International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Development of Basin Solar Still by Providing Magnetic Treatment Unit and Double Glass Cover

K.Amzad Ali[1], R. J. V.Anil Kumar[2]

[1] M.Tech student, Dept of Mechanical Engineering JNTUACEA Ananthapur, India

[2]Lecturer of Mechanical Engineering JNTUA College of Engineering, Ananthapur, India

Abstract: ***In the recent years, we are facing severe water problems. There is little pure water left on earth and nearly all of this is polluted by both pollutants and toxic chemicals. Single basin solar still is a popular solar device used for converting available brackish or waste water into potable water. Because of its lower productivity, it is not popularly used. The yield of the single basin solar still is very less compared to that of other conventional desalination methods. The basin solar still was developed by adding a magnetic treatment unit and double glass cover. The study was conducted by testing the solar still by using magnetic treatment unit with single and double glass cover, non-magnetic treatment unit with single and double glass cover. Parameters like temperature in the basin solar still, glass cover surface temperature, ambient temperature, productivity, efficiency and other properties will be calculated and compared for all the above mentioned tests.***

Keywords: Solar Still, Basin, Magnetic treatment Unit, Double Glass Cover.

1. Introduction

Water is the basic necessity for human along with food and air. Adequate quality and reliability of drinking water supply is a fundamental need. Without potable or fresh(less than about 500 parts per million(ppm) of salt) human life is not possible. Industries and agriculture also need fresh water without they cannot function or thrive. Water is, therefore, the key to man's prosperity; it is intimately associated with the evolution of civilization and hence it is aptly said that water is everybody's business. Fresh water which has obtained from rivers, lakes and ponds in plenty is becoming scarce because of industrialization and population explosion. There is almost no water left on earth that is safe to drink without purification after 20-25 years from today. Only 1% of Earth's water is in a fresh, liquid state. Moreover, these potable water sources are being polluted constantly by industrial wastes and large amount of sewage. It is said that presently 2000 million people are not getting potable water which leads to many diseases inhibits the development. For this reason, purification of water before consumption is extremely important.

With the present steep escalation of energy costs serious efforts are being made to use the freely available solar energy. Solar desalination is one of the cheapest methods used for producing distilled water. Solar still is widely used in the solar desalination. Single basin solar still is a popular solar device used for converting available brackish or waste water into potable water. Because of its lower productivity, it is not popularly used. The yield of the single basin solar still is very less compared to that of other conventional desalination methods .

The proposed method is to develop a basin solar still by providing magnetic treatment unit and double glass cover. The still productivity and efficiency depends on parameters like location, solar radiation intensity, atmospheric temperature-basin water depth, glass cover material, thickness and its inclination, wind velocity and the heat capacity. It is a technology that is not only capable of removing a very wide variety of contaminants in just one step, but is simple, cost-effective, and environmentally friendly. That is use of solar energy.

1.1. About Solar Energy

The sun radiates the energy in the form of electromagnetic waves uniformly in all direction. When absorbed by body, it increases body temperature. It is a clean, inexhaustible, abundantly and universally available renewable energy[1]. Solar energy has the greatest potential of all the sources of renewable energy and if only a small amount of this form of energy could be used, it will be one of the most important supplies of energy, especially when other sources in the country have depleted. 3.8x1024 joules of solar radiation is absorbed by earth and atmosphere per year. Solar power where sun hits atmosphere is 1017 watts and the total demand is 1013 watts. Therefore, the sun gives us 1000 times more power than we need. If we can use 5% of this energy, it will be 50 times what the world will require. The energy radiated by the sun on a bright sunny day is 4 to 7 kWh per m^2 [2].

2. Design and Operation

The proposed model of the basin solar still with magnetic treatment unit and double glass cover is as shown in the Fig 1, 2a,b and c. Apparatus consists of basin of the solar still is made of stainless steel box. The bottom and sides of the basin are insulted by1cm thick thermocol surrounded by wooden frame of 2 cm thickness. Magnetic treatment unit is connected besides the tank, consists of two round magnets of pipe size of outer diameter of 0.84 inches. Magnets (BX8X02) of field strength 1145 gauss are used. Magnetic treatment unit produces water of low surface tension which increases the rate of evaporation, and increases productivity. Balance tank was setup besides the solar still to control on water level in the basin. Aluminium foil is used as the reflector in the inner wall of basin to reflect sun rays in the

water basin. Double glass cover inclined 30^0 is provided to increase the rate condensation leads to increase in productivity and efficiency. A channel is made to collect he distilled water as shown in the Fig 1.

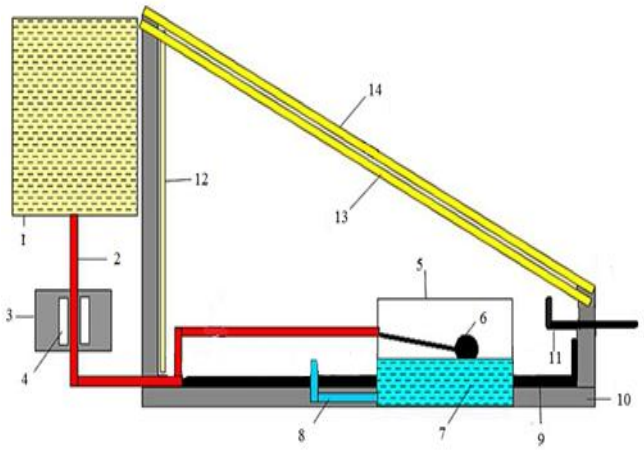


Figure 1: Schematic diagram of basin solar still with magnetic water and double glass

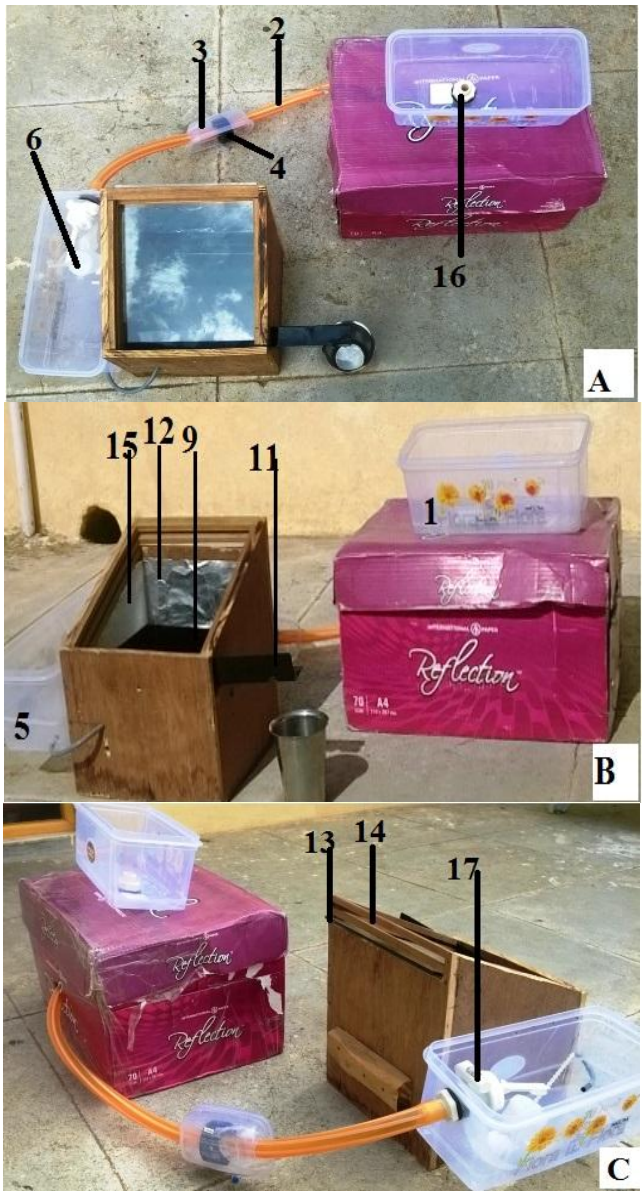


Figure 2: Working model of solar distillation system
A: Top view B: Front view C: Side view

1.Tank, 2.plastic pipe, 3.magnetic treatment unit, 4.Static magnet, 5. Balance tank, 6.Float, 7. Basin water, 8. Plastic pipe, 9.Basin, 10.Woodenframe, 11. Channel, 12.Reflector, 13.inner glass cover, 14. Outer glass cover, 15. Insulation, 16. Coupling-1, 17. Coupling-2

2.1 Operation

The basic principle of solar water distillation is simple yet effective, as distillation replicates the way nature makes rain. In the hydrological cycle, the nature is utilising solar energy for converting saline water into fresh water by solar heating of water from oceans, lakes, rivers and other large bodies of water. Vapours are being continuously generated and transported by wind to distant places which gets condensed and precipitated in the form of rain or snow at cooler regions. The working model of solar distillation is as shown in the Fig 2

The radiation falls through the glass onto the absorber. The basin is filled with brackish water, this absorber works best if the basin is coated black. The radiation warms the basin and gradually the water. To reduce heat loss to a minimum, it is vital to insulate the sides and bottom of the basin.

The water warms and evaporates, leaving the impurities behind. This vapour collects on the underside of the glass where it condenses on the underside of the glass when it has a temperature appreciably lower than that of the water and the water vapour. The condensate runs along the sloping screen and into a collecting tank through the channel. To prevent the condensate from falling back into the water, the screen must be tilted by at least 30^0 from the horizontal. As the water from the basin is evaporated the water, then the water from the balancing tank enters into the basin with the help of float and always maintains constant water level in the basin. The whole distiller must be air tight to prevent the loses of vapour to achieve the best result. In the case of double glass cover experiments, condensation will be rapid as wind is cooling the glass cover or the temperature difference between the inner glass cover and the outer glass cover. By this process of operation, temperatures of basin water, ambient and glass covers can be calculated and analyse for magnetic treatment unit with double glass cover, magnetic treatment unit with single glass cover, non-magnetic treatment unit with double glass cover, non-magnetic treatment unit with single glass cover and then calculate efficiency and productivity.

For high efficiencies the solar still should maintain:

- A high feed (undistilled) water temperature.
- A large temperature difference between feed water and condensing surface.
- Low vapour leakage.

The efficiency of the above mentioned processes can be calculated using the formulae [6].

$$\eta(\%) = \frac{M_{out}\ h_{fg}}{H_{av}\ A_g} \text{x}100 \quad (1)$$

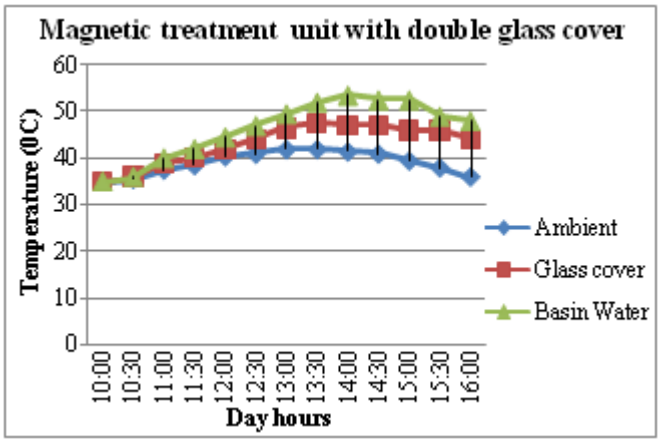
Productivity (l/m^2 day): The collection of output distilled water from distiller at limit time has been measured then productivity is calculated from the formulae[6].

$$P = \frac{M_{out}}{A_g\ t} \text{l/m}^2\text{ day} \quad (2)$$

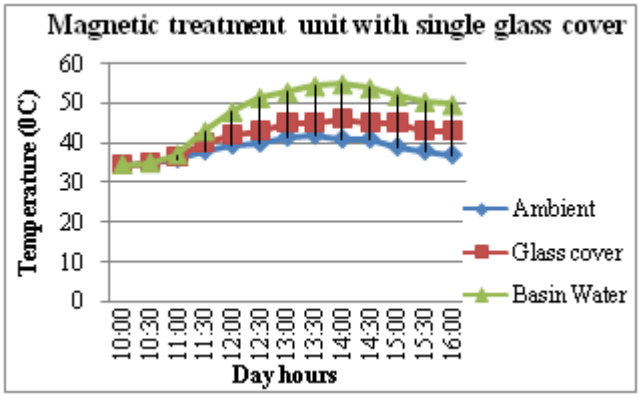
3. Results and Discussions

The experimental work was carried out in Anantapur town in India (Latitude 14.41^0, 14.68^0 N, Longitude: 77.36^0, 77.6^0E).

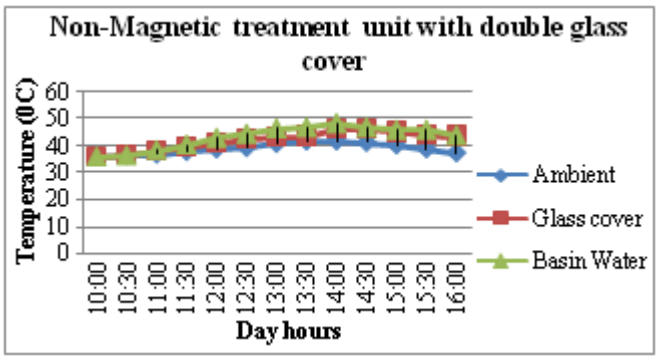
Graphs No:1 to 4 illustrated the change in the temperature of ambient, glass cover and basin water during day hours with and without magnetic treatment unit and single or double glass cover. Results showed that the temperature of ambient increases with increasing day hours up to maximum value at 1:30 pm and then it decreases. But the temperatures of glass cover and basin water are increases with increasing day hours up to maximum value at 2:00 pm and then it decreases. This is because increasing of solar radiation intensity with day hours at 10:00 am to 1:30 pm and this may be attributed to the increase of the absorbency of the solar energy entering the still by water. Also this is due to the process using mainly the thermal energy stored in the water itself. The maximum temperature of basin water are 53.5^0C, 54.5^0C, 48.5^0C, and52^0C at magnetic treatment unit with double glass cover, magnetic treatment unit with single glass cover , non-magnetic treatment unit with double glass cover and non-magnetic treatment unit with single glass cover respectively.



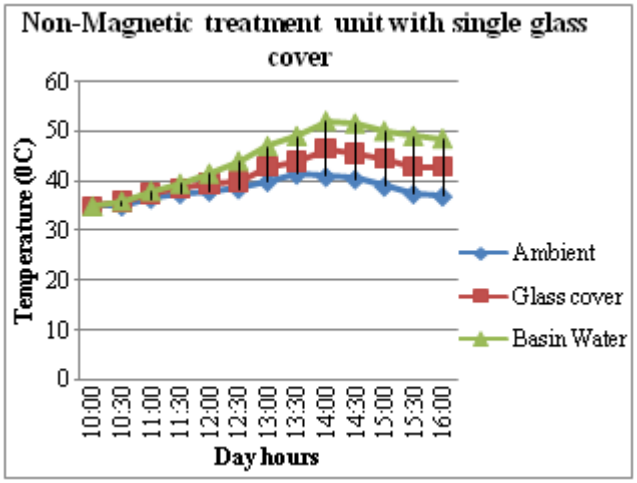
Graph 1



Graph 2



Graph 3



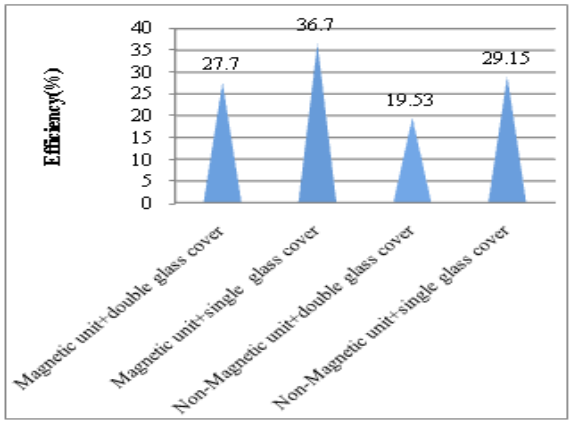
Graph 4

The efficiency and productivity for the above four experiments are calculated and shown in the table 1

Table 1

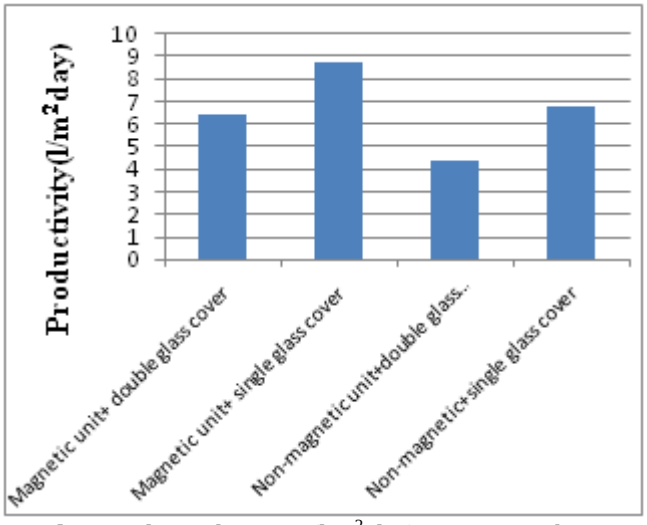
Name of the experiment	*Efficiency*	*Productivity (l/m^2day)*
Magnetic treatment unit with double glass cover	27.7	6.46
Magnetic treatment unit with single glass cover	36.7	8.74
Non-magnetic treatment unit with double glass cover	19.53	4.37
Non-magnetic treatment unit with single glass cover	29.15	6.81

The efficiencies for the above experiments are as following graph No: 5



Graph 5: Efficiency comparison between the different desalination systems

The productivities for the above experiments are in the following graph No: 6



Graph 6: Daily productivity (l/m^2 day) comparison between the different desalination systems

The results showed in the Graph 5 that the highest efficiency is at using magnetic treatment unit with single glass cover and reached to 36.7% and this is because the magnetized water leads to reduce the surface tension of water and increases the speed of evaporation. The least efficiency is at using a non-magnetic treatment with double glass cover which reaches to 19.53%. This decrease in efficiency is caused by increasing the thickness of the cover, which led to reduce the intensity of solar radiation inside to basin water.

The comparison of the daily productivity of distilled water between the different desalination systems is shown in Graph 6. The daily productivity of magnetic treatment unit with single glass cover treatment is higher than other systems. The daily productivity of the solar distiller provided with magnetic water unit and single glass cover treatment is improved by increasing the evaporation and heat transfer rate of the system as magnetic water. The daily productivity is improved by 50% compared with other conventional treatments as shown in Graph 6.

4. Conclusion

A basin solar still is fabricated and tested. The optimized modified desalination system was magnetic treatment unit with single glass cover. The efficiency is calculated as 36.7% which is more effective when compared to stills being available. The productivity of the basin solar still is enormously improved by the addition of magnetic treatment unit to single glass cover and it is improved by50% compared with other conventional treatments. Also it is found that quality of distilled water using magnetic treatment unit with single glass cover is better than other treatments.

5. Nomenclature

η = Efficiency
P = Productivity(l/m^2 day)
M_{out} = Daily produced distillate (kg)
h_{fg} = Latent heat of vaporization (J/kg)
A_g = Transparent cover area (m^2)
t = Duration of the day
H_{av}= Monthly average solar radiation per day(kJ/m^2)

References

[1] M.A.S. Malik, G.N Tiwari, A. Kumar and M.S. Sodha. “Solar Distillation”, Pergamon Press, Oxford, UK, 1982.
[2] A. Kumar, A. Kumar, G.D. Sootha and P. Chaturvadi,” Performance of a multi-stage distillation system using a flat-plate collector”, Extended Abstract, ISES Solar World Congress, Kobe, Japan, 1989.
[3] Velmurugan, V. and K. Srithar, 2011. Performance analysis of solar stills based on various factors affecting the productivity-a review. Renewable Sustainable Energy Rev., 15: 1294-1304. DOI: 10.1016/j.rser.2010.10.012.
[4] Tiwari, G.N., J.M. Thomas and E. Khan, 1995. Optimisation of glass cover inclination for maximum yield in a solar still, Heat Recov. Sys. CHP, 14: 447-455.
[5] Non- Conventional Energy Sources by G.D. Rai.
[6] Solar Energy Fundamentals and Applications by H P Garg and J prakash.
[7] Solar Energy by G.N. Tiwari.
[8] Solar Energy by S.P. Sukhatme.
[9] AlpeshV.Mehta International Journal of Advanced Science and Technology Vol. 29, April 2011.
[10] Principles of Solar Engineering by D. Yogi Goswami, Frank Kreith and Jan F. Kreider.

Author Profile

K.Amzad Ali M.Tech , Dept of Mechanical Engineering JNTUA College of Engineering in Anantapur, Andhra Pradesh, India.

R. J. V. Anil Kumar M.TECH,(Ph.D.,) Professor at Dept of Mechanical Engineering in JNTUA College of Engineering in Anantapur, Andhra Pradesh, India