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EXPERIMENTAL STUDY ON THE PRODUCTIVITY FOR DIFFERENT WATER DEPTH VARIATION – SOLAR STILLS

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Abstract - *Shortage of good, clean drinking water is a major problem for most developing countries in the world. In most cases, ponds, streams, wells and rivers are often polluted that they are unsafe for direct use as drinking water. Often water sources are brackish and contain harmful bacteria, therefore cannot be used for drinking. Solar distillation is one of the important methods of utilizing solar energy for the supply of portable water to small communities where natural supply of fresh water is inadequate or of poor quality .In this direction an experimental performance analysis was carried out on a single slope, double slope solar still with variation of water depth in the basin. Experiments were conducted for water depths of 10mm, 20mm, 30mm and 40mm .Tests were carried out for different water samples namely rain harvesting water, lake water and bore well water. Yield of still is compared with proposed hybrid unit. Measurement of various temperatures, solar intensity, and distillate water collected from still were taken for several days under local climatic conditions. The study shows that still efficiency enhances by 36.1% for rain harvesting water, 35.4% for lake water and 34% for bore well water when the still coupled with hybrid unit for 10mm water depth in the basin. Study shows that the productivity of solar still strongly depends on depth of water in basin, solar radiation and ambient temperature.*

The various other tests like TDS, Total hardness, Chlorine test, Calcium test and PH value experimentations were carried out in the U. B. D. T. C. E laboratory and found that water is safe for drinking. Thus, solar desalination becomes very attractive inexpensive long term technology.

Key Words: Solar distillation, lake water, climatic conditions, and water depth …

1. INTRODUCTION

Solar energy is the oldest energy source ever used. The sun was adored by many ancient civilizations as a powerful god. The sun is the only star of our solar system located at its center. The earth and other planets orbit the sun. Energy from the sun in the form of solar radiation supports almost all life on earth via photosynthesis and drives the earth's climate and weather [1].

About 74% of the sun's mass is hydrogen, 25% is helium, and the rest is made up of trace quantities of heavier elements. The sun has a surface temperature of approximately 5500 K, giving it a white color, which, because of atmospheric scattering, appears yellow. The sun generates its energy by nuclear fusion of hydrogen nuclei to helium. Sunlight is the main source of energy to the surface of the earth that can be harnessed via a variety of natural and synthetic processes[1].

1.1 Distillation process

Distillation is one of many processes that can be used for water purification. Solar radiation can be the source of heat energy. In this process, water is evaporated and thus separating water vapor from dissolved substances, and is then condensed as pure water.

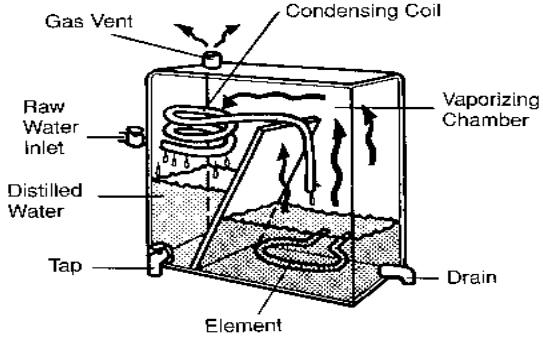

Fig -1 Distillation process

1.2 PRESENT WORK

The experiment is conducted on fabricated single slope and double slope solar still. Single slope solar still size of (1m x 1m) area, double slope solar still as size of (1m x 0.8m) area. Both solar stills individually connected to parabolic trough of size (1m x 0.635mm ϕ). The experiments are carried out for still alone and with hybrid for both single slope and double slope individually. Experiments are carried out for four different depths such as 10mm, 20mm, 30mm, and 40mm. Experiments are carried out for three different waters such as rain harvesting water, lake water, and bore well water.

Hourly and daily measurements of the still productivity, temperature of inlet water, temperature of base water, temperature of surface water, temperature of surface glass cover, temperature of vapour, temperature of inlet heat exchanger, temperature of outlet of heat exchanger and ambient air were recorded by using K-type thermocouples (±0.5 ^{o}C), digital temperature device are used for measuring the system temperature points .The experiments are conducted in the month of May 2012 during clear sky conditions at Davangere, location(14° 28' 0" N, 75° 55' 0" E).

2. RESULTS AND DISCUSSIONS

Experiments were carried out on the test rig for rain harvesting water, lake water, and bore well water for a water depth of 10mm, 20 mm, 30mm & 40mm respectively. The temperature variation, fresh water productivity, accumulated fresh water per day and the performance for the conventional and modified solar desalination systems under case study are presented in tables from 6.1 to 6.18.

According to the hourly variation of the solar radiation, for the conventional and modified solar desalination systems at dates from May 1st to May 23rd the results have been illustrated. The variation of the ambient temperature (T_a), basin water temperatures (T_{bw}), and outer glass cover temperatures (T_g) are varied and have peak values around the noon interval (11.00-3.00pm). It is noticed, as time goes on, all temperatures increase and begins decrease after 3:00 PM with respect to the variation of the solar radiation, The daily distilled water collected from both single slope and double slope (conventional and hybrid) for different water depths are plotted in fig6.3, fig 6.6, fig 6.9, fig 6.12, fig6.15, and fig6.18.It is observed that for 10mm depth the distilled water collected from rain harvesting water was high compare to lake water and bore well water. It is observed that highest yield was 2095ml/day for conventional and 3200ml/day for hybrid unit at 10mm water depth in the basin. It is noticed that the inlet temperatures of the oil through parabolic trough, T_{otr}, inlet oil to the heat exchanger, T_{ohe} (installed in the bottom of the basin) have higher values than the temperature of outlet oil as the heat exchanging between the basin water and oil in the heat exchanger.

From the graphs fig 6.19 and fig 6.20 it is found that the highest quantities of fresh water are obtained from the hybrid single slope still at depth of 10mm.Similarly for double slope from graphs 6.21 and 6.22 highest quantities of fresh water are obtained from the hybrid still at depth of 10mm. The still efficiency for different depth for conventional and modified one are listed in the table 6.19. It is observed that highest efficiency achieved was 36.1%.

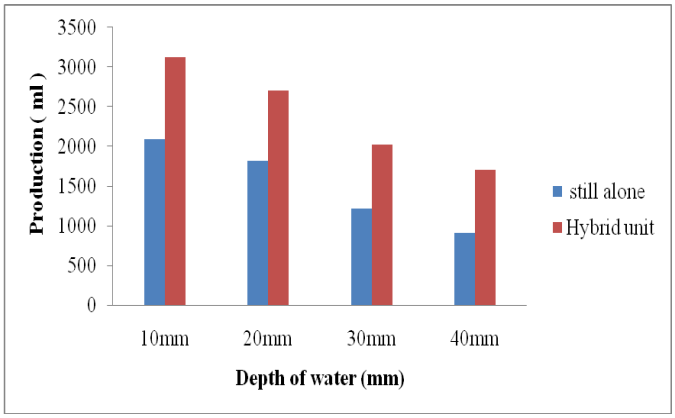

Chart -1: Distil water production v/s depth of water in basin Single slope (Rain harvesting water)

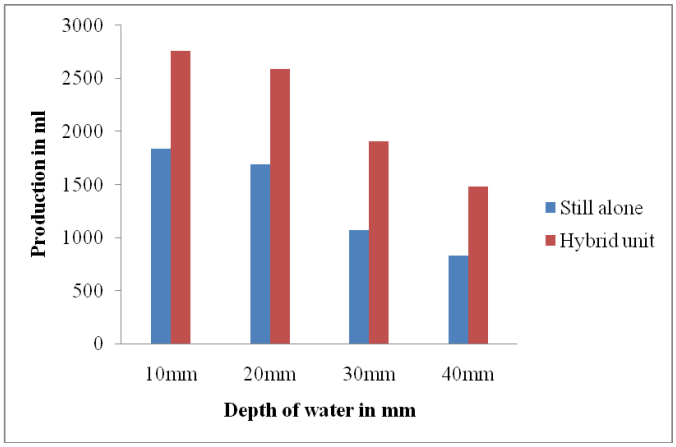

Chart -2: Distil water production v/s depth of water in basin Double slope (Rain harvesting water)

From the above graph it is observed that distil water production is more for lower depths and goes on decreases as depth increases .It is also observed that distil water production is more for hybrid unit.

Fig -1: Experimental setup of single slope with hybrid

The still with parabolic collector is as shown in the photo the collector is placed due south at a tilt angle equal to the location. For collecting the thermal oil a sump is provided which is circulated by using pump, the valve is provided to control the flow discharge of oil, heat exchanger is made by using copper material. The distilled water was collected in measuring jar from one side of the still unit.

Fig -1: Experimental setup of Double slope with hybrid

The photo graph of still with parabolic collector is as shown in the Photo The collector is placed due south at a tilt angle equal to the location. The all other arrangements remain same as single slope with hybrid.

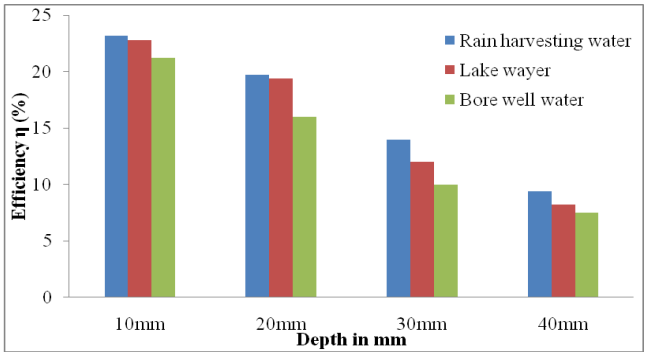

Chart -3: Efficiency v/s different depths, single slope

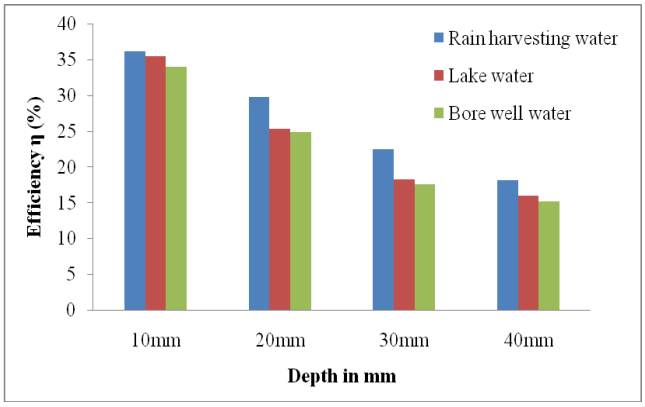

Chart -4: Efficiency v/s different depths, Hybrid unit

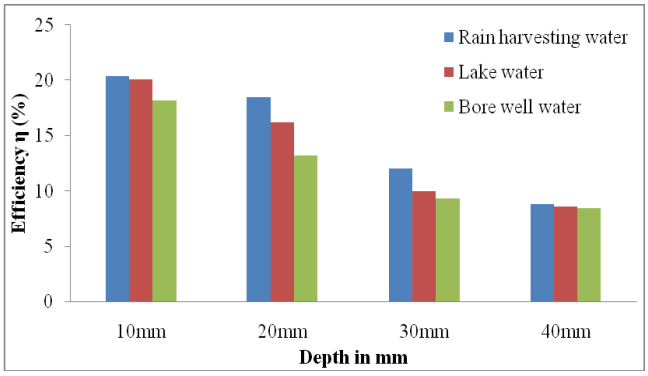

Chart -5: Efficiency v/s different depths, Double slope

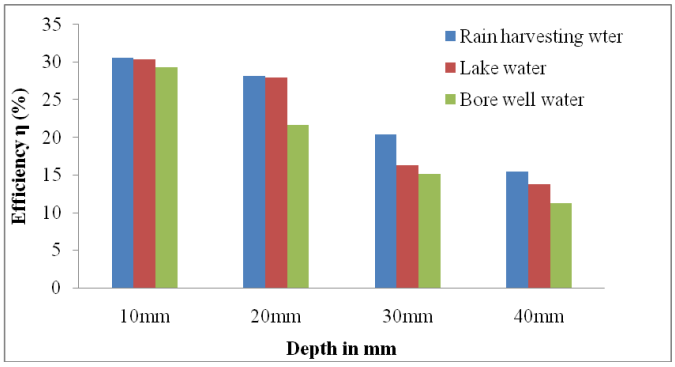

Chart -6: Efficiency v/s different depths, Hybrid unit

The graph shows variation of efficiency for different water at different depths. From the graph it is observed that highest efficiency is for rain harvesting water for 10mm depth. The efficiency goes on decreases as the depth of water increases.

3. CONCLUSIONS

From the results and discussions the following conclusions were made:

The higher values of yield are observed for 10mm water depth in the basin when compared to depths 20mm, 30mm and 40mm

The higher values of yield are observed for hybrid unit when compared to conventional desalination process

The evaporation rate increases with decrease in depth of water in basin of still

The highest yield was observed for Rain harvesting water when compared to Lake water and Bore well water

The temperatures of base water, surface water, glass cover are reached highest value between 12 hr to 14.30 hr.

The fresh water productivity increases from 1700ml/day to 3120ml/day for decrease in depth of water from 40mm to 10mm

The efficiency of still increases from 15.4% to 28.7% for decrease in depth of water in basin

The distilled water obtained from the present distillation unit is pure when compared to untreated water

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REFERENCES

[1] Soteris A. Kalogirou, "Solar Energy EngineeringProcesses and Systems", Library of Congress Cataloging-in-Publication, 2009.

[2] S.P. Sukhatme, "Solar energy: Principles of thermal collection and storage second edition", Tata McGraw-Hill publications Fourteenth Reprint, 2006.

[3] M. Boukar and A. Harmim, "Effect of climatic conditions on the performance of a simple basin solar still: a comparative study", Journal on Desalination, vol 137, (2001), pp. 15-22.

[4] Robert E. Foster, Sharon Eby And William Amos, "Ten years of Solar Distillation application along the U.S.- Mexico Border", Solar World Congress, International Solar Energy Society Orlando, Florida, (2005).

[5] Zenaib S, Abdel-Rel im and Asharaf Lasheen, "Experimental and theoretical study of a solar desalination system located in cario, Egypt", Journal on desalination, vol 217, (2007), pp. 52-64.

[6] O.O. Badran, "Experimental study of the enhancement parameters on a single slope solar still productivity", The Ninth Arab International Conference on Solar Energy (AICSE-9), Kingdom of Bahrain, vol 209, (2007), pp.136-143.

