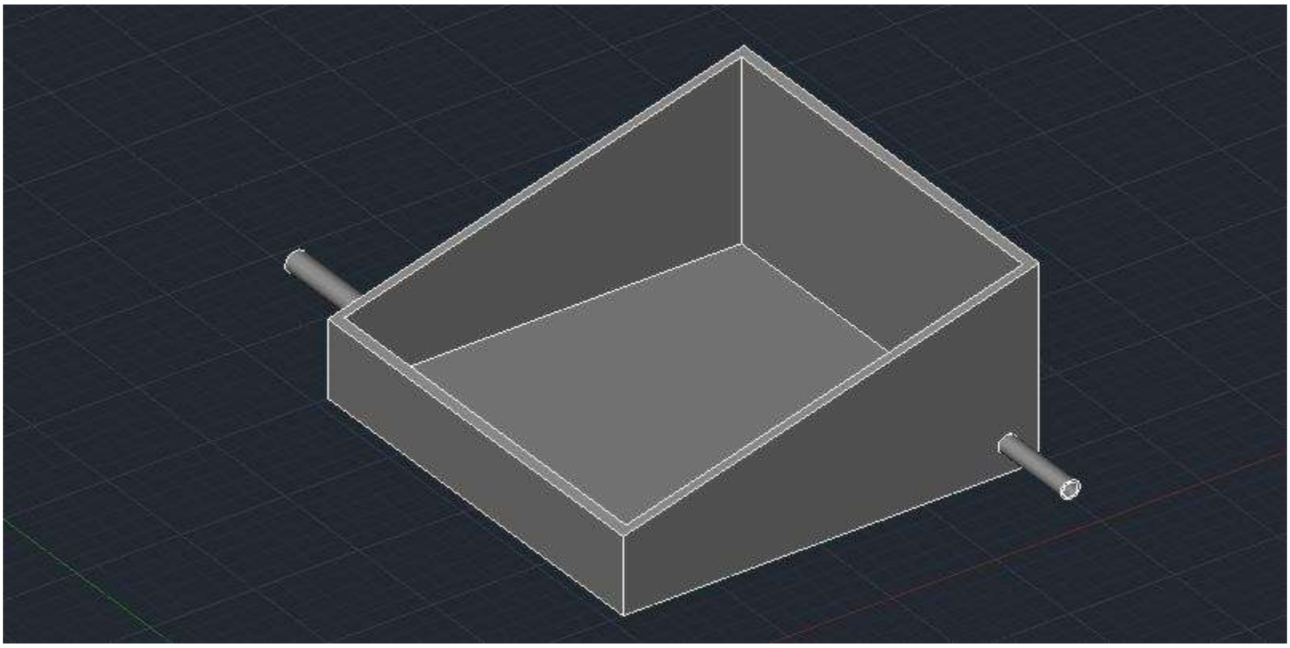

Figure 2: The solar still frame

All experiments started from 8 am morning to 5 pm evening on each day. The basin water temperature and ambient temperature were measured on hourly basis while the distillate output was measured at the end of each day.

RESULTS AND DISCUSSION

The averaged solar intensity for the system is shown in figure 3 clearly indicating the peak solar intensity during experimentation at 13:00 hours. Figures 4 and 5 shows the graph of ambient and water basin temperatures against the time of the day for 4mm and 6mm glass cover thickness respectively while figure 6 shows the comparison between the basin water temperature for 4mm and 6mm glass cover thicknesses. Figure 4 shows that, 4mm glass cover thickness increases basin water temperature, Tw, compared with 6mm glass cover thickness of the solar still. For both glass cover thicknesses, the system attains its maximum basin water and ambient temperatures of 53 and 34°C respectively at 13:00 hours for 4mm glass cover thickness and 51 and 35°C for 6mm glass cover thickness corresponding to the time period for solar radiation peak. Evaporation of water which is a fundamental factor in solar still is dependent on the thermal energy obtain from absorb solar energy by the system. The variation in basin water temperatures, Tw, between the glass cover thicknesses is as a result of the differences in the evaporative heat transfer coefficient which is more for 4mm glass cover compared to 6mm and is agreement with the earlier works of Hitesh and Shah (2011). The model produces 1.6 litres and 1.55 litres of pure water from brackish water obtained from a well using the 4mm and 6mm glass cover thicknesses for 8 hours during the harmattan period.

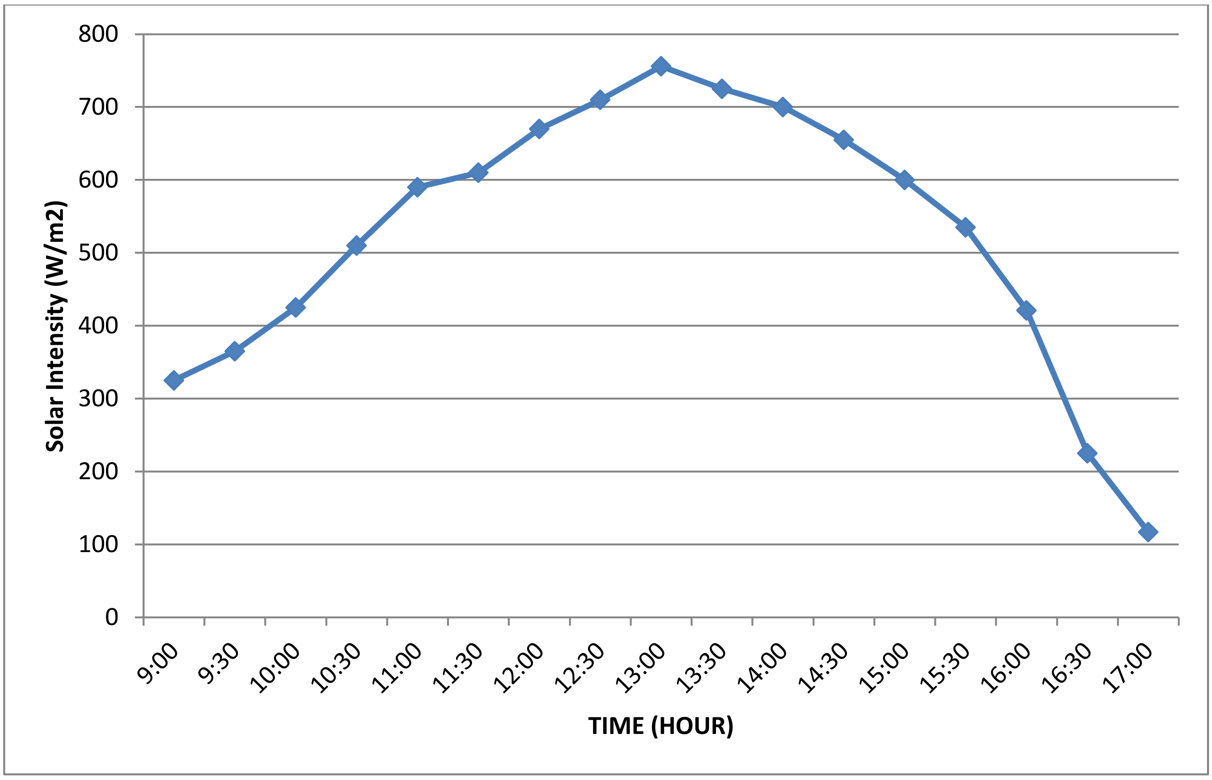

Figure 3: Variation of Solar Intensity with Time of the Day.

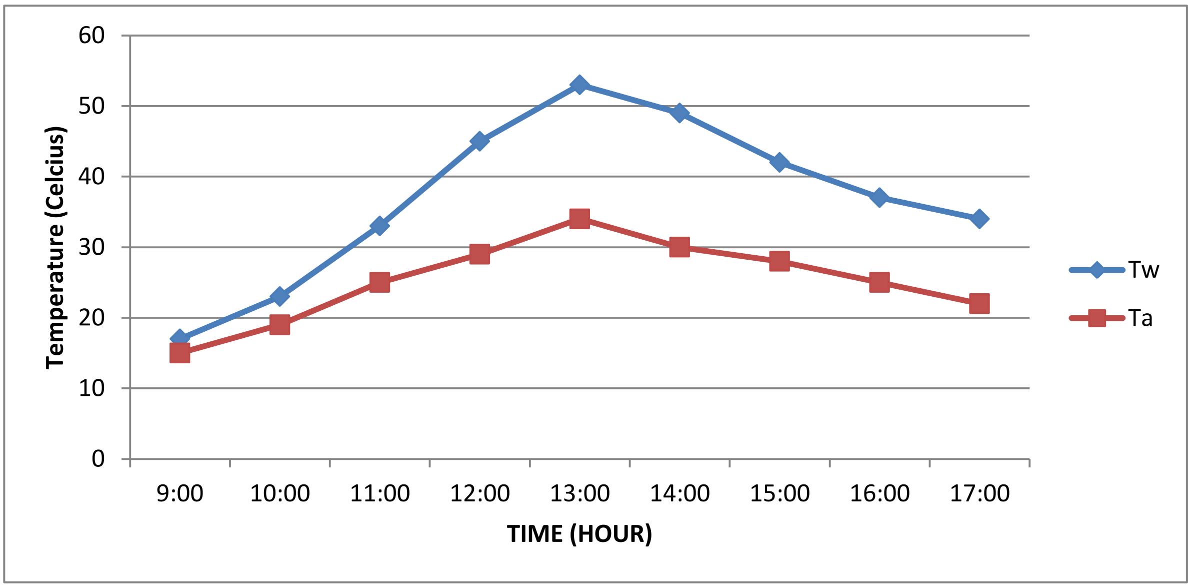

Figure 4: Effect of 4mm Glass Cover Thickness on Water Temperature of Solar Still

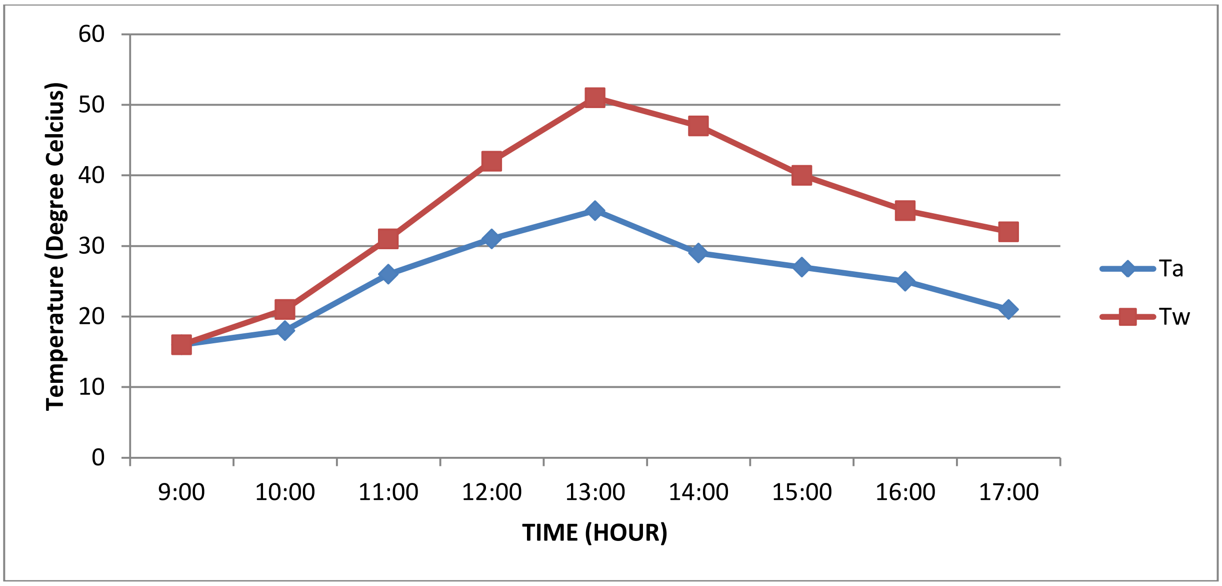

Figure 5: Effect of 6mm Glass Cover Thickness on Water Temperature of Solar Still

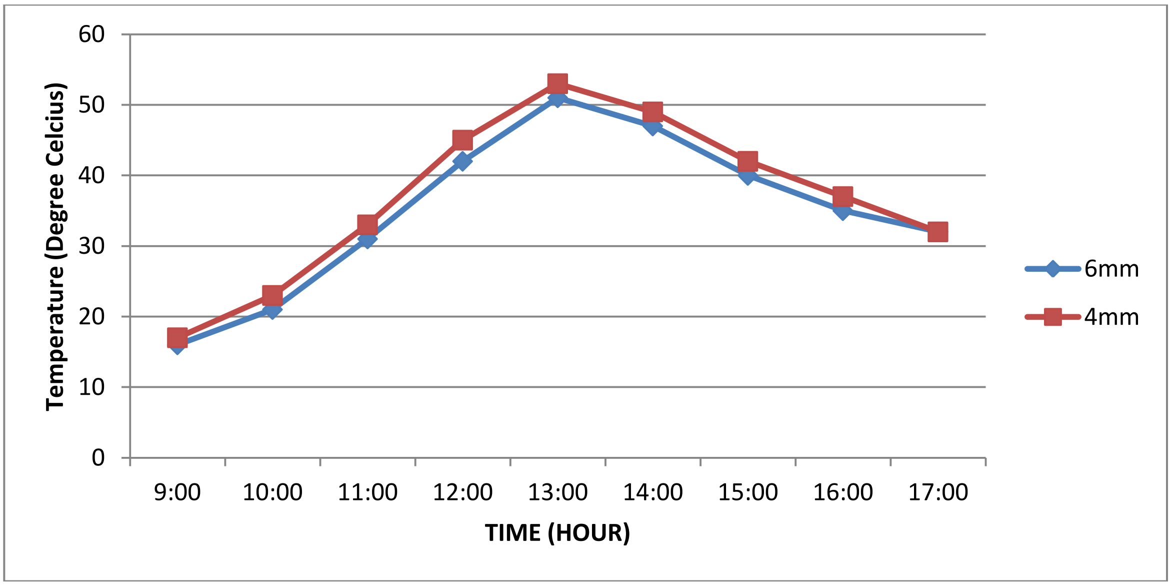

Figure 6: Effect of Varying Glass Covers Thickness on Water Temperature of Solar Still

CONCLUSION

Pure water for small families can be obtained through the use of appropriate solar technology at a relative cheaper rate. Increase in temperature increases the rate of evaporation and thus, 4mm glass cover thickness is preferable over 6mm glass cover.

It is recommended that other parameters such as wind speed, back and edge heat losses, collector tilt could be investigated to ascertain their effect and sensitivity on the system overall performance.

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