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Comparison on Single Basin Double Slope Glass Passive and Active Solar Still with Different Depths of Water Layer

MD NIZAMUDDIN ANSARI

Department of Mechanical Engineering, Crescent College of Technology, Bhopal-462038, India.
*Corresponding author E-mail: engg.nizam26@gmail.com

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ABSTRACT

Two major challenges for human society today are shortage of fresh water and shortage of conventional energy. Solar still is the best method to convert saline, brackish water into fresh water using the unconventional source of energy which is freely and abundantly available in planet of earth. In this work effect of water depth on the single basin and double slope glass passive and active solar still was studied. A solar collector is connected with solar still to convert the passive still into active still. Both set up was fabricated from a transparent glass. The study covers the influence of water depth of 1 cm, 2 cm and 3 cm in the still productivity on both set -up. The results stated that distilled water collection is higher for lower depth of 1 cm either Passive or Active solar still. Also concluded that Active solar still gives more productivity as comparison to passive solar still.

Keywords: Solar still, Solar collector, Water depth, Productivity.

INTRODUCTION

Need of pure water is important in day-to-day life. The availability of drinking water per capita is shrinking because of population growth. The possible water sources are the rainwater, bore wells and river or lake water. This surface water must be purified for human consumption. This may involve removal of dissolved substances and harmful bacteria. Popular and generally used methods are filtering with sand which only removes un dissolved material while chlorination and boiling kill harmful bacteria only.

Solar desalination represents the most prominent and economical method especially when used in villages areas where sunlight is abundant. It is an eco friendly technology which can open up new purified water sources and contributes efficiently in the sustainable development of villages and urban areas as well. Generally the solar still are selected due to their simplicity in construction. No need of regular maintenance and no need of skilled person for operation. So, little operational and maintenance cost.

Hossen Taghvai and Hamed Taghvaei[1] studied various water depth on the still productivity. Ali. F.Muftah and M.A.Alghoul[2] reviewed that water depth is an important design factor in the distillation process. T. Rajaseenivasan and K. Kalidasa Murugavel[3] worked on single and double basin solar still and showed that productivity is varied by various water depth. Jianyin Xiong and Guo Xie[4] stated that still can produce yield not only in a day, but also in the night time. M.T Chaibi[5] reviewed solar desalination performance in irrigation for rural arid areas. T. Rajaseenivasan and K. Kalidasa Murugavel[6] reviewed different methods to improve the productivity in solar still. P.V. Kumar[7-8] reviewed different solar still designs in terms of passive and active solar stills. A. K. Kaviti[9] presented the detailed review on inclined solar stills to enhance the productivity.

System Description

A single basin double slope solar still has been fabricated with transparent glass as shown in Fig.1 and Fig. 2. The dimensions of both the solar stills are (1m x 0.5m x 0.1m). The thickness of the side glasses and bottom glasses are 8 mm and the upper slope glasses are 3.5 mm and at this depth a slope of 15^0 was given. All sides are made with same material. The bottom surface was coated with black paint. The solar still was insulated so that the heat dissipation could not take place to the surrounding.

A flat plate solar collector is also added with Passive still to make it Active solar still which is fabricated through Galvanized iron sheet whose thickness was 2.5 mm. and its inner surface is painted with black colour. The upper surface is covered with transparent glass. It is rectangular in shape whose dimensions are (30cm x 15cm x 10cm). A copper tube is circulated with snake shape through which water is circulated. All surfaces of the collector are covered with thermocol insulation except top surfaces. At top surface glass is used.

The condensed water is collected in the V-shaped drainage provided below the glass lower edge on both sides. The condensate collected on both side of the still is continuously drained through flexible hose and stored in the bottle. A hole in the basin side wall allowed inserting the thermo-couples for the measurement of the basin water, still, condensate temperature, and water level temperature. The hole is closed with insulating material to avoid the heat and vapour loss. Another hole is provided for water inlet. A small pipe is inserted through this hole to supply saline water continuously to the basin from storage tank through a flow regulator. And in case of Active solar still its outlet, solar collectors inlet is connected and at its outlet, still inlet port is connected, thus the mass of water in the basin always kept constant. But in the passive solar still there is no need of solar collector. Observations are recorded for 8 hrs duration starting from 10 a.m.to 5 p.m. The temperature of the atmosphere, basin water and the condensate are noted for every 1hr. The temperature reading and condensate water collected on both side of the still are also noted.

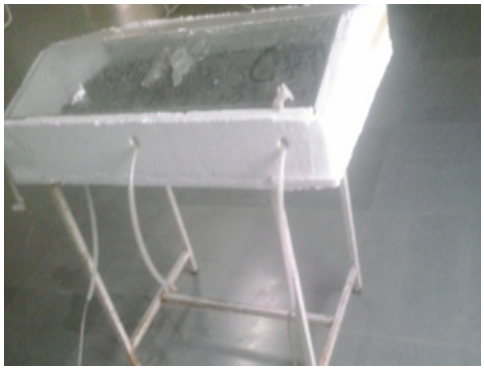

Fig.1: Experimental Setup of double slope glass Passive Solar still

Fig. 2: Experimental Setup of double slope glass active solar still

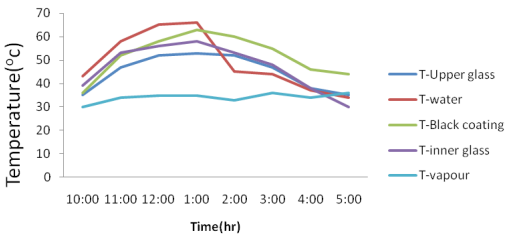

Fig. 3: Variation of temperature with time when water level 1 cm

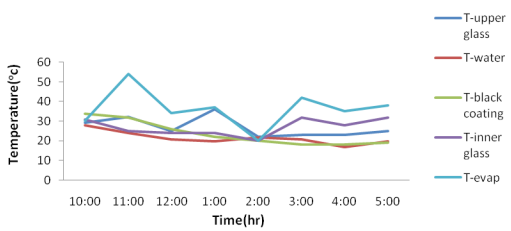

Fig. 4: Variation of temperature with time when water level 2 cm

EXPERIMENTAL PROCEDURE

Experiments on double slope solar still with various depth of water such as 1 cm, 2 cm and 3 cm was done on the month of October 2015 through Active and Passive solar still. It was done for 8 hours in a day from 10:00 am to 05:00 pm. Solar intensity variation is uncertain for each day and experiment was done on these days where the sun was fair so that the results made worthy of comparison. Solar still was placed in glass facing East-West direction.

The various measured parameters such as glass temperature, water temperature, absorber temperature; vapour temperature was measured by using K-type thermocouples through temperature indicator device. All the parameters and amount of condensate water production was noted for every day in both the stills.

RESULT AND DISCUSSION

The effect of depth of water with Passive solar still

Fig. 3 Indicates the variation in temperatures at different positions in the still when 1 cm depth of water present in the still. It is clear that First day all temperatures are increasing till 1pm and attained maximum values of water temperature (T-water), Black coating temperature (T-black coating), inner glass temperature (T-inner glass) at 1pm. As shown in Figure. After that the temperature start decreasing till the end of measurement. In Fig.3 and Fig. 4, first all temperatures start decreases till 1:00 – 2:00 pm after that they start increasing and then decreases till the end of measurements. Second and third day, sun started with high intensity and there was sudden change in the climate for first half day.

The effect of depth of water with Active solar still

Fig.6. Illustrates the variation in temperatures at different positions in the still when 1 cm depth of water layer present in the still. It is clear that at all temperatures are increasing till 1pm and attained maximum values of water temperature (T-water), inner glass temperature (T-inner glass), black coating surface temperature (T-black surface) at 1pm. Then values start decreasing till the end of measurement. Similar observations were found in Fig.7 also. In Fig. 8, first all temperatures start decreased till 1:00 pm then they remain almost steady till the end of measurements. On the observed day for fig.8, sun started with high intensity and there was sudden change in the climate for first half day.

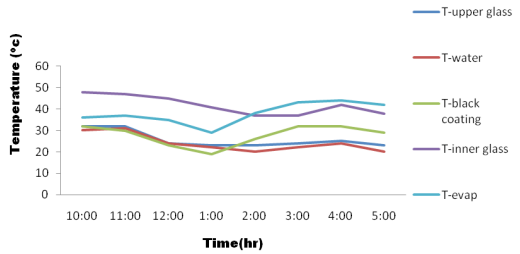

Fig. 5: Variation of temperature with time when water level 3 cm

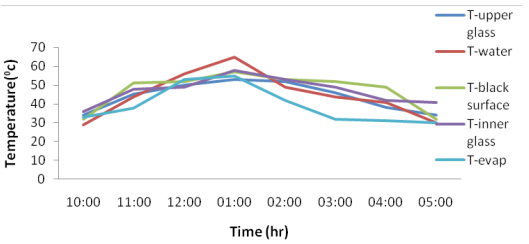

Fig. 6: Variation of temperature with time when water level 1 cm

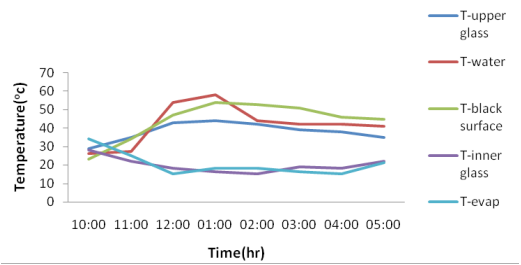

Fig. 7: Variation of temperature with time when water level 2 cm

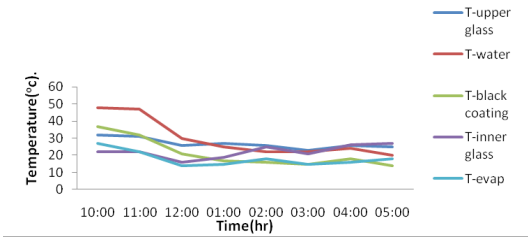

Fig. 8: Variation of temperature with time when water level 3 cm

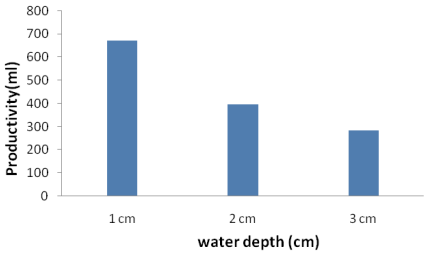

Fig. 9: Cumulative productivity for various water depths with Passive solar still

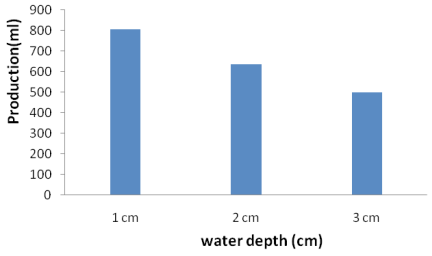

Fig. 10: Cumulative productivity for various water depths with Active solar still

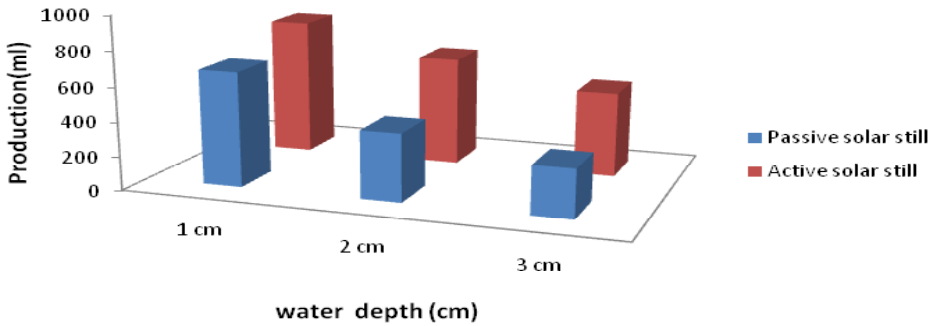

Fig. 11: Cumulative productivity for various water depths with Active solar still

Comparison of Cumulative collections for various depths

Cumulative production is the total amount of production for a period of 8 hours Calculated from the Fig.9 (Passive Solar still) and Fig.10 (Active Solar still.)

Comparison of cumulative collection for various depth of water with Passive and Active solar still.'

It is clear from the above Figures that total productivity is higher at 1 cm and lesser at 3 cm for the period of 8 hours (from 10:00 am to 5:00 pm).Variations in the cumulative production was compared with the different water depth in the still. Rate of evaporation varies due to variation in the amount of water in the still and due to this; cumulative production becomes different in each case. It is also observed that cumulative production is higher with the Active Solar Still as comparison to Passive Solar Still at different water depth.

CONCLUSION

In this work a double slope single basin Passive and Active type of solar still with basin area of 0.5 m^2(100cm x 50cm) and flat plate solar collector area of 0.045 m^2 (30 cm x 15 cm) are fabricated and used in this analysis. Performance of the Passive and Active solar still is compared for different depths of water ist is found that the distilled water productivity is increased by 20.00% through Active solar still. It is also concluded that with the increase in depth of water, distilled water collection decreases. So, best distillate is observed at 1 cm depth of water.

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