Austin Chemical Engineering

Austin Publishing Group

Mini Review

Performance Analysis of Solar Stills Using Sea Water with Different Heat Absorbing Materials as Still Basin-An Overview

Rao NN*, Suman P and Sridevi V
Department of Chemical Engineering, Andhra University, India

***Corresponding author:** N. Narayan Rao, Department of Chemical Engineering, Andhra University, India

Received: November 03, 2017; **Accepted:** November 29, 2017; **Published:** December 06, 2017

Abstract

Although more than 2-3[rd] of the earth crust is covered with water were less than 1% of it is (freshwater) is in humans, plants & animals reach for their survival. The demand in fresh water for drinking, agriculture & industry largely exceeds the amount that fresh sources can meet. In newly growing countries it is a challenge to access safe/fresh water. Around those accessible purification-technologies solar distillation has been center of focus in the present world. Since the production of solar still will be extremely less, numerous researches are going on to increase the production of the solar still. An effort was made to review all the existing various research works that were carried out & developed by the researchers to enhance the production of the solar still with their ability in this present field. It is found from the literature survey that, among the various methods using sand beds in the still basin is economically acceptable & convinced to the society.

Keywords: Solar Energy; Solar Still; Phase Change Materials; Heat Absorbing Materials; Productivity

Introduction

Fresh water is the basic need of human welfare and it is adversely affected by the pollution created by man- made activities, even though water represents 2/3 of the earth covered in water, yet all that, less than 1% is fresh water [1]. In the next ten years there should be a depletion of water resources and scarcity due to increase in the population growth. Around 1.5 to 2 million children die and 35 to 40 million people are affected by water borne toxic chemicals [2]. Distillation may be the a standout amongst those techniques that could a chance to be utilized to water purification Also it is that's only the tip of the iceberg prominent especially for rural regions [3,4]. The technology is simple and more economical than the other available methods. It operates similar to the natural hydrological cycle of evaporation and condensation. Solar distillation may be used to process drinking water alternately to prepare immaculate water for domestic, modern What's more business purposes. Desalination alludes all the of the procedure of evacuating salt also different minerals from water. Those salts furthermore minerals don't dissipate alongside water. Ordinary table salt, for example, doesn't turn under vapor until it gets to a temperature over 1400 ^{0}C, in this way it remains in the salt water the point when the water evaporates.

This is additionally the route we get new water in the clouds starting with the oceans. The standards of operation are same for all the solar stills. The basin of the still will be loaded for ocean water, the occurrence solar radiation is transmitted through the glass cover, furthermore may be consumed likewise high temperature by black surface which holds that ocean water [5]. The water starts to hotness up and the humid content of the air trapped the middle of the water surface and the glass disguise increments. The water vapour which is heated starts evaporating from the basin and on cooling it start condensing and from as liquid droplets inside the glass cover. In this particular process the microbes and the slats that were present inside the original water were left behind. The distillate is collected through a interior collection pipe which is attached to the glass cover at the bottom and stored in a storage bottle .The quantity of distilled water that is produced per unit area is very less in single slope solar still, makes it unacceptable in some situations. The productivity of the water can be increased by using the materials which have tendency to change phase and they can absorb heat in the solar still.

Experimental

Literature review

Many experiments have been carried out by Tripathi and Tiwari to analyses the effects of different water depths basin solar stills on the mass and heat transfer coefficients for the active and passive modes and concluded that as the water depths in the solar still increases, the distillate output significantly decreases [6]. Distilled water was also influenced by the presence of wind and the climatic changes which decreases the amount of diffuse solar energy received by the sea water [7]. The highest water collection during day time could be achieved by the uncoated sponge While using different types of absorbing materials like metallic wire sponge(coated and uncoated) and black igneous rocks [8]. The thermal conductivity of the paraffin wax is improved by embedding the aluminum powder in it (Eman-Bellah) [9]. The efficiency of a single basin solar still increases by 50% by adding carbon nanotubes to the water in the solar still basin [10]. El-Sebaii has investigated the effect of wind velocity on the output parameters of active and multi effect passive solar stills and concluded that the yield and thermal performances increases

Citation: Rao NN, Suman P and Sridevi V. Performance Analysis of Solar Stills Using Sea Water with Different Heat Absorbing Materials as Still Basin-An Overview. Austin Chem Eng. 2017; 4(3): 1056.

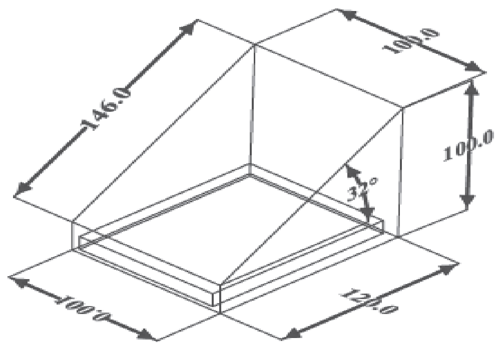

Figure 1: Single slope solar still.

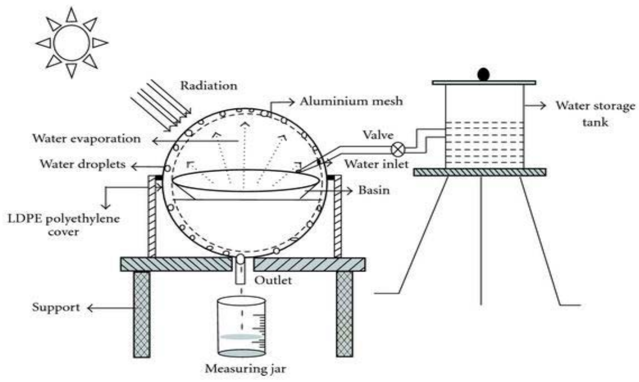

Figure 2: Spherical solar still.

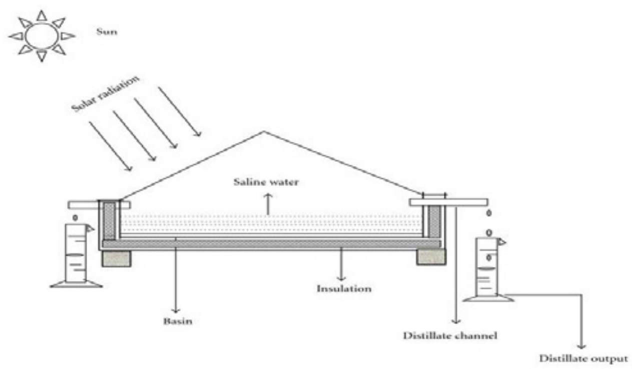

Figure 3: Pyramid solar still.

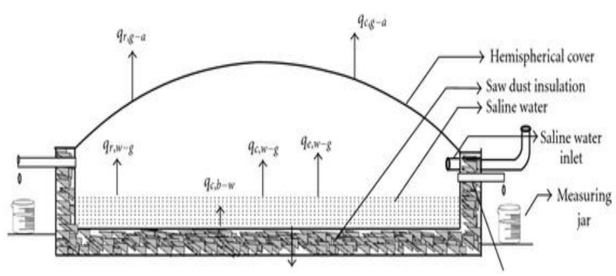

Figure 4: Hemispherical solar still.

with increase in wind speed since the rate of evaporation increases with increase in wind velocity [11,12]. Z.M. Omara & A.E. Kabeel found that using the black sand beds and the yellow sand beds in the solar still increases the productivity by 42% & 17% respectively, compared with a conventional still [13]. Krishna P.V & Priyab B.H concluded that an aluminum basin with black paint showed better efficiency when compared to that of a copper electroplated aluminum basin. The efficiency has increased from 54.66% to 65.63% [14]. The performance of the solar stills can be improved by reducing temperature of the glass cover and conduction losses from the base, sides and edges. Preventing losses due to leakages of water vapor by perfect sealing [15].

Solar desalination methods

1. Humidification and dehumidification technology
2. Solar stills
3. Multi-stage flash (MSF)
4. Reverse Osmosis
5. Electro dialysis
6. Membrane distillation

Types of solar stills

Single slope solar still: A single slope solar still (Figure 1) is a very simple device used for converting available brackish or saline or waste water into potable water. This is fabricated easily with locally available, materials like wood, aluminum etc. the maintenance is also very cheap and no skilled labor is required. Moreover, it is an excellent solution for solving drinking water or potable water problem.

Spherical solar still: A spherical solar still design with collector area of X m^2 is presented. The still consists of a shallow circular basin of diameter D m that is made of steel. The circular absorber basin is coated with black paint for maximum absorption of incident solar radiation. The circular basin is fixed at the middle of the spherical aluminum mesh at radial height of H m. The saline water is stored in a basin with a capacity of 16 liters. The basin in the spherical solar still is fitted without having any physical contact with the top cover made of low-density polyethylene (LDPE) sheet. The LDPE sheet of thickness t mm is spread over the spherical mesh. A gap of an m is maintained between the circular basin and top cover. The evaporated water, which is condensed on the top cover, passes between this gap, and trickles down towards the distilled water collection segment as illustrated in Figure 2.

Pyramid solar still: A pyramidal glass solar still design with collector area of X m^2 is presented in Figure 3. The still is filled with saline water to height of Ym. We can use sawdust as an insulating material in the solar still and minimize the cost of fabrication and the cost of fresh water production. Saw dust would be a good alternative for glass wool and eco-friendly in nature. The water storage basin of the still is constructed with dimension Lm×Bm×Hm of mild steel. The water storage segment is provided of diameter Dm, and the remaining 0.05m is allowed for the water collection segment.

Hemispherical solar still: The water storage basin of the hemispherical still is constructed with a diameter of Dm and a height

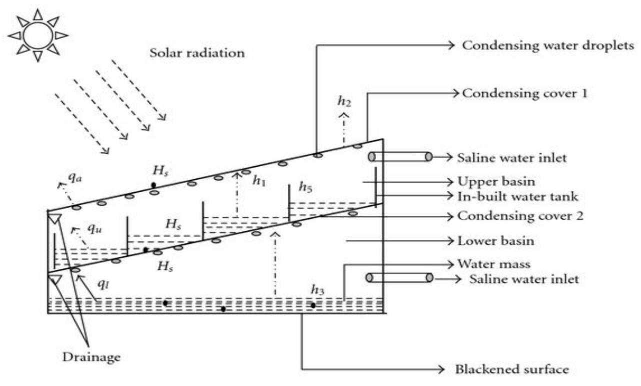

Figure 5: Double- basin solar still.

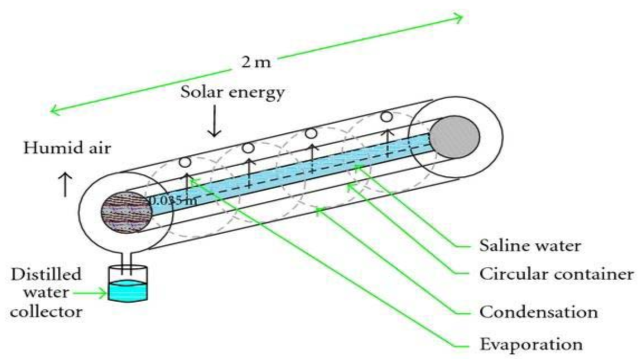

Figure 6: Tubular solar still.

Table 1: Design parameters of the tubular solar still.

Parameters	Values
Length of the glass tube	2 m
Length of the rectangular basin	1.96 m
Length of the circular basin	1.96 m
Thickness of the glass tube	2.5 mm
Weight of glass tube	2 kg
Weight of the concentric tube	7 kg
Material-top cover	Borosilicate
Absorber	Copper

of Hm using mild steel as illustrated in Figure 4. The water storage basin is painted black to increase the absorptivity. The still was filled with saline water to a height of H1m. The top hemispherical cover of diameter D1m and height H2m is constructed of transparent acrylic sheet of 3mm thickness with solar transmittance equal to 88%. The outer box of the still is constructed of wood of thickness 4 mm with the dimension Lm×Bm×Hm. The bottom of the basin is filled with sawdust (to support the weight of the basin) up to a height of 0.15m. The sides of the basin are insulated with the glass wool.

Double- basin solar still: A double-basin experimental solar still is fabricated as shown in Figure 5. The overall size of the inner basin is L1mm×B1mm×H1mm and the outer basin is L2mm×B2mm×H2mm. The solar still has a 3mm thick top cover, inclined at 17° on all the sides, and supported by steel frames. The upper basin is partitioned

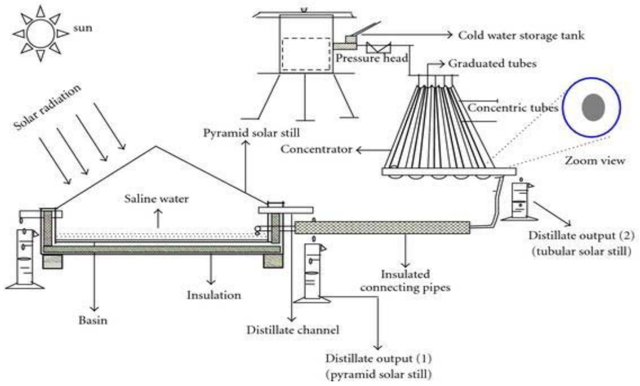

Figure 7: Cpc-Tss-pyramid solar still.

into three segments to avoid the formation of dry spots on the higher portion of the inner glass cover. Silicone rubber sealant has been used to seal off and prevent the water leakage between the boxes of the still. A hole in the basin's sidewall allows saline or wastewater filling, as well as collecting the condensed water. Moreover, this is also used for inserting the thermocouple wires required for temperature measurements. When the still is in operation, the hole is closed with an insulating material to avoid heat and vapor losses.

Tubular solar still: A CPC concentric tubular solar still design with a rectangular absorber is presented as shown in Figure 6 and the specification shown in Table 1. The inner and outer circular tubes are positioned with a 5mm gap for the flowing water and air to cool the outer surface of the inner tube. A rectangular trough of dimension Lm×Bm×Rm is designed and coated with black paint using a spray technique. The water level in the trough decreased due to fast evaporation from the basin, so a dry spot appeared in the basin. This is avoided in successive trials by flowing the water continuously in the still with the help of a graduated tube. This tube maintains a constant level of water in the basin independent of the evaporation rate. This continuous supply of water is maintained by a water storage tank, which is kept near the CPC still. The outlet of the storage tank is connected to the inlet of the CPC still.

Cpc-Tss-pyramid solar still: The inner and outer tubes are positioned with a 5mm gap for flowing cold water to cool the outer surface of the inner glass tube. A circular basin of dimension Lm length and a diameter Dm was designed and coated with black paint using a spray technique. Pyramid solar still of area an m×Bm is designed (Figure 7). The bottom of the still is insulted using saw dust. The solar still insulated with saw dust reduces the cost of fabrication. Consequently, the cost for fresh water production is less. In the view of eco-friendly material, saw dust would be a good alternative for glass wool. The pyramid solar still is coupled with a non tracking CPC with help of insulated pipes. The top cover is cooled by flowing cold water at a constant flow rate of 10mL/min. It is adjusted by using a pressure head. It is adjusted for maintaining constant water level in the water storage tank initially during the experiment. A graduated measuring jar is used to measure the flow rate. The process is repeated many times until steady cold-water flow in between the tubular cover

Conclusion

Based on the studies of various designs of solar stills mentioned above, the design fabrication of single slope solar still is easy & affordable to get potable/fresh water from impure water using solar energy. It can be operable with minimal professional knowledge on it. The performance of the still can be enhanced with the use of heat observing materials like aluminum, copper-electroplated aluminum, paraffin wax, sand, light cotton cloth, jute cloth, sponge. Among these materials sand is the material which is abundantly available at low cost with a higher production of fresh water and can effectively use for Indian climatic conditions.

References

1. Sampath kumar K, Arjunan TV and kumar PS. The Experimental Investigation of a Solar Still Coupled with an Evacuated Tube Collector. Taylor & Francis. 2013; 35: 261-270.

2. Chendake AD, Pawar RS, Thorat PV, Pol AD. Design and Development of Double Slope pipe Solar Distillation. Unit. 2015; 1-6.

3. Somanchi N, Sri Lalita Swathi Sagi, Thotakura Ashish Kumar, Ajay Parik. Modelling and Analysis of Single Slope Solar Still at Different Water Depth. Science direct. 2015; 4: 1477-1482.

4. Alludeen A, Johnson K, Gana sundar P, Abuthahir A, Srithar K. Study on stepped type basin a solar still. Journal of king sauid university. 2014; 26: 176-183.

5. Udhayabharathi K, Baskar P, Shafee SM, babu RS. Performance Analysis of wick type Solar stills. Int.J.Chem.Sci. 2015; 13: 11092-1122.

6. R. Tripathi and G. N. Tiwari. Effect of Water Depth on Intimal Heat and Mass Transfer for Active Solar Distillation. Desalination. 2005; 173: 187-200.

7. Hanane, Aburideh, Atel Deliou, Brahim. Abbord, Fatma Alaoui. An experimental study of a solar still application on the Sea water desalination of Fouka. Sciverse. 2012; 33: 475-484.

8. Abdullah S, Abu-Khader M, Badran O. Effect of Various Absorbing Materials on the Thermal Performance of Solar Stills. Desalination. 2009; 242: 128-137.

9. M.S.Eman-Bellah and A.M.R.Ghazx. Thermal Conductivity Enhancement in a Latent Heat Storage System. Sol. Energy. 2007; 81: 839-845.

10. Gnanadason MK, Kumar PS, raj kumar, S Yousuf M.H.S. Effect of Nano fluids in a Vacuum Single Basin Solar still. IJAERS. 2011; 1: 171-177.

11. El-Sebaii AA. Effect of Wind Speed on Active and Passive Solar Stills, Energy Conversion and Management. 2004; 45: 1187-1204.

12. El-Sebaii AA. On Effect of Wind Speed on Passive Solar Still Performance Based on Inner/Outer Surface Temperatures of the Glass Cover, Energy. 2011; 36: 4943-4949.

13. Omara Z M and Kabeel AE. The Performance of different Sand beds solar stills. IJGE. 2014; 11: 240-254.

14. Krishna PV, Priya BH, Sridevi V, Kumar KH. Experimental Studies on Single Slope Solar Distillation Unit with different coatings on Basin. Austin Chem Engineering. 2016; 3: 1044.

15. YP Yadav. Performance Analysis of a Collector Coupled Solar Still, IJSE. 2000; 21: 29-44.

Austin Chem Eng - Volume 4 Issue 3 - 2017
ISSN : 2381-8905 | www.austinpublishinggroup.com

Citation: Rao NN, Suman P and Sridevi V. Performance Analysis of Solar Stills Using Sea Water with Different Heat Absorbing Materials as Still Basin-An Overview. Austin Chem Eng. 2017; 4(3): 1056.