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A Review on Solar Water Distillation Using Thermal Energy Storage.

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ABSTRACT

Although two-thirds of earth is covered by water, the scarcity for potable drinking water has increased world-wide. This is mainly because of the huge increase in industries and population. De-salination is one of the processes to convert saline water into drinking water. One of the techniques for carrying out de-salination is by using solar stills. In solar stills, the heat energy from sun rays is used for the conversion of saline to potable drinking water. By evaporation and condensation processes that occur in the solar stills, de-salination happens. Various research works are being carried out to increase the efficiency of solar stills. Many internal and external modifications are done on the solar stills to enhance its performance. These modifications are briefly reviewed in this paper.

Keywords: Basin, Desalination, Distillation, Solar still.

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INTRODUCTION

The availability of potable water is a significant problem for the communities who will be in this world in the desert regions or particularly for people in arid region. Water is the essential requirement for human along with food and atmosphere. There is more or less no water left on Earth that is secure to drink without distillation. Only 1% of Earth's water is in a fresh, liquid state, and nearly all of this is contaminated by both diseases and poisonous chemicals. For this reason, distillation of water supplies is enormously important. The future of the globe is high dependent on renewable energy sources.

The depletion of fossil fuels and increase in environmental awareness has given technique to renewable energy alternatives. Many techniques have been developed for water desalination. Desalination powered by renewable energy sources is gorgeous solution to address the universal water-shortage problem without contributing significant to conservatory gas emissions. Though solar distillation is a simple technique, productivity seems to be low due to the huge thermal capacity and utilization of time. Researchers have taken hard work to make extraordinary designs of solar still for higher distillate yield. Solar energy is a fresh source of energy and has been used extensively for various purposes. Among this technique solar desalination is establish to be more economical and eco-friendly.

Classification of Solar still

Passive and Active are the two different types of solar stills.

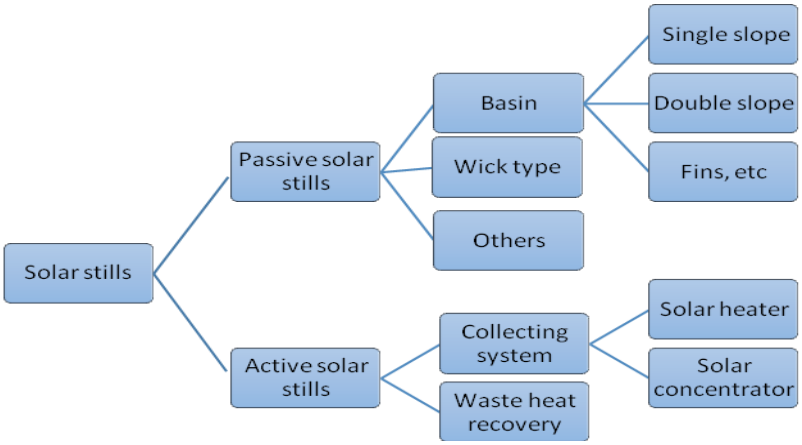

Fig 1. Classification of Solar Stills

Passive solar still

Passive solar water distillation is an economical, low-tech alternative for pure consumption water without bottles, including types of distillers, cost comparisons and going automatic. It is a conventional method and solar radiation is the only source for raising the salt water temperature. Since it operates at low temperature the output of pure water is also low.

Active solar still

Extra thermal energy is fed into the basin to increase the evaporation rate. It produces higher productivity compared to the passive solar still.

Factors affecting parameters

The main parameters affecting productivity are the depth of the basin, material of basin, Velocity of air, solar radiation, inclination angle of glass cover and ambient temperature

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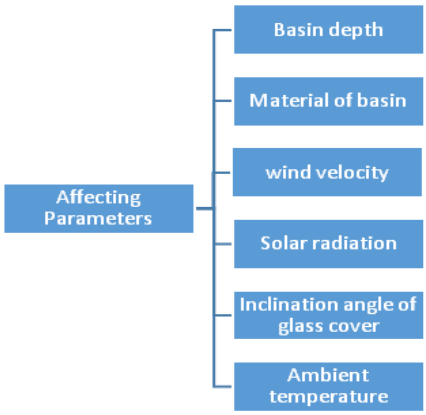

Fig 2. Factors Affecting Parameters

More researches are going on solar still with solar pond, with flat plate collector and with concentration collector. The efficiency of each type of solar still is analyzed and comparison done between the theoretical and experimental values. The various works carried out by previous researchers in solar desalination are listed below.

Table 1. Previous Investigation Obtaining Fresh Water with Solar energy

S.No	Name of the Authors	Experiment method	Modified by		Result
1	Al-Hamadani and Shukla S.K (2011)	Solar Distillation	Still alone		30%
2	Anil K Rajvanshi (1981)	Solar still added Dies	Red Die	With 50 ppm	3.60 kg
				With 100 ppm	3.05 kg
			Black Die	With 50 ppm	4.31 kg
				With 173 ppm	5.60 kg
			Green Die	With 50 ppm	5.55 kg
				With 100 ppm	5.19 kg
3	Bilal A Akash et al., (1998)	solar still	Black Rubber		38%
			Black Ink		45%
			Black Dye		60%
4	Dr. Srithar.K (2010)	Solar still Coupled with	carbon + Methanol		24.19%
			Methanol + sponges + carbon		27.41%
			carbon + Methanol + sponges+ Pebbles		30.23%
			carbon + Methanol + sponges + sand		32.32%
5	El-Sebaii.A.A et al., (2009)	Solar Still	With PCM		4.998 kg/m^2/day
			PCM With stearic acid		9.005 kg/m^2/day
6	Hikmet S Aybar et al., (2005)	Three different still basin variants	Bare plate material		1290ml/day
			Black wick cloth		1705ml/day
			Black wick fleece		2995 ml/day
7	Hussain A.K.M (2003)	Solar still with passive condenser	At glass cover		42%
			At condenser		58%
8	ImadAl-Hayek and Omar Badran (2004)	Solar still	With SGHT		45%

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			With ASGHT	56%
9	Janarthanan.B et al., (2995)	Wick solar still	Open cycle	Efficiency Increases
			Closed cycle	
10	Janarthanan et al (2006)	Solar Still deviations between experimental and numerical results	Glass cover	8%
			wick water Tilted surface	2%
			wick water Floating surface	1%
			lower end on glass cover of Flowing water	2%
11	Khaled M S Eldalil (2009)	Solar still	with Backed helical	35% (3.4 $l/m^2/day$)
			with wires Vibration	60% (5.8 $l/m^2/day$)
12	KoilM. Koilraj Gnanadason et al., (2013)	Solar still	Using GI and Copper Sheet	80% (490ml/day)
13	Mitesh I Patel et al., (2013)	sloped solar still depth water 10 cm	Red dye	18.4% (11963 ml)
			Blue dye	25.48%
				(12679 ml)
			Black dye	30.38%
				(13173 ml)
14	Mona M Naim et al., (2002)	Solar still	Solar heating Using PCM	40 ml/min
				4.536 $1/m^2$
15	Nafey A.S et al., (2001)	Solar still	Black Rubber	20%
			10 mm thick Gravel	19%
			Size: 20-30 mm	
16	Nijmeh.S et al., (2005)	Solar still with	$K2Cr_2O_7$	17%
			$KMnO_4$	26%
			Violet dye	29%
17	Rajendra Prasad et al., (2012)	Solar still	Without gel	36%
			Graphite filled With silica gel	49%
18	Safwat Nafey et al., (2002)	Solar still	3 cm Coated with aluminum	15%
			6 cm Perforated black plate	40%
19	Salah Abdallah et al (2009)	Solar still	Coated metallic with wiry sponges	28%
			Uncoated metallic among lean sponges	43%
			Black rocks	60%
20	Sampathkumar K et al., (2012)	Solar still	Still alone	1965 ml/day 8%
21	Sampathkumar and Karuppusamy (2012)	Solar still	Solar still alone	(1965 ml/day) 49.7%
22	Selva Kumar.B et al., (2008)	solar still with "V" type	With charcoal	30.05%
23	Swetha K and Venugopal J (2013)	Sloped solar still	(PCM) with Laurie acid	36%
24	Swetha.K and Venugopal.J (2014)	slope solar still	Sand alone	13%

			Sand Using Lauria acid	36%
25	Teltumbade T.R and Walke P.V (2015)	solar still	Sponge,Black ink and Rubber mat are absorbing materials	Rubber mat more yield
26	Valsaraj.P (2002)	30 mm water depth Solar still	Normal still	10% 1600 kg/m^2
			Aluminium sheet Perforated	31% 1700 kg/m^2
			Aluminium sheet folded into "V" wave	43% 2400 kg/m^2
			With natural circulation	56% (5.1kg/m^2/day)
27	Velmurugan.V and Srithar.K (2007)	Solar still integrated	Mini solar pond	27.60%
28	Velmurugan.V et al., (2006)	Solar still	Still alone	2.77 l/m^2/day
29	Velmurugan.V et al., (2008)	Stepped solar still	Without Modification	(1.01 l/8h)
30	Velmurugan.V et al., (2009)	Solar still	Using Pebbles	67%
31	Velmurugan.V et al., (2009)	Stepped solar still	Fin	53% (1.27 l/m^2)
32	Vinoth Kumar and Kasturi Bai (2008)	Solar still	Condensation	30%
33	Zeinab and Ashraf (2007)	Solar still	solar parabolic with focal pipe	18% Productivity Increased

CONCLUSIONS

- Solar energy is abundant, everlasting, environment and free of cost responsive. Solar distillation is the best solution for small communities which are facing problems with lack of fresh water. Solar still is easy in operation, maintenance and repair. The efficiency of solar still can be increased by usage of sponges, gravels, dyes etc.
- From the previous investigations and works, it is found that, several researchers have done experiments on desalination with the use of solar energy at different water depths, at various glass cover inclination angles, using different dyes and using different energy storage materials like gravel, black rubber mat, pebbles and sponges.
- But the work using heat pipe on solar still is limited and hence provide scope for further investigation.

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