

Augmentation of Double Slope Basin Solar Still by Using Different New Absorber Materials

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ABSTRACT: To obtain clean drinking water is major problem for most developing countries. In most cases, ponds, wells, rivers and sea water are often polluted that they are unsafe for direct use as drinking water. The solar desalination method is one of the distillation method, which uses sun energy to convert saline Water in to potable water. In this work, the daily efficiency and distillate productivity of a double slope single basin solar still was enhanced by testing it with new different absorber material configurations.

KEYWORDS: Absorber plate, Material, Basin solar still, Daily efficiency, Productivity

I. INTRODUCTION

Solar distillation has the advantage of cost saving over other types of distillation such as reverse osmosis, because solar energy is limitless and easily available and likewise seawater is readily available, there is an abundance of these sources. Solar distillation has proved to be highly effective in cleaning up water supplies to provide safe drinking water. As energy requirement to produce 1 liter (i.e. 1kg since the density of water is 1kg/liter) of pure water by distilling brackish water requires a heat input of 2260kJ. Distillation considered only where there is no local source of fresh water. In order to evaporate 1 kg of water at a temperature of 30°C about 2.4×10^6 J is required. Assuming an insolation of 250 W/m², averaged over 24 h, this energy could evaporate a maximum of 9 L/m²/day. In practice, heat losses will occur and the average daily yield, which might expected from a solar still, is 4–5 L/m²/day. Today's state-of-the-art single-effect solar stills have an efficiency of about 30–40%..

II. LITERATURE REVIEW

Various researchers modified the design of single basin solar stills to improve its productivity. Based on the design, basin solar stills can be further classified as:

- Double slope basin solar still
- Triple basin solar still
- Inverted multi basin solar still
- Spherical solar still

International Journal of Innovative Research in Science, Engineering and Technology

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- Pyramid solar still
- Tubular still

2.1 Double slope basin solar still

Murugavel *et al.* (2008) designed a single basin double slope simulation solar still as shown in Figure 2.1. Here; the distillate was collected from the two slopes of the glass.

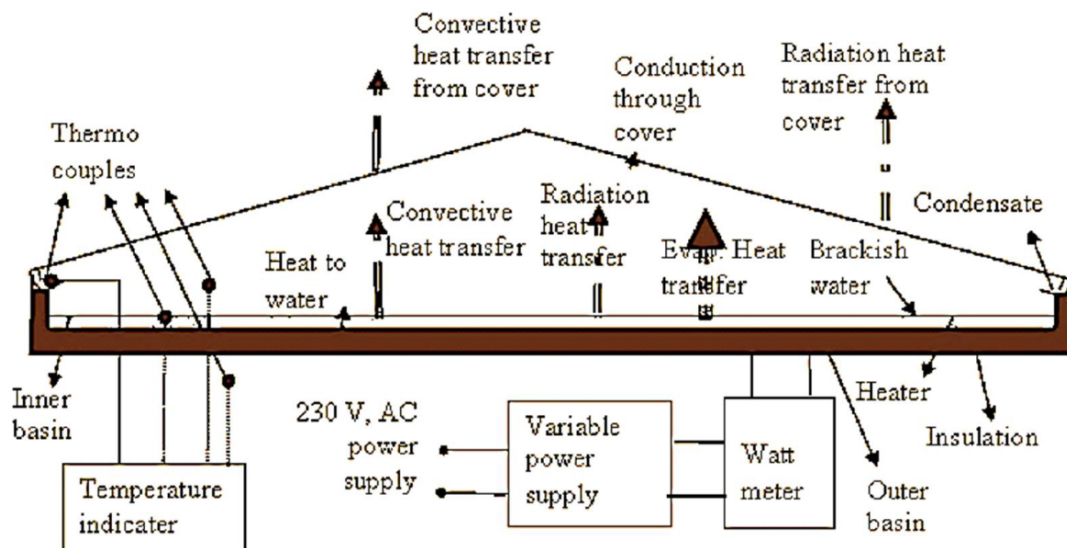


Figure 2.1 Single basin double slope simulation still

2.2 Triple basin solar still

Sebaili *et al.* (2005) constructed triple basin still consists of two glass sheets fixed in between the basin liner and the glass cover of a single-basin still as shown in Figure 2.2.

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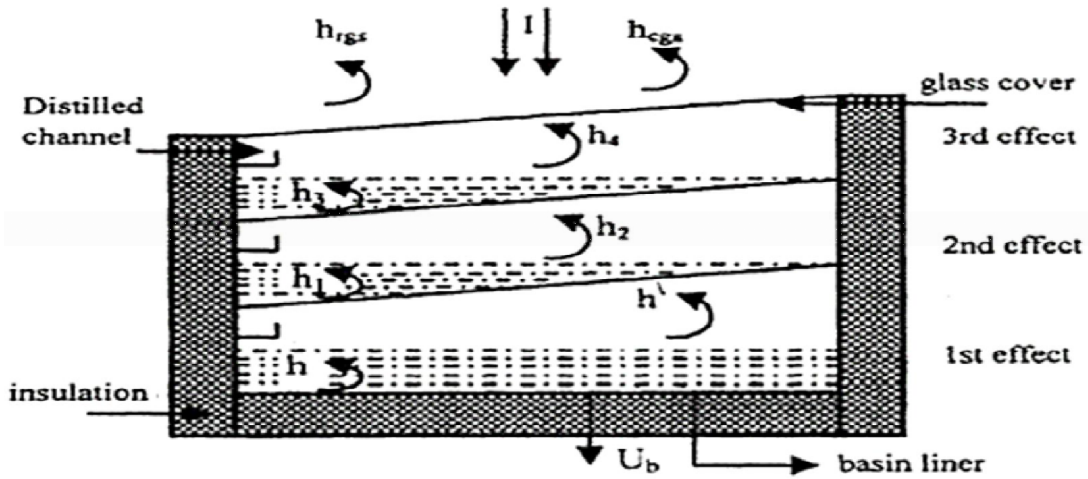


Figure 2.2 Triple basin solar still

2.3 Inverted multi basin solar still

Suneja & Tiwari (1999) designed an inverted absorber multi basin solar still to increase the water temperature and to reduce the bottom heat loss as shown in Figure 2.3.

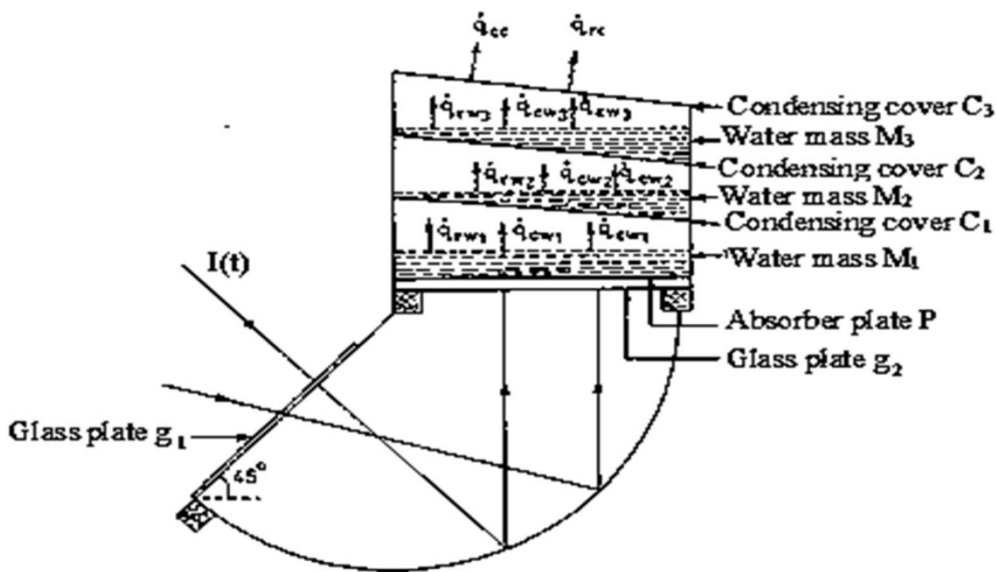


Figure 2.3 Inverted absorber multi basin solar still

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2.4 Spherical solar still

Jayaprakash *et al.* (2009) designed a simple spherical solar still with low thermal capacity, light weight, cheap cost, and ease operation as shown in Figure 2.4.

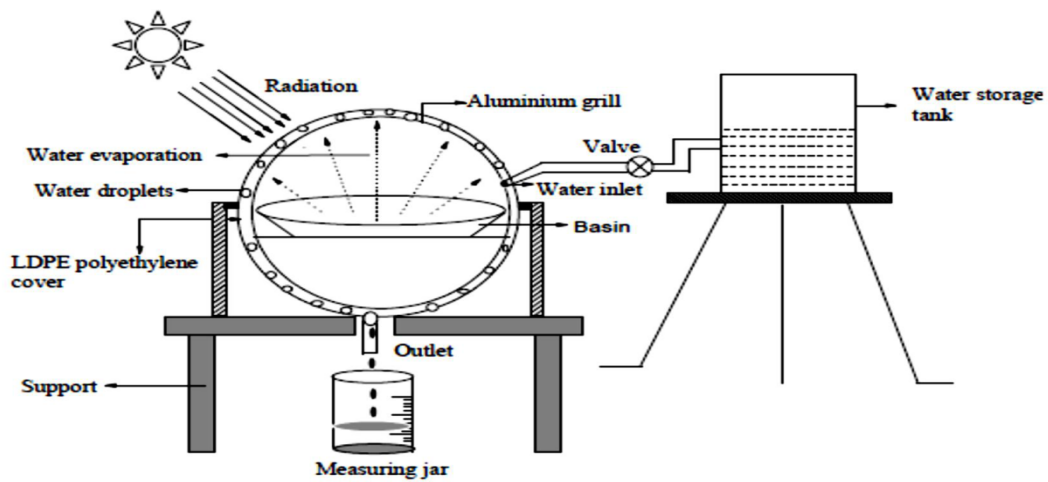


Figure 2.4 Spherical solar still

2.5 Pyramid solar still

Kabeel *et al.* (2009) designed a pyramid solar still, framed with concave wick surface as shown in Figure



Figure 2.5 Pyramid-shaped solar still

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2.6 Tubular solar still

Tiwari & Kumar (1988) designed a tubular solar still, which possesses a rectangular black metallic tray kept at a cylindrical glass tube as shown in Figure 2.6.

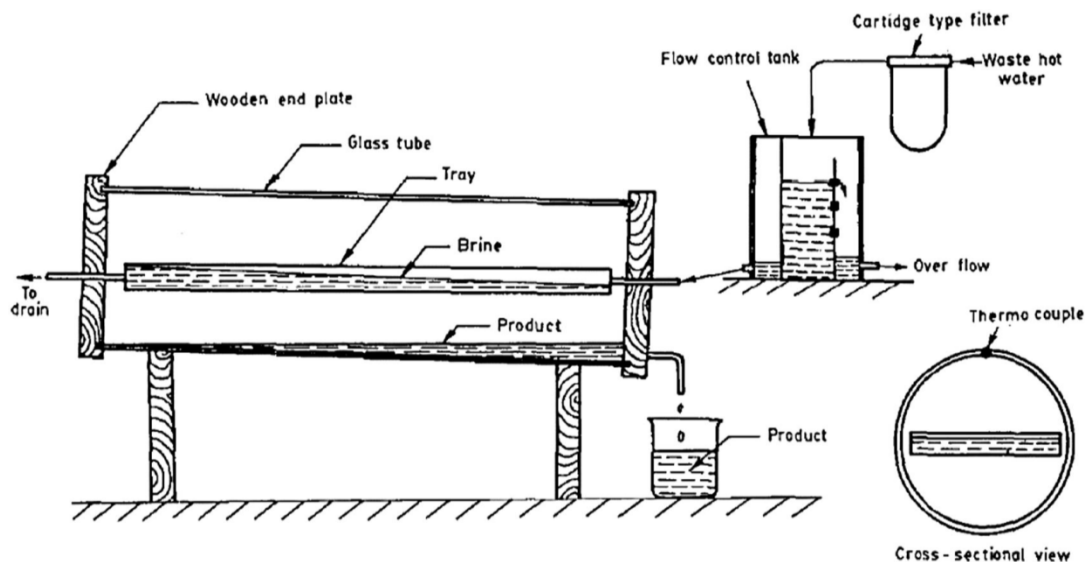


Figure 2.6 Tubular solar still

III EXPERIMENTAL SET UP AND PROCEDURE

In this work, an inclined double slope basin solar still has been fabricated which is made up of mild steel and tested at 30° inclination. Mild steel sheet is used for the construction because of better resistance to corrosion in low and medium temperatures, low weight and easy formation. The stills consist of flat absorber plate covered with the inclined glass on the top with an air gap of about 2.5 cm that creates an enclosure. Surveys reveal that the optimum inclination through the year is nearly equal to the location latitude. This optimum angle is about 30°. Absorber plate is painted with matte black paint to increase the absorptivity. Feed water is heated by solar energy. The water evaporates and condensed on the inner side of the glass cover after releasing the latent heat. Distilled water is conducted to the collection channel and concentrated feed water is taken out from the outlet at the lower end of the still. Bottom and side walls of the still are well insulated in order to decrease heat loss. The total dimensions of the double slope still basin were 1 × 1 × 0.15 m made up of mild steel. The inclined desalination system consists of a flat absorber plate made up of 3 mm thick mild steel plate, a rectangular stepped & cascade absorber plate made up of 3 mm thick mild steel plate, 3mm glass cover, condensate channel, distribution pipe, and insulated water tanks with thermocol. The dimensions of the basin solar still were 0.9 × 0.8 × 0.65 m made up of mild steel. The basin still also consists of a flat absorber plate made up of 3mm thick mild steel plate, 3mm glass cover, condensate channel, with thermocol insulation. A copper absorber material is also used instead of the mild steel plate to improve the daytime productivity. The various properties of the absorber materials is given in Table 3.1. Fig 3.1 shows the schematic of experimental set up

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Absorber Material	Density (kg/m ³)	Specific heat (kJ/kg k)	Thermal conductivity (W/mk)
Mild steel	7833	0.51	54
Copper	8960	0.92	413

Table 3.1 Properties of various absorber materials used in the still



Figure 3.1 Schematic of double slope single basin solar still

IV. RESULTS AND DISCUSSION

4.1 Variation of different temperatures with global radiation in various absorber plates.

The experimentation begins with flat absorber plate on. Figure 4.1 a and 4.1 b show the variation of different temperatures and global radiation variation with respect to local time during the experimental days for mid steel and copper absorber plates respectively.

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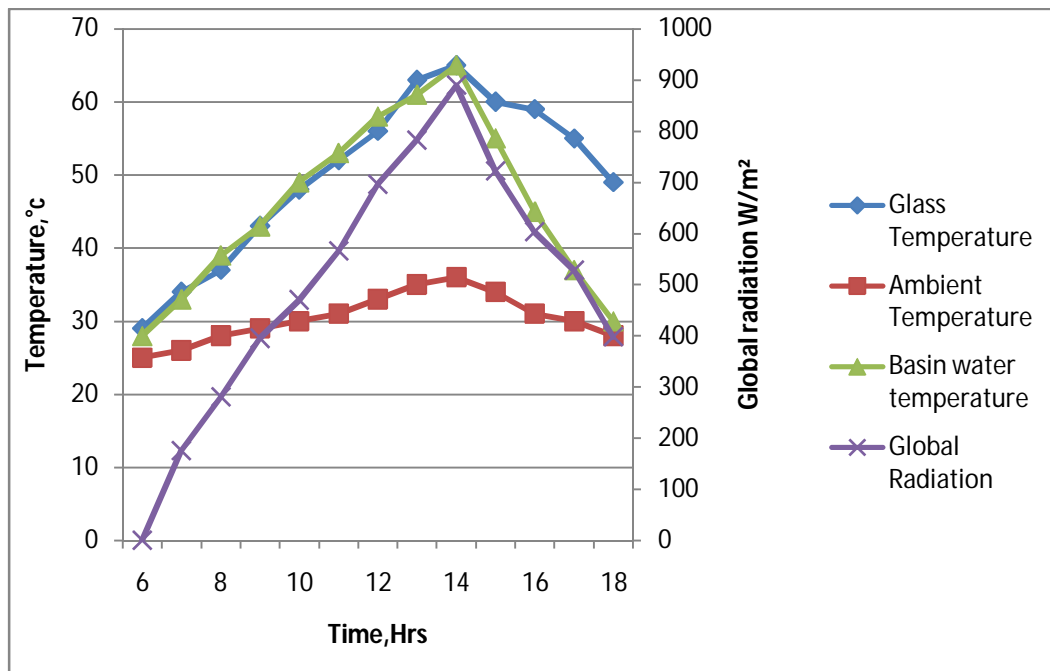


Fig 4.1 a Variation of different temperatures with global radiation (mild steel absorber)

Figure 4.2 shows the variation of different temperature and global radiation variation with respect to local time during the experimental of copper absorber plate.

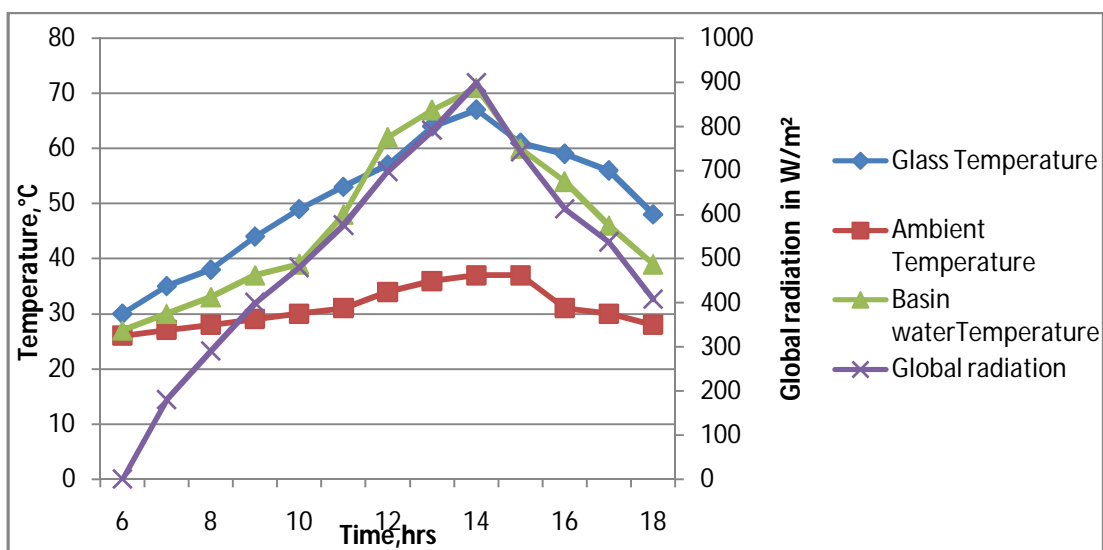


Fig 4.1b) Variation of different temperatures with global radiation (copper absorber)

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4.2 Variation of productivity with time in flat absorber plate:

Figure 4.2 a shows the variation of productivity with respect to local time during the experimental of mild steel absorber plate. The highest productivity of 440 ml occurs at 2.00 p.m for flat absorber.

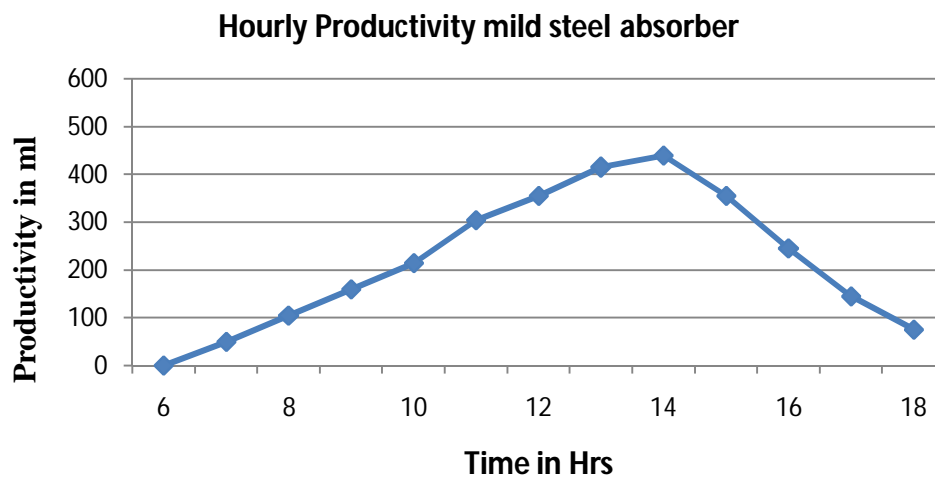
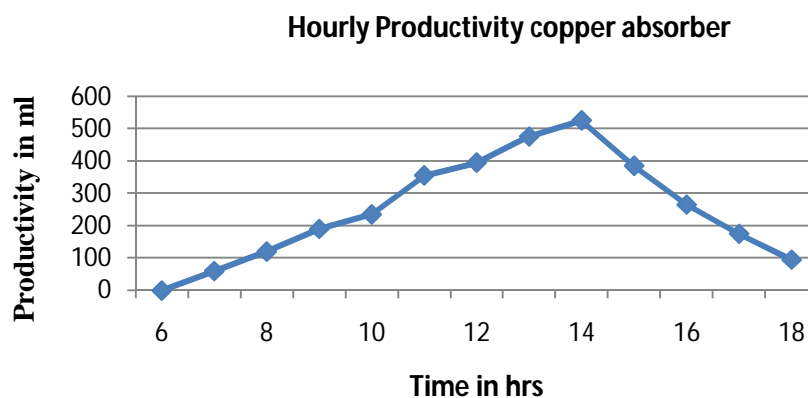


Figure 4.2 b shows the variation of productivity with respect to local time during the experimental of copper absorber plate. The highest productivity of 525 ml occurs at 2.00 p.m for flat absorber.



V. CONCLUSION

In this work, a performance study was made on different absorber plates. Also, the performance of a double slope single basin type solar still was experimentally investigated with various absorber materials (mild steel absorber and copper absorber). Based on this experimental study, copper absorber was found to be the best absorber material for the solar desalination application due to its high thermal conductivity and specific heat capacity. A comparative study was made for different absorber conditions used in the inclined solar still. The result indicates that the total production rate was increased by 19.3%, when copper absorber was used instead of mild steel absorber.

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Vol. 8, Issue 3, March 2019

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