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SOLAR POWER WATER DISTILLATION

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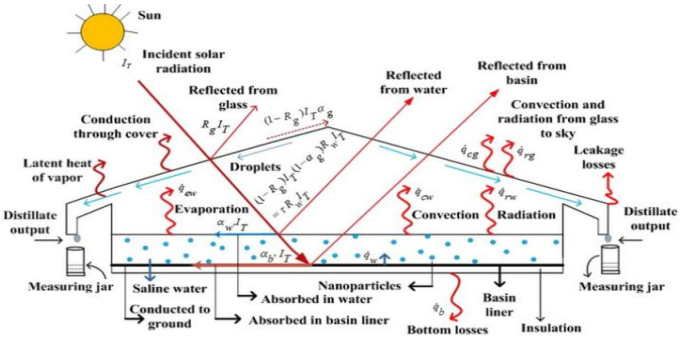
Abstract - Water is the main source for sustaining living beings on earth. Water shortage has become one of the major global challenges, which is linked to population growth. Ground water and reservoirs are the available sources of fresh water to fulfill the needs of living beings. But these sources are not always useful due to dissolved impurities. Solar distillation is an effective method by which we can purify the water with the help of solar radiation. The main goal of this paper is to improve the water quality by building a solar water distillation system.

***Key Words*: Solar water distillation, Solar Energy, Active techniques, etc.**

1. INTRODUCTION

Water is an essential element on earth for the living beings. Nearly 70% of earth surface is covered with water .Water is available in different forms such as sea water, surface water, underground water, and atmospheric water. Water on earth is contaminated with impurities and chemical substances. Therefore it cannot be used for agriculture, industrial and human consumption. Demand for clean uncontaminated water is an integral part of daily life. Healthy drinking water is unavailable in impoverished region is increasing day by day parallel to increasing population on earth. Its impact on industrial, agriculture and health is not possible to ignore. Excessive use of chemical fertilizers for agriculture, industrial discharge of chemical waste, surface run off from construction sites makes water polluted.

Renewable energy is accepted as a source for energy in future on this earth. Distillation is thermal energy based process that removes impurities from water. Solar distillation is one of the methods of getting potable water using solar energy. Solar distillation is cost saving in comparison to other types of distillation such as reverse osmosis, due to easily available solar energy. Solar distillation is highly effective in cleaning up impure water to provide safe drinking water. It is an affordable and reliable source of potable water. Now day's solar stills are widely used for distillation. It is one of the most important and technical application of solar energy. It is an inexpensive device.



2. BASIC PRINCIPLE OF SOLAR STILL

A solar still is a device used to produce clean, drinkable water from dirty water using solar energy from the sun. This process removes impurities and eliminates microbiological organisms. It is coupled with thermal collectors, concentrators, and photovoltaic panels which makes the system active and increases distillation three to six times. The sun energy heat water to the point of evaporation. When water evaporates, water vapour rises, which condenses on the glass surface.

3. PARTS OF THE SOLAR STILL

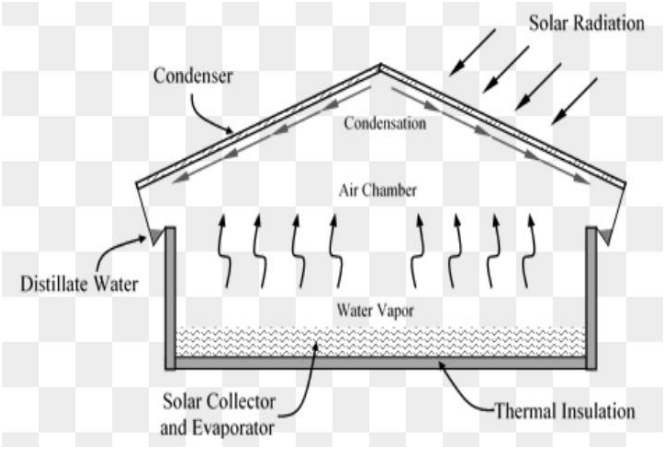
The major parts of a solar still are given below.

A. Transparent cover-It should have high transmittance for solar radiation, opaque to thermal radiation, low cost, light weight, easy to handle and apply, long life, resistance to abrasion and universal availability. This cover transfer solar radiation into the still and also helps to condensate the vapour. The material uses for transparent cover are glass.

B. Black liner-It should be durable, easily cleanable, water tight, low cost and should be able to tolerate temperature around 100 degrees Celsius. It is used to absorb solar radiation in the basin of the solar still.

C. Basin tray- The water is initially stored in the basin tray of the solar still. The materials used for basins should have

long life, high resistance to corrosion and low cost. The commonly used materials are steel, galvanized iron, wood, aluminium, asbestos cement, concrete etc.



.**D. Sealant**-It is used to prevent the vapour leakages through the sides of the transparent cover in the solar still. Materials should remain resilient at low temperatures. Materials used as sealant are putty, tars, tapes silicon etc.

E. Insulation-The solar still are thermally insulated to prevent the heat loss through the side walls and the basin. Vapour leakage is prevented by sealant. The energy received from the sun should be kept inside the still to vaporize water. The materials used are saw dust, glass wool etc.

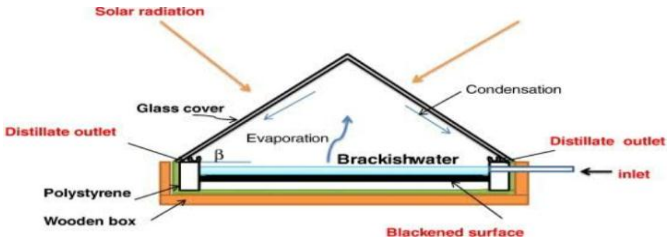
F. Condensate channel-The vapours which are generated inside the solar still is condensed on the inner surface of the transparent cover and water droplets move down words through the transparent cover. The fresh water is collected through the condensate channel fitted inside the solar still. The materials used for the condensate channel are galvanized iron, aluminium, plastic materials etc.

G. Water supply system-Brackish water should be supplied into the still continuously. In noctournal production stills water is fed once a day. In wick type systems, the feed rate of water should be kept equal to the evaporation rate of water from the still. The water supply system includes overhead tank, pipes to carry water into the still and regulatory valves.

4. TYPES OF SOLAR WATER DISTILLATION SYSTEMS

Solar distillation process is carried out by two different modes namely **passive distillation system and active distillation system.**

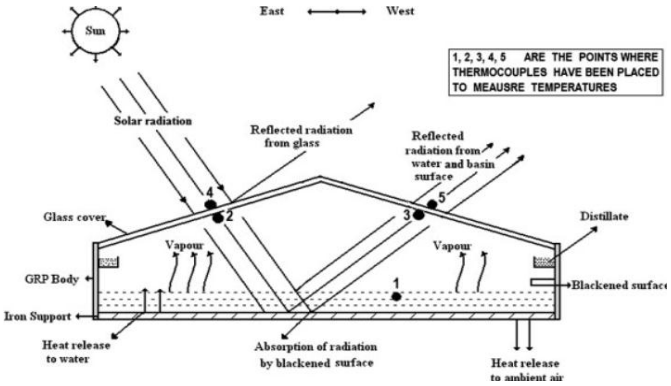
A. Passive distillation system:- It uses direct sun energy for its operation. It gives lower yield in comparison with active distillation system. In present days, most of the solar stills are working on passive distillation system because they need sunshine to operate it. The solar radiation is received directly by the solar still and is the only source of energy for rising the water temperature and thus the evaporation of water which condenses on the glass surface leads to lower productivity of pure water. The solar still used for passive distillation system is of a convectional design is basically a sealed enclosure, containing impure water. The impure water is heated by absorption of solar radiation which is passed through the glass cover. The convective circulation of humid air induces the temperature difference between the impure water and the top condensing glass cover. This causes the transport of water vapour from the impure water to the top transparent glass cover and from there it condenses into the distillate chamber. The parameters which are affecting the solar still are water depth in the basin, material of the basin, wind velocity, solar radiation, inclination angle of the glass cover and ambient temperature. The yield from the solar still is proportional to the temperature difference of water in solar still and inside of the glass cover.



Experimental observations made on 27 may 2018 by passive solar distillation system

Time (hrs)	INNER GLASS TEMPERATURE (ºC)	OUTER GLASS TEMPERATURE (ºC)	WATER TEMPERATURE (ºC)	SURROUNDING TEMPERATURE (ºC)	DISTILLATE OUTPUT (ML)
10:00 AM	39.4	31.3	40.3	31.9	98
11:00 AM	48.4	46.6	56.1	33.2	156
12:00PM	57.7	55.3	64.2	36.6	168
1:00 PM	62.3	58.7	68.8	39.2	180
2:00 PM	64.5	60.6	70.5	42.1	205
3:00PM	56.6	52.4	63.8	43.4	230

B. Active distillation system: It is an efficient technique to fulfill the need of potable water for a family using renewable energy. It uses external sources of energy to power blowers, pumps and other types of equipment to collect, store and convert solar energy. These external sources supply thermal energy to the basin water along with the direct sun rays. It uses pumps or fans to circulate fluid through solar collectors. It combines with external sources such as flat plate collector, photo voltaic panels, evacuated tube collector, heat pipe and hybrid system which improves the daily distillation productivity and makes the solar still active. The solar collectors use liquid or air as conductors to store and convert energy. Those that use liquid are known as hydraulic collectors, while those that contain air are called air collectors. Liquid conductors are more common than those that are air-based, as liquid is generally more efficient at conducting heat; while air based solar systems have the benefit of non freezing.



The active solar distillation is mainly classified into three categories, such as high temperature distillation, pre-heated water distillation, nocturnal production. Some of the basic benefits of active systems is that controls can be uses to maximize their efficiency. It promotes faster and larger quantities of fresh water generation. Drawback of active solar distillation system is its high initial cost and low efficiency. It also include that the external power sources can fail and that control require maintenance. To improve the performance of active solar distillation system combinations of different parameters can be tested. Integration of solar distillation technologies with other systems can improve the energy efficiency of the system. To make the active solar system less costly, along with improvement in its efficiency is a big challenge for the researchers.

Experimental observations made on 28 may 2018 by active solar distillation system

Time (hrs)	INNER GLASS TEMPERATURE (ºC)	OUTER GLASS TEMPERATURE (ºC)	WATER TEMPERATURE (ºC)	SURROUNDING TEMPERATURE (ºC)	DISTILLATE OUTPUT (ML)
10:00AM	40.3	32.4	41.1	32.4	132
11:00AM	50.9	47.3	60.6	35.3	188
12:00PM	58.2	55.7	63.4	37.5	254
1:00PM	63.4	59.1	70.2	38.7	421
2:00PM	67.7	62.5	74.5	40.9	456
3:00PM	57.4	54.2	65.9	42.6	308

5. RESULT OF SOLAR STILL

The production of distilled water depends on the solar radiation and on the level of water in the tank. When the radiation increases production also increases. There is an inverse relationship between solar radiation and water level in the tank. The daily output of solar still depends upon the ratio of water vaporization energy and latent heat of vaporization.

The solar still output is given by:-

$M_{OUT} = \eta_{OVERALL} \times G \times A / \Delta hv$

$\eta_{OVERALL}$= Overall Efficiency of Solar still

Δhv = Enthalpy of vaporization

A=Area of basin

M_{OUT}=Water output

ASSUMPTIONS

A. Glass cover inclination is small.
B. The condensation that occurs through the glass is film type.
C. The solar still is vapour leakage proof.
D. Irradiation of sun, can take a longer production time.
E. Water level in the basin is maintained at a constant level.
F. The absorbing heat capacity of the glass cover is negligible.

6. CONCLUSION

Water and energy are the basic necessity for all of us to lead a normal life on earth. Solar energy is abundant and limit less, free of cost and environmental friendly. The technology based on solar energy and its usage is very important and useful for developing and underdeveloped countries, to sustain their energy needs. Use of solar energy in distillation process is one of the best applications of renewable energy in daily life. Solar distillation is the best solution for small communities who are facing problem in getting fresh water. Solar still is good for operation, maintenance, repair and are user friendly to the human beings in nature. The development of solar powered water distillation has demanded the need of efficient operation to maximize the efficiency. This paper investigates the optimization of different parameters of distillation process. According to this maximum output is possible in the month of March and April.

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REFERENCES

1.Malik, M.AS, Tiwari, G.N., kumar, A., and Sodha, M.S. Solar Distillation. Pergamon press Ltd, 1982, 20-150.
2.G. Mink, M. Aboabbous and E. Karmazsin, "Design parameters, performance testing and analysis of a double-glazed, air-blown solar still with heat recycling, Solar Energy", 62 (1998) 309–317.
3.Coffrin, Stephen; Frasch, Eric; Santorella, Mike; and Yanagisawa, Mikio, "Solar powered water distillation device". Mechanical Engineering Undergraduate Capstone Projects.Paper 95, 2007.
4.Brenidorfer B, Kennedy L, Oswin Bateman CO, Trim DS (1985). Solar dryer; their role in post-harvest processing, text book, first edition, 133 Int. J. Sci. Technol. Educ. Res. Commonwealth Secretariat Marlborough house, London, Swly 5hx.p.237.
5.Kumar S, Tiwari GN, "Performance evolution of an active solar distillation system". Energy-an. Int. J., 21(9): Pages 805-808, 1996.
6.Donald R. Rowe, Isam Mohammed Abdel-Magid, Handbook of Wastewater Reclamation and Reuse, CRC Press,Jul 25, 1995, Page 205.
7.Anil,K,Rajvanshi., 1981.Effect of various dyes on solar distillation. Solar Energy Vol. 27, pp: 51-65.
8.Bilal, A, Akash.,Mousa, S, Mohsen., Omar Osta., YaserElayan., 1998. Experimental Evaluation of a single basin solar still using different absorbing materials. Renewable Energy, Vol. 14, Nos.1-4, pp: 307-310.
9. HimaBinduBanoth., BhramaraPanithapu., Ravi Gugulothu., Naga SaradaSomanchi., Devender, G.,Devender, V.,BanothuKishan., 2014.A Reviewon Performance of Solar Still with Different Techniques. Proceedings of International Conference on Renewable Energy and Sustainable Development (ICRESD 2014), pp: 393-398.
10. NagasaradaSomanchi., HimaBinduBanoth., Ravi Gugulothu., Mohan Bukya., 2014. A Review on Performance of Solar Still Coupled with Thermal Systems. Proceedings of 2014 1st International Conference on Non Conventional Energy (ICONCE 2014), pp: 114-118.
11. SampathkumarKaruppusamy., 2012.An experimental study on single basin solar still augumented with evacuated tubes. Thermal Science, Vol.16, No. 2, pp: 573-581.
12. H. Aybar, "Mathematical modeling of an inclined solar water distillation system," Desalination, vol. 220, 2006.
13. K. S. Ramesh and P. S. Dusan , "Fundamentals of Heat Exchanger Design," Hoboken, New Jersey, John Wiley & Sons, 2003.
14. H. Anderson and D. Cummings, "Agriculture Victoria," November 1999. [Online]. Available: http://agriculture.vic.gov.au/agriculture/farm-management/soil-and-water/salinity/measuring-the-salinity-of-water. [Accessed 13 Febuary 2017].
15. "MATLAB," [Online]. Available: https://se.mathworks.com/products/matlab.html. [Accessed 18 May 2017].
16. "Valves online," [Online]. Available: http://www.valvesonline.co.uk/manual-valves/float-valves/brass-ball-float-valve.html. [Accessed 2 April 2017].
17. "climatemps.com," [Online]. Available: http://www.mogadishu.climatemps.com/december.php. [Accessed 10 May 2017].
18. Lenntech Water treatment & purification Holding B.V, "lenntech.com," [Online]. Available: http://www.lenntech.com/calculators/conductivity/tds-engels.htm. [Accessed 13 February 2017].
19.Gleick, P.H. (2002). Dirty Water: Estimated Deaths from Water-Related Disease 2000–2020, Pacific Institute for Studiesin Development, Environment, and Security, pp. 1–12.
20.Stuber, M.D., Sullivan, C., Kirk, S.A., Farrand, J.A., Schillaci,P.V., Fojtasek, B.D., &Mandell, A.H. (2015). Pilot demonstrationof concentrated solar-powered desalination of subsurfaceagricultural drainage water and other brackish groundwater sources, Desalination, 355, 186–196.
21.Reddy, K.V., &Ghaffour, N. (2007). Overview of the costof desalinated water and costing methodologies, Desalination,205, 340–353.
22.Al-Alshaikh, A. (2014). A Comparison between MSF and MED Desalination Technologies, The 2nd Saudi International Water Technology Conference. King Abdulaziz City for

Science and Technology (KACST), Riyadh, Kingdom of Saudi Arabia, 23–25.
23.Sivakumar, V., &Sundaram, E.G. (2013). Improvement techniques of solar still efficiency: A Review, Renewable and Sustainable Energy Reviews, 28, 246–264.
24.Miller, J.E. (2003). Review of Water Resources and Desalination Technologies, in: Report 2003-0800, 54, Sandia National Laboratories.
25.Mathioulakis, E., Belessiotis, V., &Delyannis, E. (2007).Desalination by using alternative energy: Review and State-of-the art, Desalination, 203, 346–365.