International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 3.45 (SJIF-2015), e-ISSN: 2455-2585
Volume 3, Issue 11, November-2017

DESIGN OF SOLAR STILL INTEGRATED WITH CONDENSER FOR BETTER OUTPUT

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Abstract: water is the basic necessity for human along with food and air. There is a little pure water left on earth and nearly all of this polluted by both pollutants and toxic chemicals. For this reason, purification of water before consumption is extremely important. Solar desalination is one of the cheapest methods for distilled water production. Single basin solar still is a popular solar device used for converting available brackish water into portable water. Because of its lower productivity, it is not popularly used. The basin still is developed by adding the condensing unit. In this study was conducted by testing the solar still by using the condensing unit with a single glass cover. It has been observed that condensing unit attachment gives the higher productivity and efficiency as compared to the single basin solar still without condensing unit.

Keywords: solar still, Basin, Condensing unit, single glass cover, exhaust fan.

1. INTRODUCTION

Water is a blessing from god and it assumes a key part in the improvement of an economy and thus for the welfare of the country. The interest for the new water is expanded quickly because of populace development and fast industrialization. Non accessibility of drinking water is one of the real issues looked by both created and creating nations. Today, most of the health issues are owing to the non availability of clean drinking water. In recent decades, various parts of the world receive insufficient rainfall resulting in increase in water salinity. The pollution of water resources is increasing drastically owing to several factors including growth in population, industrialization, urbanization, etc. These activities adversely affected the water quality in rural areas and agriculture [2] .All around, 200 million are spent a day, for the most part females, to gather water from far off, frequently dirtied sources. On the planet, 3.575 million individuals pass on consistently due to water related ailment. Basic medical facilities were not spotted in numerous villages in the developing and developed countries. Most of rural people are still unaware of the consequences of drinking untreated water. People living together in remote areas where fresh water supply by transport is expensive, face the problem of water shortage every day [1].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 water into portable 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 condensing 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 simple, cost effective, and environmentally friendly.

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 [9].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 [5]. Solar radiation is absorbed by the Earth's land surface, oceans – which cover about 71% of the globe – and atmosphere. Warm air containing evaporated water from the oceans rises, causing atmospheric circulation or convection. When the air reaches a high altitude, where the temperature is low, water vapour condenses into clouds, which rain onto the Earth's surface, completing the water cycle. The latent heat of water condensation amplifies convection; producing atmospheric phenomena such as wind, cyclones and anti-cyclones Sunlight absorbed by the oceans and land masses keeps the surface at an average temperature of 14 °C. By photosynthesis, green plants convert solar energy into chemically stored energy, which produces food, wood and the biomass from which fossil fuels are derived.

2. EXPERIMENTAL SET UP

In this research design the single basin solar still with condensing unit is designed and constructed from 1.5 mm galvanized iron with a net basin area 0.1815 m^2. A 4 mm thick glass cover was fixed at an angle of 17^0 to horizontal. In order to maximize the absorption of solar radiation and the inner side of the galvanized basin is painted by black paint .To prevent the heat loss from the base and sides of the galvanized basin in the solar still was covered with 14 mm thick thermocol. The still contains the 10 mm diameter copper condensing coil and low power exhaust fan with a 12 V capacity is to be connected at the back side of the solar still. The exhaust fan runs through the sealed lead acid battery. This is called as the advanced solar still which has been attached with condensing unit.

The proposed model of the basin solar still with condensing unit is as shown in the Fig 1, 2A, B and C. Condensing unit is connected back side of the still. It consists of small power an exhaust fan run with a 12V sealed lead acid battery. Tap water is used as a coolant. The saturated air with water vapour is removed from the basin by using the low power exhaust fan. It produces the cool fresh water at through copper coil.

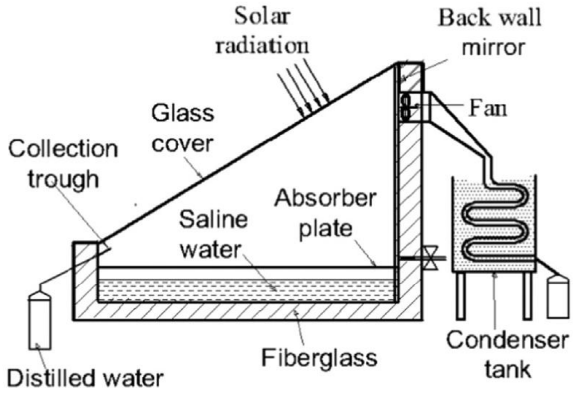

Fig: 1. Schematic diagram of solar still with condensing unit

Fig .2A

Fig .2B

Fig.2C

A. Front view B. Top view C. Side view

1. Glass cover, 2. Water inlet, 3.Water tank, 4. 12v Battery, 5. Cooling fresh water collection, 6. Battery, 7. Funnel, 8. Channel, 9. Exhaust fan, 10. Solar still, 11.Solar basin, 12. Solar still, 13. Cooling water, 14. Copper coil.

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 the saline water into fresh water by solar heating of water from oceans, lakes, rivers and other large bodies of water. Vapour are being continuo sally 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 fig 1.

The radiation falls through the glass on to the Absorber. The basin is filled with brackish water, this absorber works best if the basin is coated with black paint. The radiation warms the basin and gradually the water. To reduce the 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 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 17^0 from the horizontal. As the water from the basin is evaporated the water. The whole distiller must be air tight to prevent the losses of vapour to achieve the best result.

An exhaust fan is used to remove the water vapour from the basin and allowed to pass through the copper condensing coil. By adding this copper condensing coil to the still the efficiency and productivity both are increases. By this process of operation, the temperature of basin water, ambient and glass covers can be calculated and analyse for still with condensing unit with single glass cover and non condensing unit with single glass cover and then calculate the efficiency and productivity.

2.2 FOR HIGH EFFICIENCIES THE SOLAR STILL SHOULD MAINTAIN

- A high feed (impure) 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].

$$\eta(\%) = \frac{M_{out}\ h_{fg}}{H_{av}\ A_g}\ x100 \qquad (1)$$

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

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

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). Fig. 3 and Fig. 4 illustrate the change in the temperature of ambient, glass cover, condensing coil and basin water during day hours with and without condensing unit of the solar still. A result shows that the temperature of ambient increases with increasing day hours up to maximum value at 2:00 pm and then it decreases. But the temperatures of glass cover and basin water are increases with increasing time up to maximum value at 2:30 pm and then it decreases. This is because increasing of solar radiation intensity with time at 10:00 am to 2:00 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 temperatures of basin water are 48.5^0C and 47^0C at solar still with condensing unit with and solar still without condensing unit respectively.

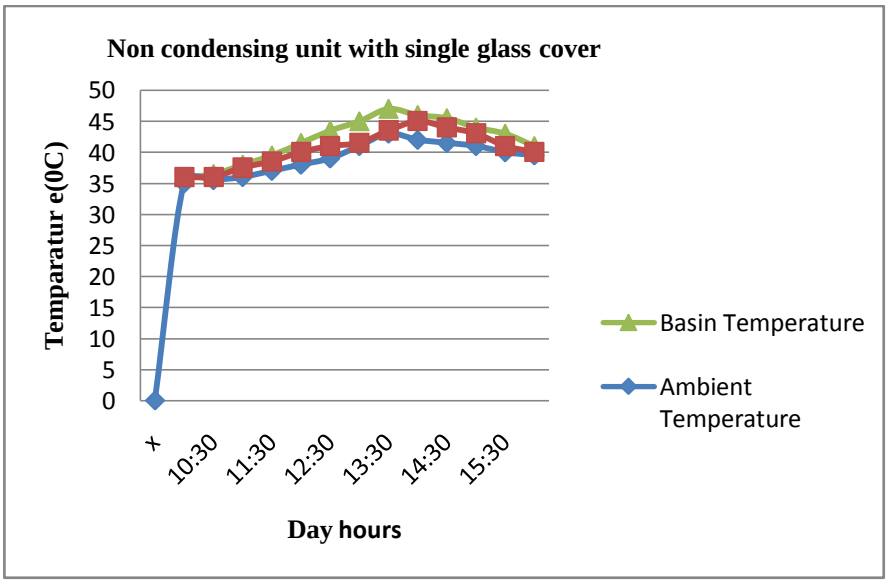

Fig.3 change of temperature v/s time without condensing unit

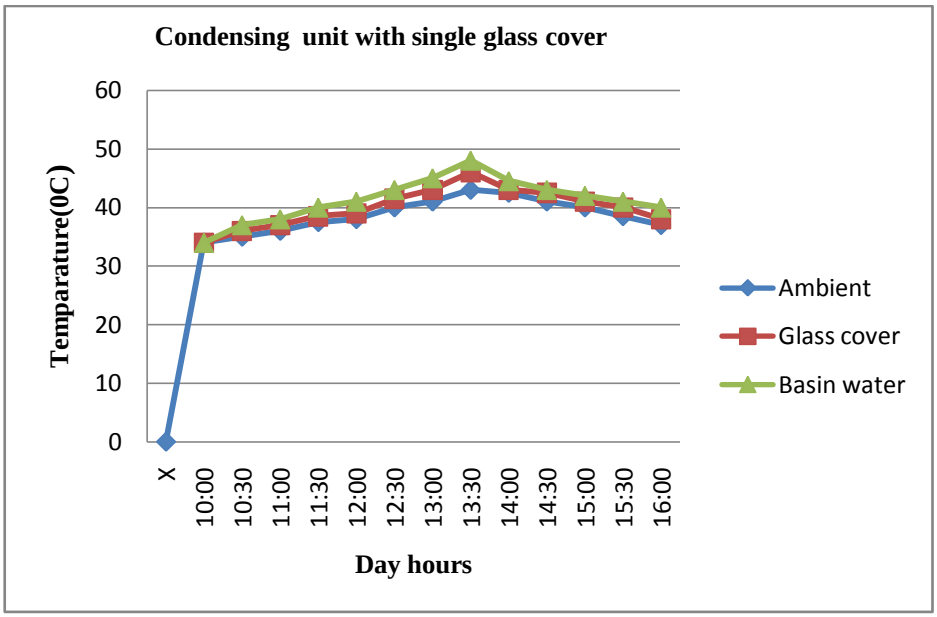

Fig.4. Change of temperature v/s time with condensing unit

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

TABLE 1

Name of the experiment	Efficiency (%)	Productivity (l/m2 per day)
Solar still without condensing unit	32.31	3.08
Solar still with condensing unit	37.4	4.032

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

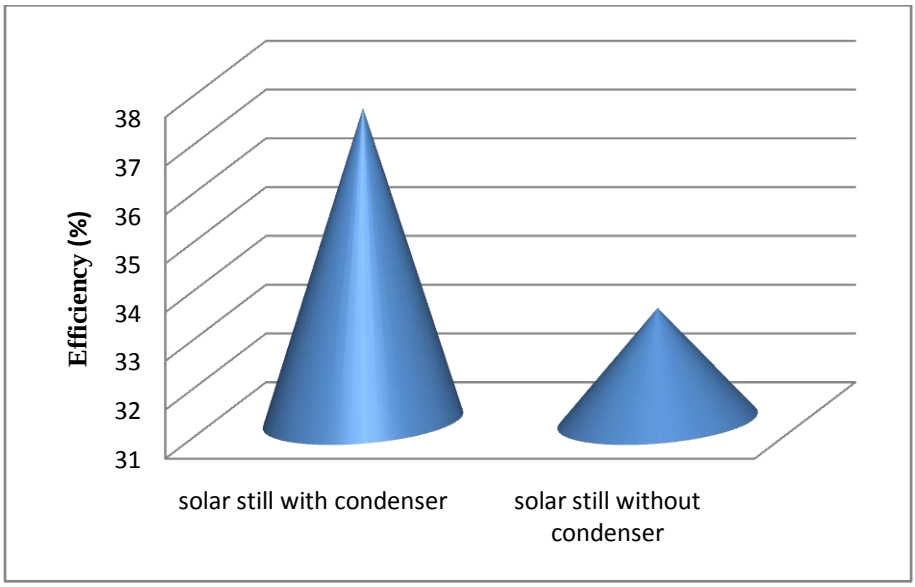

Fig: 5. Efficiency comparisons of solar stills with and without condensing unit

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

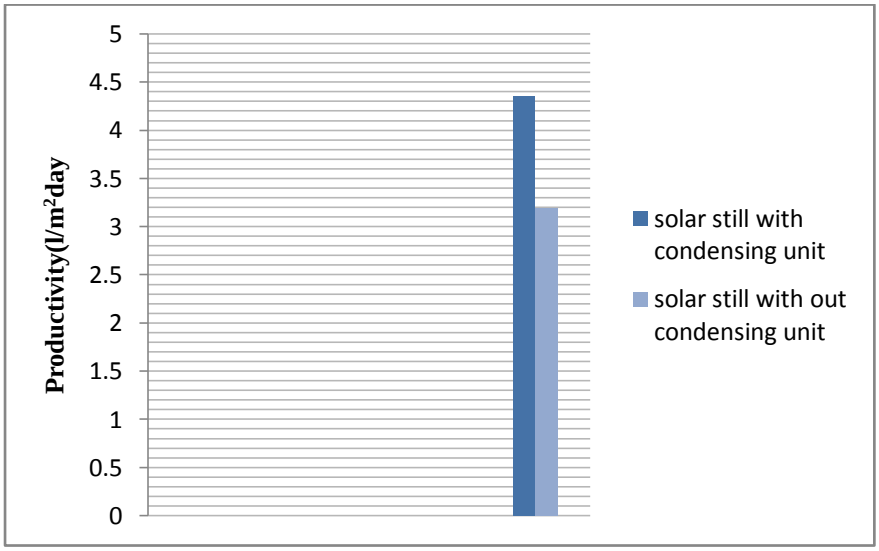

Fig. 6.productivity (l/m^2 per day) comparisons of solar stills with and without condensing unit

The results showed in the Graph 3 that the highest efficiency is at using of solar still with condensing unit and reached to 37.43 % and this is because the condensing unit leads to provide cooled water to increase the productivity of portable water significantly increases the productivity and efficiency of the solar still.

The comparison of the daily productivity of distilled water between solar still with and without condensing unit is shown in Graph 4. The daily productivity of solar still with condensing unit is higher than other systems. The daily productivity of the solar distiller provided with condensing unit is improved by increasing the evaporation and heat transfer rate of the system.

4. CONCLUSION

A basin solar still is fabricated and tested. From the above results it has been observed that the productivity and temperature difference has been increased with increasing solar radiation. It has been found that the efficiency and productivity of a basin solar still fitted with a condenser is higher than that obtained with a basic type of basin solar still. If the basin solar still with condenser is improved by 4.15 % .Highest values of these have been observed in between 1:00 pm to 2:00 pm. The productivity is found to be higher the still with condenser 4.032 litres /m^2 as compared to 3.08 litres/m^2 per day obtained from the still without condenser. Also it is found that quality of distilled water using condensing unit with single glass cover is better than other treatments. The productivity of solar still has been increasing with decreasing the water depth in the basin.

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