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Comparative Study of Simple Passive Solar Still with and without Multilayer Absorber Plate: An Experimental Approach

Palak Patel[1], J.D.Patel[2], U.R.Soni[3]
[1]*M.E Thermal Student at Sardar Patel Institute of Technology, Piludara, Gujarat, India*
Email ID:patelpalak25@gmail.com
[2]*Assistant Professor at Sardar Patel Institue of Technology, piludar, Gujarat, India*
Email ID:Jaksanpatel_mech1986@yahoo.com

[3]*Ph.d Student, Department of Mechanical Engineering, PAHER, Udaipur, Rajasthan, India*
Email ID:Soniur@gmail.com

Abstract: This Paper presents a new approach to enhance the productivity of a simple Passive Solar Still by introducing additional Multilayer absorber Plate at the basin of Solar Still. Simple Passive Solar Still with Multilayer Absorber Plate is fabricated and tested at Mehsana (Latitude: 23.6^0 N and Longitude: 72.40^0 E) ,Gujarat,India.The experiments were conducted with varying water depth of 0.5 cm, 1 cm, 1.5 cm,2 cm with and without Multilayer Absorber Plate. For both case Per Day Productivity decreases as water depth increases and Overnight Productivity increases as water depth increases. For the same basin area Per Day Productivity and Overnight Productivity of Multilayer Absorber Solar Still for 0.5 cm water depth increases by 3.9% and 28.94% for 1 cm water depth increases by 4.9% and 29.06% for 1.5 cm water depth increases by 5% and 40% for 2 cm water depth increases by 5.2% and 40.38% respectively compare to Solar Still without Multilayer Absorber Plate for typical summer days for same water depth.

Keywords: Solar Still, Water Depth, Per Day Productivity, Overnight Productivity, Multilayer Absorber Plate

I. INTRODUCTION

Water is a basic need of all the human beings existing on the earth. With the passage of time the population growth and industrial revolution has occurred. Which may leads all people toward the shortage of pure drinkable water. Supply of drinkable water in a scare zone in some underdeveloped as well as in some developing countries is a major problem. Man has been dependent on rivers, lakes and underground water sources for fresh water from a longer time of period. Most of the human dices are due to brackish water and dirty water problem. No of children died and millions of people are affected by water borne dices. So each developing and underdeveloped country tries to manage of its water resources. Very large amount of earth water is salty.

Only very small quantity of fresh water is available on the earth and this amount also not distributed properly. So, developed and under developed countries are suffering the problem of potable water. Distillation is an oldest technique to distillate brackish or salty water in to potable water. Various technologies were invented for distilled water from time to time and based on requirement it has been accepted by people without knowing future environmental consequences.

Distillation of brackish or saline water, wherever it is available, is a good method to obtain fresh water. The conventional distillation processes such as, thin film distillation, reverse osmosis and electrolysis are energy intensive techniques, and are the feasible for large stage water demands. But solar distillation technique gives better reliability and self dependence of water in scare zone so lot of research is going on for improvement in solar still.

Hiroshi Tanaka tried to use internal reflector on side wall and external bottom reflector [1], Sangeeta suneja and Tiwari tried to use Inverted Absorber [2] in Double basin solar still, Rahul dev and Tiwari used Inverted Absorber in Single basin solar still [3], Farshad Tabrizi had studied effect of sandy heat reservoir [4] on the performance of solar still Bilal akash gone thorough survey to use black dye and ink [5] in the solar still and found increase in productivity. Z.M.Omara et.al had studied the effect of hybrid system with simple passive solar

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still and still with cotton wicks [6] for overnight productivity sanjeev kumar and Tiwari added PV collectors [7] and got increase in the productivity.

A.A.Al-karaghouli et. al made experimental comparison of styrobore insulation [8] with single and double basin solar still and found 40% increase in productivity with styrobore insulation for Double basin , T.rajaseenivasan et.al studied comparative study of double basin and single basin solar still [9], Vimal dimri found the effect of condensing cover material [10] on the productivity. one can used charcoal pieces [11] at the basin of solar still to increase the productivity, one studied the effect of varying the tilt angle [12] on the productivity. Hitesh panchal studied the effect of glass cover thickness [13] on productivity and obtained optimum productivity of 4 mm glass cover thickness. Bapeshwara rao et.al. [14] Studied the effect of flowing over the upper glass cover of double basin solar still and observed the increase in production.

Several authors suggested to use double basin solar still compare to single basin [15] to utilize the latent heat of evaporation to the upper basin rather vesting to atmosphere in case of single basin. Rasool Kalbasi et.al use Multi effect passive desalination system to utilize the lost heat in solar still for increasing water temperature.

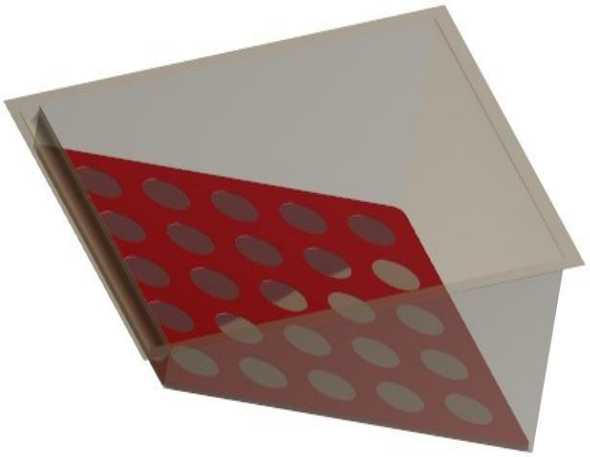

Fig.1: Pro-e model of Solar Still with Multilayer Absorber plate

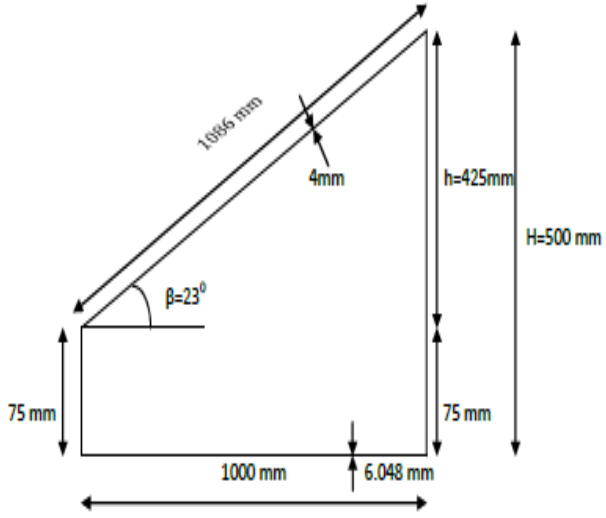

Fig.2.Line diagram of solar still with dimension

MATERIALS AND SOLAR STILL SPECIFICATIONS

A Pro-e model of Solar Sill with Multilayer Absorber plate is shown in Fig.1. Fig.2 shows the line diagram of solar still with dimensions. The basin area of solar still was fabricated 1 m^2 from a black painted galvanized iron sheet of 0.64 mm (22 gauges). The Multilayer Absorber made of 2 layers one of 1.024 mm (18 gauges) galvanized iron sheet with holes of 90 mm diameter and another is without hole. Between this two plates copper conduction path of 4 mm was brazed.Fig.3 shows cross sectional view of Multilayer Absorber and Fig.4 shows Photograph of Multilayer Absorber plate.

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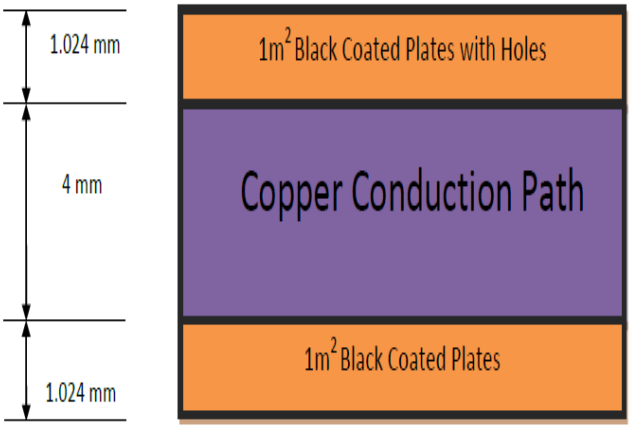

Fig.3 c/s view of Multilayer Absorber plate

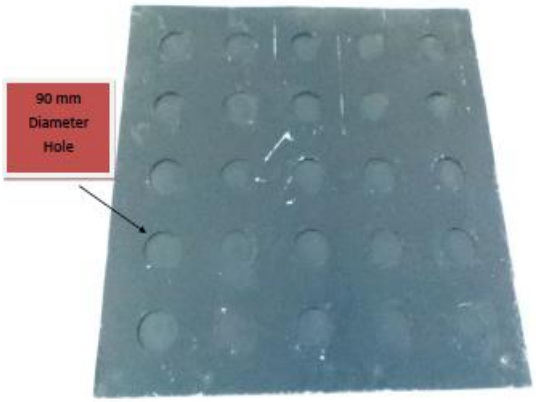

Fig.4 Photograph of Multilayer Absorber Plate

The glass cover of the still was made up of 4 mm simple window glass with tilt angle of 23^0 as per the latitude of the place facing south. The glass cover is placed on still and entire still is made leakage proof with help of silicon jell. Water inlet is given on upper side of solar still with initially 1010 ppm Total dissolve solids measured with TDS meter. One blow off hole is also present at the basin to remove remaining salty water after conducting the experiment. Solar still is insulated with 12 mm thermocol insulation. A digital thermocouple was used to find the all experiments temperature like glass cover temperature, water temperature, vapour temperature and ambient air temperature.

II. EXPERIMENT PROCEDURE

After designing and manufacturing the Solar Still the experiments were started at Mehsana (Latitude: 23.6^0 N and Longitude: 72.40^0 E) for 8 typical days in summer climatic condition neglecting the effect of Wind velocity.4 days readings were taken without multilayer Absorber Plate for 0.5 cm, 1 cm, 1.5 cm, 2 cm water depth and 4 days readings were taken with Multilayer Absorber Plate for same water depth on Solar Still. The Readings were taken between 9.00 am to 5.00 pm and productivity obtained considered as Day productivity after that from 5.00 pm to 9.00 am considered as overnight productivity and the total productivity considered as Per Day Productivity. Solar radiation was measured with solar power meter; all experimental temperatures measured with digital thermocouple and distilled output with measuring jar.Fig.5 shows the Experimental set up while taking readings with all instruments.

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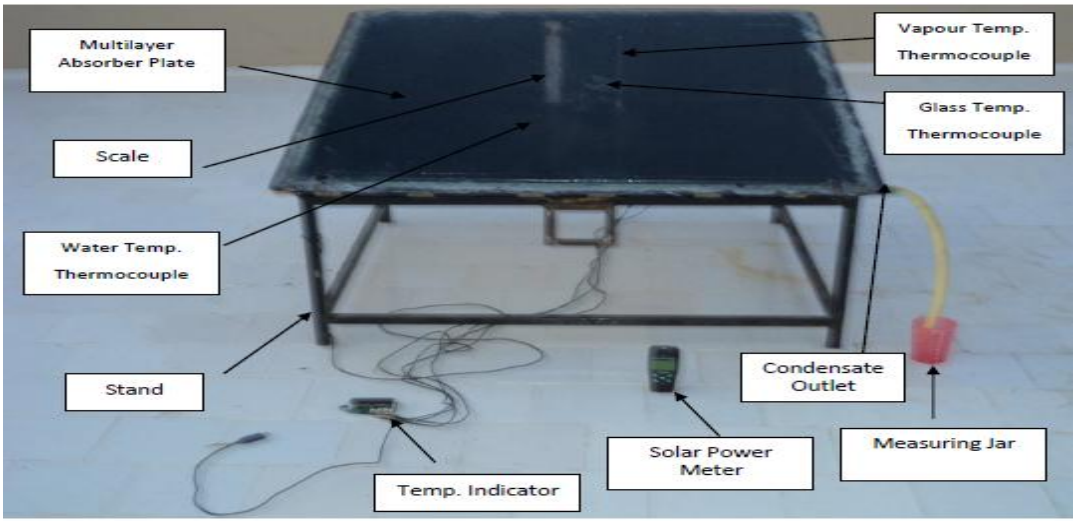

Fig.5: Experimtal set up with all measuring instruments

Sr.No	Instruments	Accuracy	Range
1	Solar Power Meter	10 W/m^2	2000 W/m^2
2	Digital Thermocouple	±0.5°C	-10°C to +85°C
3	Digital Temp. Indicator	2 Decimal	-15°C to +95°C
4	Measuring jar	10 ml	500 ml
5	TDS Meter	±2%	9990 ppm (mg/L)

Table.1: Accuracy and Range of instruments

III. RESULTS AND DISCCUSIONS

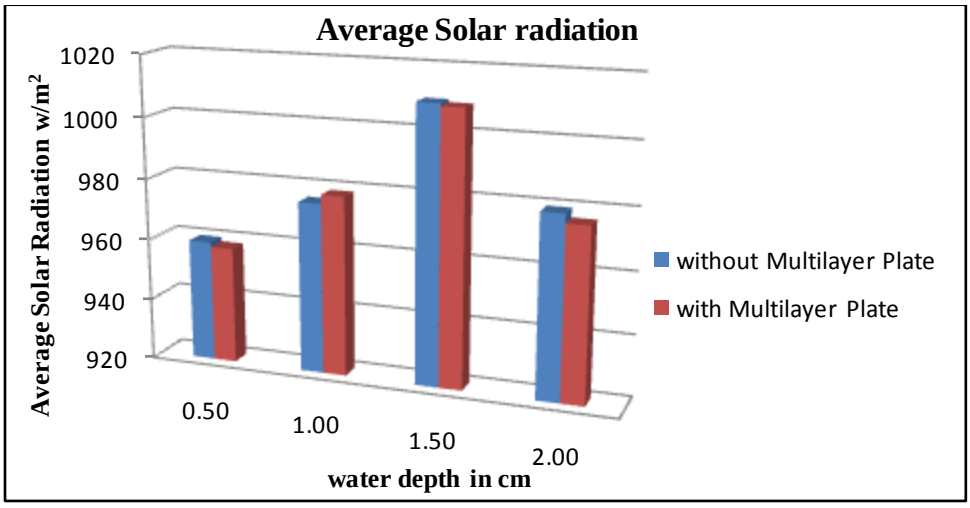

Fig.6 Variation of Average solar Radiation with and without Multilayer Absorber Plate

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Above fig.6 shows the variation of Average solar radiation for solar still with and without Multilayer Absorber Plate for 8 typical days. It is clear from the graph there was radiation nearer to same for the days of experiments for given water depth.

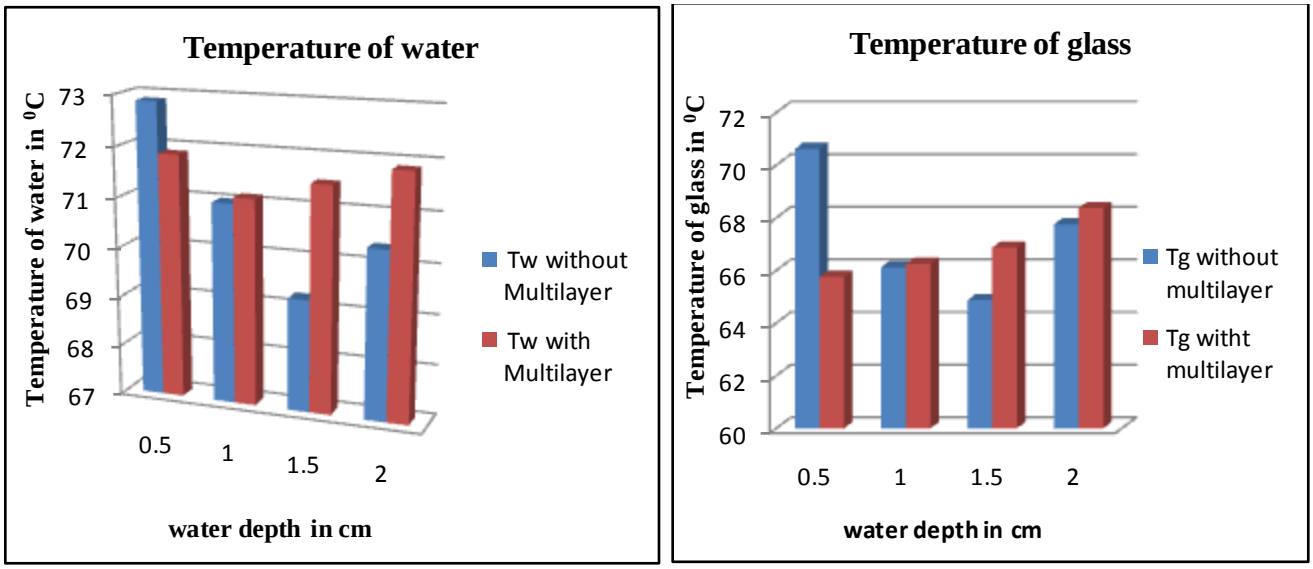

Fig.7: Comparison of water and glass temperature at 2.00 pm

Fig.7 shows the comparison of water and glass temperature at 2.00 pm with and without Multilayer Absorber plate. From above graph it clear that using the Multilayer Absorber Plate temperature difference between water and glass increases and productivity increases.

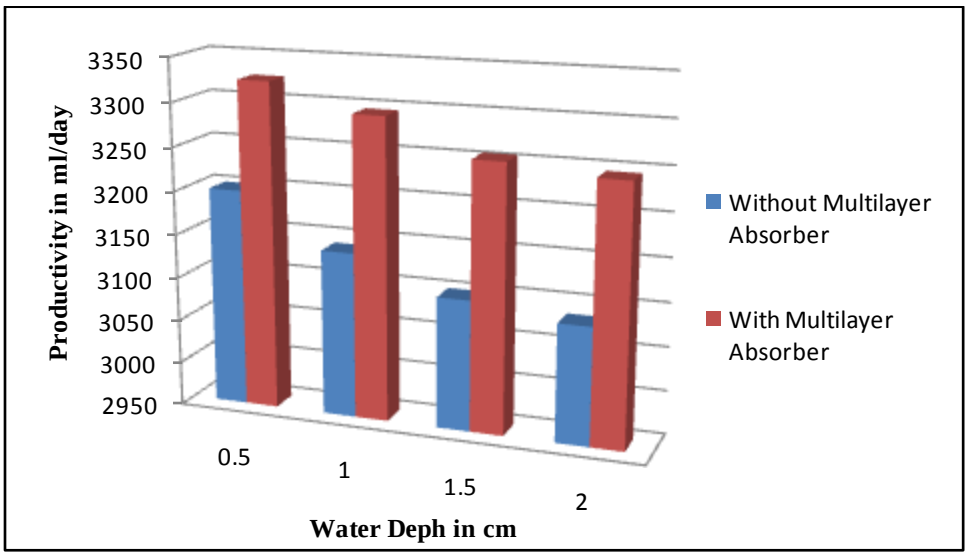

Fig.8: Comparison of Per Day Productivity of solar still

Fig.8 shows the shows the comparison of Per Day Productivity of solar still with and without Multilayer Absorber Plate.From above graph it is clearly seen that Per Day Productivity of solar still with Multilayer

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Absorber Plate is nearer to same or little higher due to plate absorbs solar radiation part of water but copper conduction path enhance the heat transfer rate to water for all water depth compare to solar still without Multilayer Absorber Plate.TDS measured with and without Multilayer Absorber was 0.47 ppm and 0.27 ppm respectively.

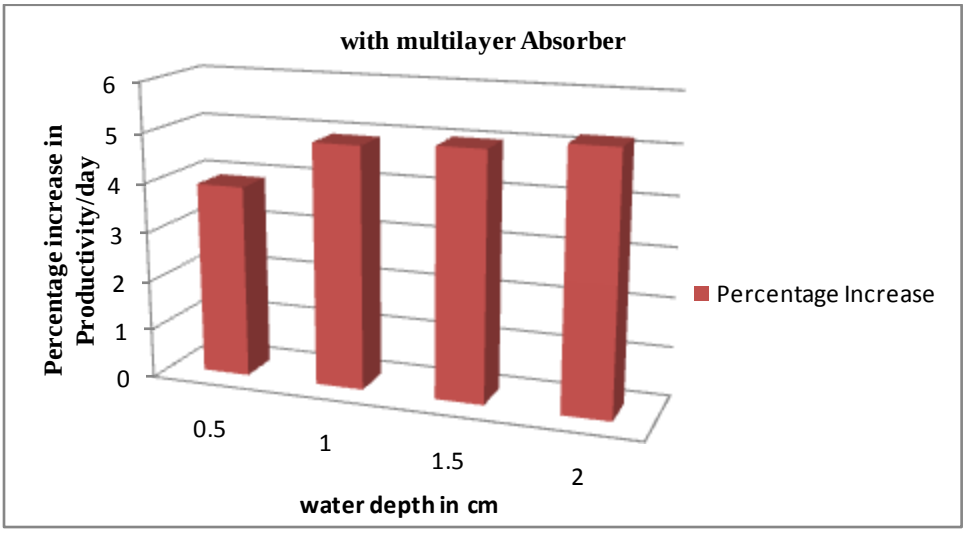

Fig.9: Percentage increase of Per Day Productivity of solar still with Multilayer Absorber Plate

Fig.9 shows the Percentage increase in the productivity of solar still with Multilayer Absorber Plate and compare to solar still without Multilayer Absorber Plate for various water depths. It is concluded from the graph that Productivity increases by 3.9%, 4.9%, 5% and 5.2% with 0.5 cm ,1 cm, 1.5 cm and 2 cm water depth respectively with Multilayer Absorber Plate in simple passive solar still.

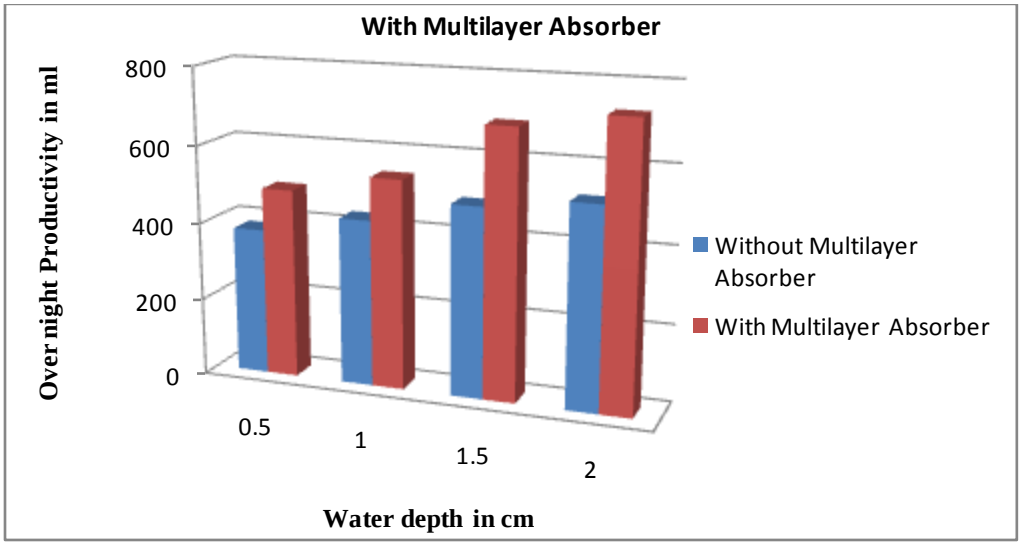

Fig.10: Comparison of Overnight Productivity of solar still

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Fig.10 shows the Overnight Productivity of solar still with and without Multilayer Absorber Plate and here is the comparison is made between them and it is clearly shown that Overnight Productivity of solar still is with Multilayer Absorber is higher compare to solar still without Multilayer Absorber solar still for shown water depth. Heat energy stored by water and Multilayer Absorber Plate releases at night time when sun is not there for heating of the water.

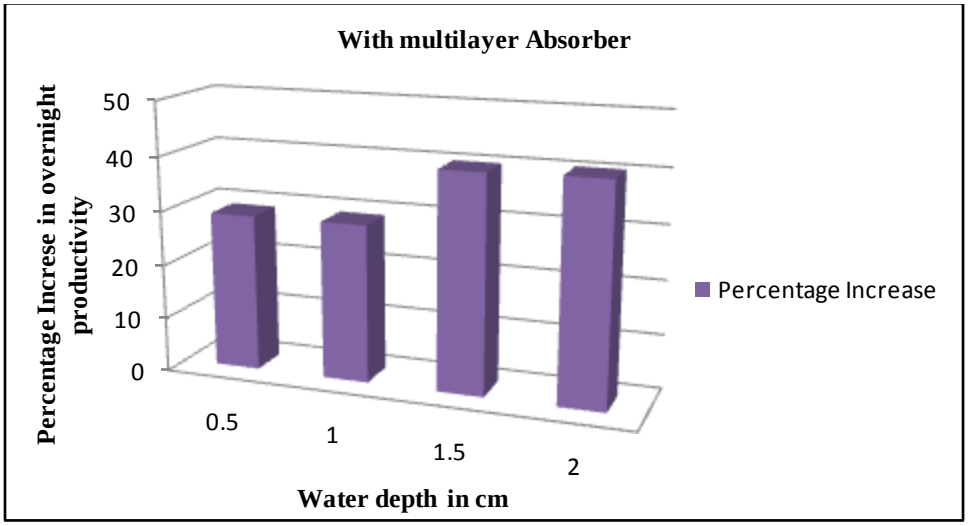

Fig.11: Percentage increase of Overnight Productivity of solar still

Fig.11 shows the percentage increase in Overnight productivity of solar still using Multilayer Absorber plate compare to solar still without use of Multilayer Absorber plate. It is concluded from graph that productivity increases 28.94 %, 29.06%, 40% and 40.38% for 0.5 cm, 1 cm, 1.5 cm and 2 cm water depth respectively with Multilayer Absorber Plate in simple passive solar still.

IV. CONCLUSION

- The Productivity of Multilayer Absorber Solar Still increases with increase in Solar Radiation and which directly affects the Productive output.
- Productivity of Multilayer Absorber Solar Still has a little effect of atmospheric ambient air temperature.
- Per Day Productivity of Multilayer Absorber Solar Still is nearer same or little high compare to Simple Passive Solar Still for same basin area because of plate absorbs the solar radiation part of water but the copper conduction path try to enhance the heat transfer rate from plate to water.
- Per Day Productivity of Multilayer Absorber Solar Still Decreases as increase in Water Depth.
- Overnight Productivity of Multilayer Absorber solar still is quit high compare to Simple Passive Solar Still by realising stored heat at daytime for same floor space area.
- Overnight Productivity of Multilayer Absorber Solar Still increases with increase in Water depth because more water Depth stores more heat which releases at night

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