PERFORMANCE IMPROVEMENT OF SINGLE SLOPE SOLAR WATER DISTILLATION PLANT

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***Abstract*: Rapid depletion of limited resources on earth at present time has lead to focus on future energy demand in form of solar energy as a renewable source of energy. Solar energy is a major renewable source with potential to meet many of challenges to world in this paper a parabolic trough solar water distillation plant with manual tracking system has been developed for max. fresh water generation. Parabolic trough is fabricated by cutting wooden hemispherical structure with a high reflective silver mirror film pasted on a thin sheet of aluminium. Three copper tubes of different diameter were taken. Experiment was conducted on different tube diameter by passing water through a pump. Focal length was kept constant throughout experiment with a fix water amount of 20 ltrs. during month of October 2018 at Gwalior (M.P.) 26.22 N Latitude 78.10E Longitude.**

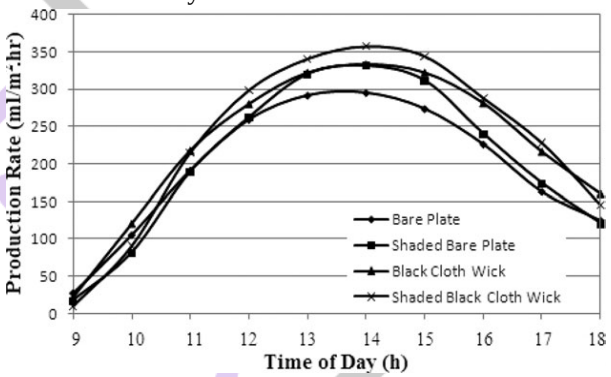
INTRODUCTION

Solar energy is major source of energy for our earth. Solar energy is a high energy radiant energy source with great advantage over alternate energy sources. We know world is facing an extreme problem of fresh drinking water and by 2015,40% of world's population will be living in regions without an adequate fresh water availability. In many areas, modern distillation techniques are not affordable due to financial and economic issues and many distillation techniques uses high amount of electricity and other costly equipments. Using solar thermal energy, we can use better efficient distillation techniques which are an environmentally free and friendly.

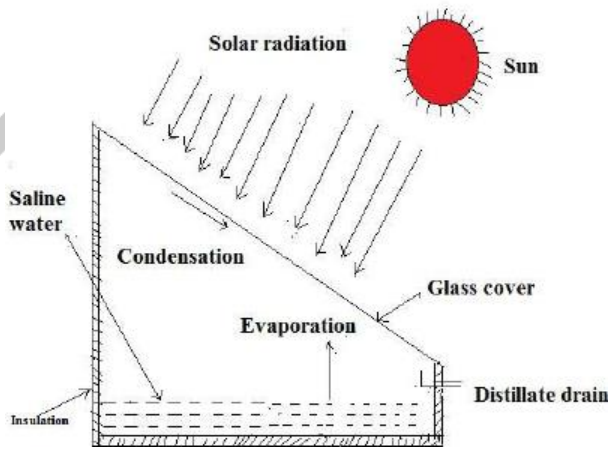
The basic principles of solar water distillation are simple, yet effective, as distillation replicates the way nature purifies water. The solar energy heats water to the point of evaporation. As the water evaporates, water vapour rises, condensing on the glass surface for collection. The process removes impurities such as salts and heavy metals, as well as destroys microbiological organisms. The end result is water cleaner than the purest rainwater. [4]

Anil kr. Tiwari and G.N. Tiwari[1] have conducted a experimental study of purification of contaminated water by solar energy in which they observed best Inclination of single slope passive solar still having glass cover for high distillation efficiency. The results were obtained by keeping three solar stills of different angle of inclination for one year time period.they found 15^0 inclinations for higher yield under uniform climatic conditions.

Emrah Denis [4] conducted a comparative experiment to formulate problem of inclined solar water distillation system for obtaining maximum thermal energy absorption. He proceeded with four different variants such as bare plate, shaded bare plate, black cloth wick and shaded black cloth wick. After performing out with all four variants, he concluded that shaded black cloth wick solar distillation system was better than other and maximum amount of thermal efficiency was achieved.



Med uGu and Ndatuwong[6] performed an experiment by designing a solar distillation plant in Nigeria to analysed heat and mass transfer mechanisms. They did theoretical analysis of performance of plant and found that with rate of increase of solar radiation, instantaneous efficiency also increases as well as increase in feed water temperature.



Single Slope Solar Still

Ruby et al[7] did an experimental study by deigning a parabolic solar trough collector to obtain high amount of steam by thermal temperature. Using solar radiation at parabolic trough, they observed that high temperature water was processed into approx. 300 pounds per ssq. Inch of

steam. That processed steam could be use for domestic as well as industrial purpose.

Saurav Gupta et al[8] have performed an experiment by using single slope solar water distillation system using parabolic tough concentrator. They used aluminium as absorber in concentrator and analysed thermal absorption at different focal length and different copper tube diameter. After completing process, they resulted that maximum temperature was obtained at 240 mm focal length and on 19 mm diameter copper tube .

Sagade et.al. – conducted an experiment on parabolic trough made of fiber glass reinforced plastic with its aperture area coated by aluminium foil with reflectivity of 0.86. The line focussing parabolic trough with mild steel receiver has been tested with and without glass cover. As per Indian condition, low cost FRP parabolic trough system proves to be beneficial for industrial heating and for domestic heating. [11]

Mohd. Rizwan, Mohd. Abdul Raheem Junaidi et.al.[12] have designed a solar parabolic collector for water distillation to evaluate maximum distilled water output with low maintenance. They used highly polished Aluminium sheet as a reflector and a copper tube as an absorber. After completing process, maximum temperature obtained was 106^0C at 1 pm.

Kanika Mathur et.al[13] have designed and fabricated a solar distillation water system to obtain maximum pure water output with help of an external mirror reflector attached to solar still. After performing experiment at three different water level, they concluded that volumetric efficiency of system is 23.33% for an input of 15 liters of water per day.

M. Gowtham et.al.[14] have designed and experimented a water desalination process by concentrating solar energy through a parabolic trough concentrator with paraffin wax as latent heat storage material adding with different scrap material for heat storage like sponges, pebbles and mild steel billets. After carrying out experiment with various heat storage material, the concluded that heat storage capacity was maximum of 54.08% with paraffin wax and mild steel scraps.

Mehta et.al.[15] have fabricated and designed a solar water distillation model which convert impure water into pure water by solar energy. They resulted the amount of pure water from evaporation of impure water and calculated that 1.5 ltr. of fresh water was produced from 14 ltr. of impure water during six hr. of time period and efficiency of model was around 64.37%.

EXPERIMENTAL METHODOLOGY

Experimental setup

Solar water distillation plant is an alternate for hot and fresh water generation due to low cost and operation. Modern advance machines require high cost investment and electricity. So after preparation of final setup, following research methodology for experiments are :-

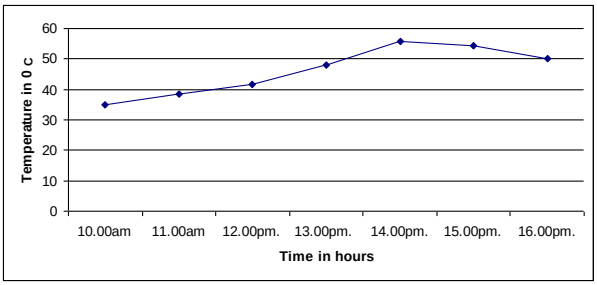
a) First, established setup at top of roof and matched best sun angle.

b) Took reading at different tube diameter keeping water input and focal length constant on which we got max. temp and water output.

c) Took four readings in four days during month of October at Govindpuri, Gwalior (M.P.) from 10.00am. to 16.00 pm. daily at constant weather conditions.

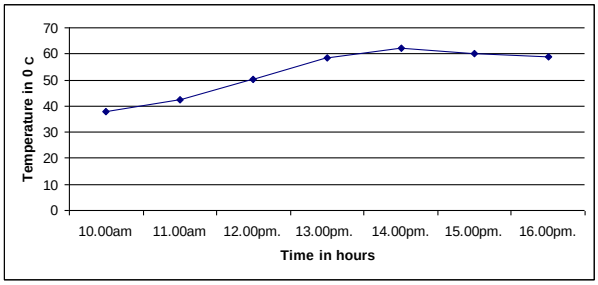
Case-1 Variation of Temp. with time

Experiment conducted without copper tube from day timing 10.00am. to 16.00 pm. water obtained was 67 Ml. on date 11-10-2018.



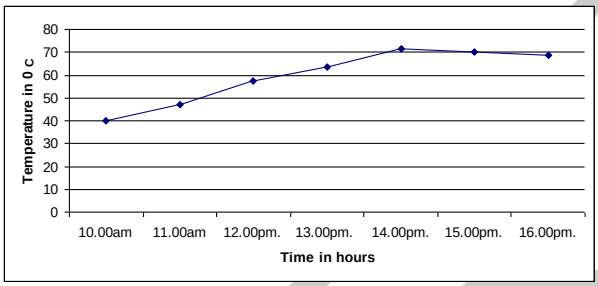
Case-2 Variation of Temp. with time

Experiment conducted by using 9.52 mm dia tube at 177 mm focal length on 12-10-2018 from day timing 10.00am to 16.00pm. water obtained was 86ml.



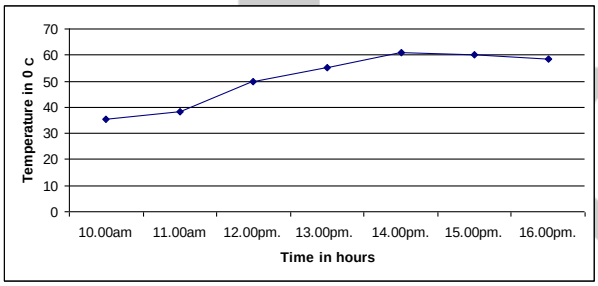
Case-3 Variation of Temp. with time

Experiment conducted by using 12.7 mm dia tube at 177 mm focal length on 13-10-2018 from day timing 10.00am to 16.00pm. water obtained was 115ml.

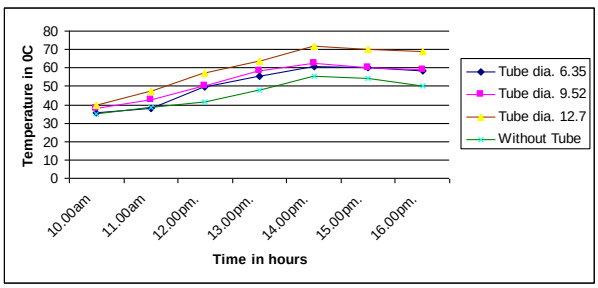


Case-4 Variation of Temp. with time

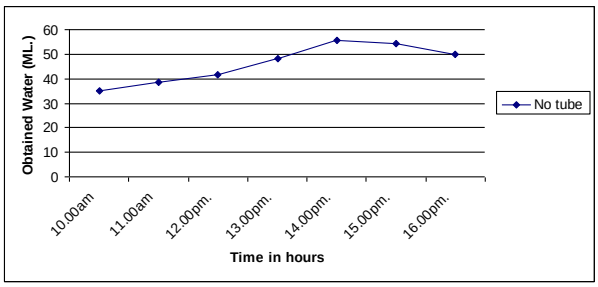
Experiment conducted by using 6.35 mm dia tube at 177 mm focal length on 14-10-2018 from day timing 10.00am to 16.00pm. water obtained was 80ml.



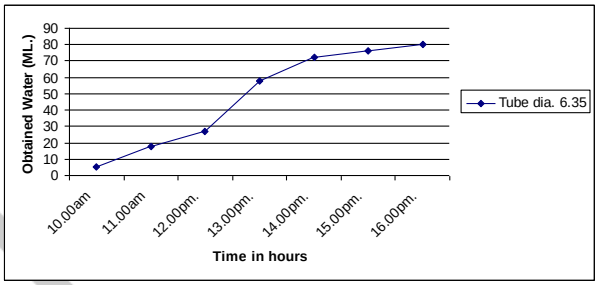
Combined variation of temp. with time at four cases



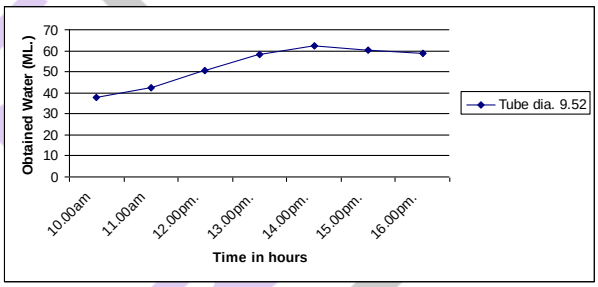
a) Variation of obtained distilled water without no tube



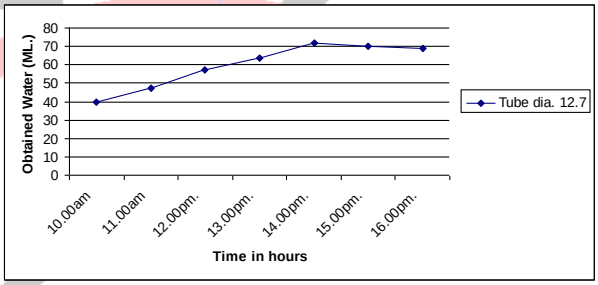
b) Variation of obtained distilled water with tube dia 6.35



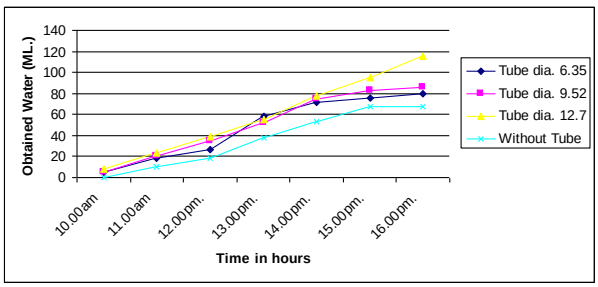
c) Variation of obtained distilled water with tube dia 9.52



d) Variation of obtained distilled water with tube dia 12.27



Combined variation of obtained water (ML) with time in four cases a, b, c, d



CONCLUSION

We have got maximum temp. on 12.7mm dia tube at 14.00pm. which is 71.6 ^{0}C and highest water obtained from experimental operation was 115ML at constant focal length.

FUTURE WORK

Future work in this experiment may be to change reflector material like metallic film or high refracting index material such as Maylor. Experiment can be done in summer season for better efficiency of collector.

REFERENCES

[1] Anil kr.Tiwari and G.N. tiwari2007,Annual performance analysis and thermal modelling of passive solar still for different inclinations of condensing cover. International Journal of Energy Research.

[2] Al-Hayek, I., & Badran, O.O. (2004). The effect of using different design of solar stills on water distillation, Desalination, 169, 121–127.

[3] Ruby, Steve (American Energy Assets, California) 2013 "Industrial Process Steam Generation using parabolic trough solar collection". California Energy Commission. Publication number CEC-500-2011-040.

[4] Saurav gupta and neelesh soni, 2016, Experimental Analysis of Parabolic Trough Solar Water Heater By Using Different Tube Diameter. IJRSR

[5] Ganapathisubbu S. and Santosh Kumar, 2013 "performance analysis of a spectrally selective concentrating direct absorption collector." IJERT

[6] Sagade et.al. 2013, "Performance evolution of low cost FRP parabolic trough reflector with mild steel receiver." International Journal of energy and environmental engineering.

[7] Mohd. Rizwan, Mohd. Abdul Raheem Junaidi, Mohd. Suleman, Mohd. Aamer Hussain, Oct. 2014 "Experimental verification and analysis of solar parabolic collector for water distillation." International Journal of Engineering Research.

[8] Kanika Mathur, Mathewlal Thomas, Parth lineswala, Siddharth Mayar, Oct. 2015, "Solar distillation of water". International Research Journal of Engineering and Technology.

[9] M. Gowtham, M. Sharath Chandr, K.V.saila malli karujanam, N. Karthikeyan, June 2011, "concentrated parabolic solar distiller with latent storage capacity". International Journal of Chemical Engineering and applications.

[10] Alpesh Mehta, Arhun Vyas, Nitin Bodar, Dharmesh Lathiya, April 2011. "Design of solar distillation system". International Journal of Advanced Science & Technology.