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# Efficiency Improvement of a solar still under Theinfluence of Magnetic field

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**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. 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 solar still is very less compared to that of other conventional desalination methods. The basin solar still is developed by adding a magnetic treatment unit. The study is conducted by testing the solar still by using with magnetic treatment unit and without magnetic treatment unit. Parameters like temperature of the basin solar still, glass cover surface temperature, ambient temperature, productivity, efficiency and other properties will be calculated and compared for the above mentioned tests.

**Keywords:** Solar Still, Basin, Magnetic treatment Unit, non-magnetic treatment unit.

## 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 water (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. 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. 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.

**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.  $3.8 \times 10^{24}$  joules of solar radiation is absorbed by earth and atmosphere per year. Solar power where sun hits atmosphere is  $10^{17}$  watts and the total demand is  $10^{13}$  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 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 insulated by 1cm 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. A channel is made to collect the distilled water as shown in the Figure 1

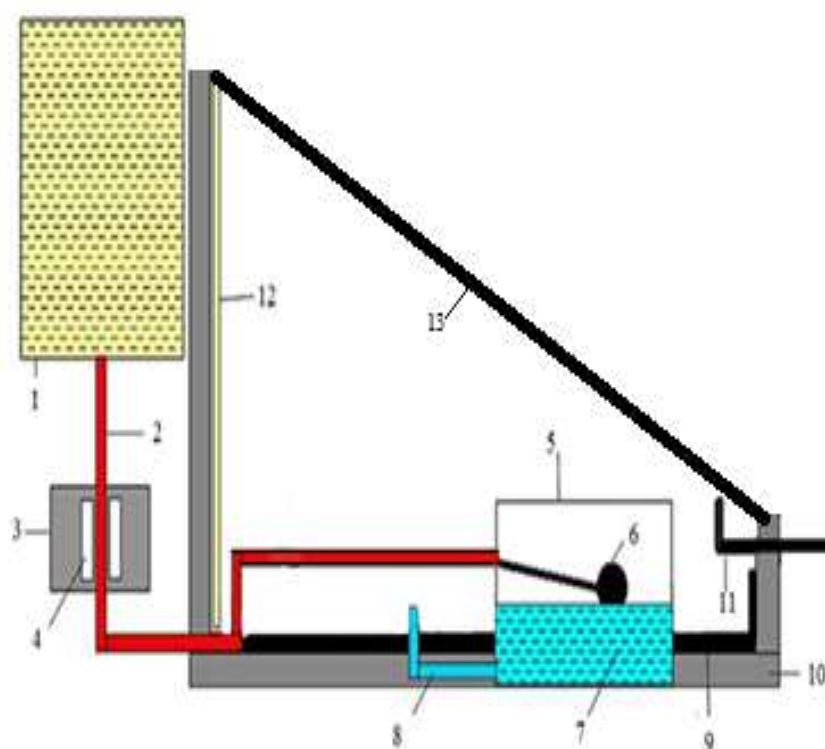


FIGURE 1 .Schematic diagram of solar still with magnetic treatment unit



**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. Wooden frame, 11. Channel, 12. Reflector, 13. Glass cover, 14. Insulation, 15. Coupling-1, 16. Coupling-2

**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 Figure.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° 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. By this process of operation, temperatures of basin water, ambient and glass covers can be calculated and analyse for solar still with magnetic treatment unit, solar still without magnetic treatment unit 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].

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

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

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

### 3. RESULTS AND DISCUSSIONS

The experimental work was carried out in Anantapuramu town in India (Latitude 14.41°, 14.68° N, Longitude: 77.36°, 77.6°E). Figure. 3 and Figure 4 illustrate the change in the temperature of ambient, glass cover and basin water during day hours with and without magnetic treatment unit of the solar still. Results shows 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 time up to maximum value at 2:00 pm and then it decreases. This is because increasing of solar radiation intensity with time 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 54.5°C and 52°C at solar still with magnetic treatment unit with and solar still without magnetic treatment respectively.

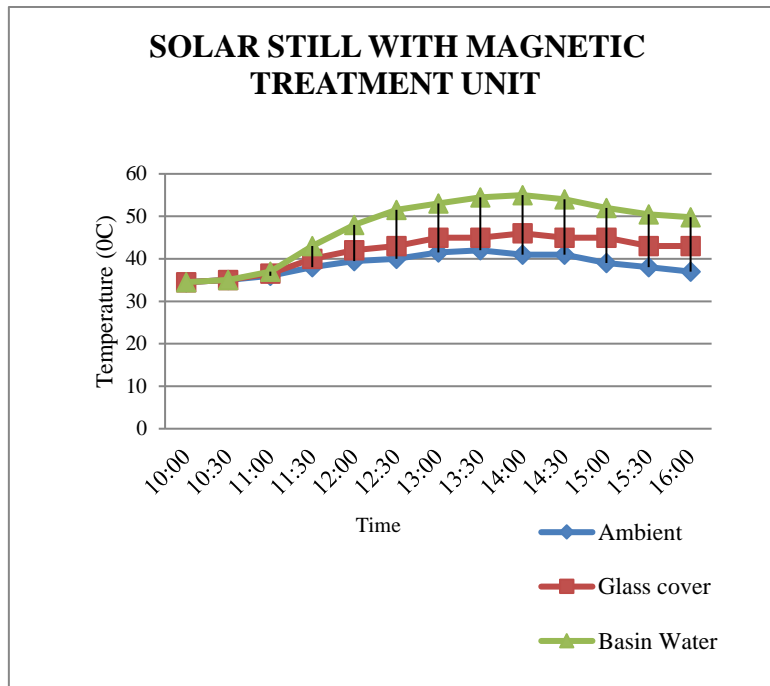


FIGURE 3. Graph of Solar still with Magnetic treatment unit

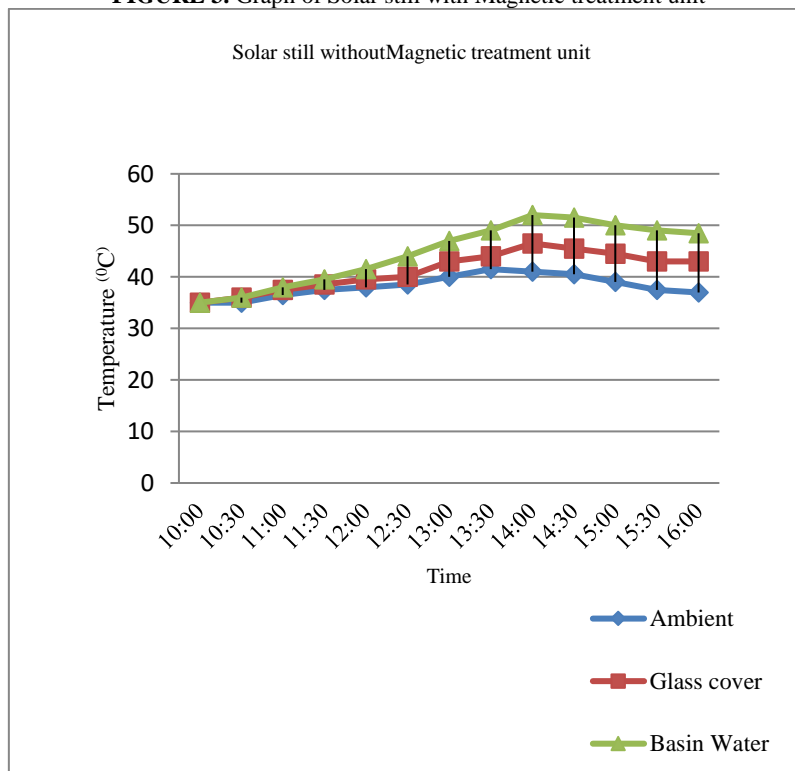
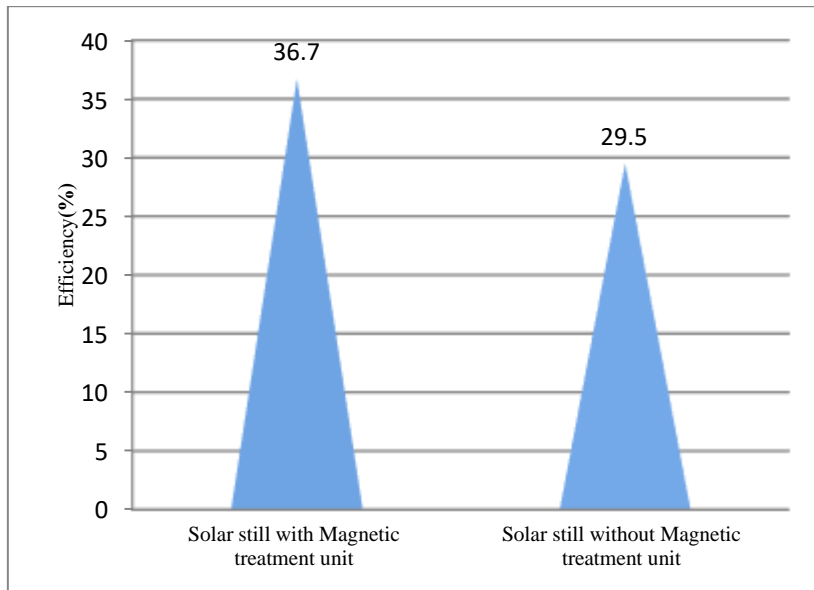


FIGURE 4. Graph of Solar still without Magnetic treatment unit

**TABLE 1.** The efficiency and productivity for the experiments are calculated and shown in the table 1.

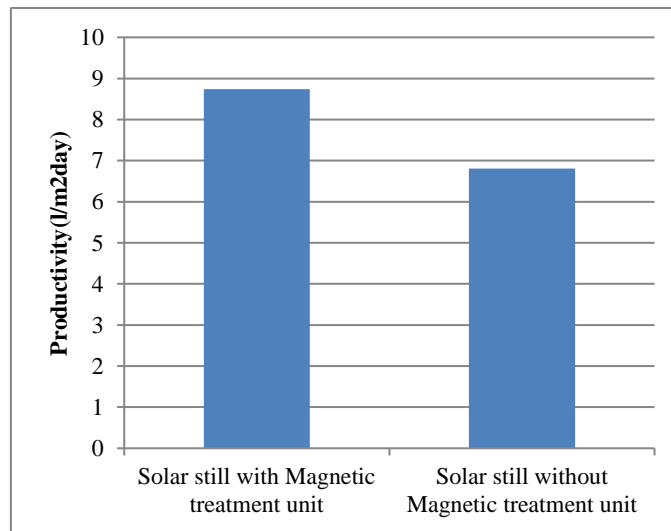
Name of the experiment	Efficiency	Productivity (l/m <sup>2</sup> per day)
Solar still with Magnetic treatment unit	36.7	8.74
Solar still without Magnetic treatment unit	29.15	6.81

The efficiencies for the above experiments are as following Figure. 5.



**FIGURE 5.** Efficiency comparisons of solar stills with and without magnetic treatment unit

The productivities for the above experiments are in the following Figure. 6.



**FIGURE 6.** Daily productivity (l/m<sup>2</sup> per day) comparisons of solar stills with and without magnetic treatment unit

The results showed in the Graph 3 that the highest efficiency is at using of solar still with magnetic treatment unit 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 comparison of the daily productivity of distilled water between solar still with and without magnetic treatment unit is shown in Graph 4. The daily productivity of solar still with magnetic treatment unit is higher than other systems. The daily productivity of the solar distiller provided with magnetic treatment unit is improved by increasing the evaporation and heat transfer rate of the system as magnetic water. The daily productivity of solar still with magnetic treatment unit is improved by comparing with solar still without magnetic treatment unit as shown in Graph 4.

#### 4. CONCLUSION

A basin solar still is fabricated and tested. The optimized modified desalination system is solar still with magnetic treatment unit. 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 and it is improved by 28% 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.

#### Nomenclature

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

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