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Performance Analysis of Single Basin Solar Distillation with Parabolic Reflector

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ABSTRACT: India is a country of villages and some interior location where drinking water is a major problem, and they face the challenge of usable water for human living. For the need of drinking water, water for irrigation and some industrial purposes, fresh water source must be explored. But demand for industry and extensive cultivation, cannot be meet out to solve this problem solar desalination could be an appropriate solution. Solar distillation is one of the most straightforward techniques used in water desalination. The present study is based on the experimental investigation on double slope solar still. This alternative is best suited for the place which has cost-free solar energy, for the plant installation and its less maintenance of the setup. The project is aimed to use renewable solar energy as a source for producing drinking water of local source. The conversion of raw water to purify water has been done by a solar still system.

KEYWORDS: Single Basin Single Slope Solar Still with Reflector, Solar Energy, Active techniques, etc.

I. INTRODUCTION

The industrial revolution and increased population is the main hurdle to meet out the proper supply of fresh water against its demand. The fresh water is also needed for human life and animal-based small industries in the remote and arid part of the country where solar intensity is high, but the quantity of useful water is less. Distillation, electro dialysis, reverse osmosis and vapour compression phenomenon, are being utilized to make available freshwater from raw water. The pricewise energy used in these processes is quite high. Besides the cost, accessibility of energy interior land and arid regions are not in approach. Henceforth solar distillation is the ancient effective technique to convert the raw water to potable water. Due to the availability of cost free energies such as sun and wind power to take in use in such remote areas, which is scrupulously act to utilize the renewable energy is the best choice to make to obtain potable water. The earthy source can fulfill the requirement for potable water in their capacity to overcome the shortage of fresh water. Therefore it is an intelligent decision to take in use solar energy directly by utilizing solar stills. Apart from this seawater constitutes 96.9% of global water, so this salty can also be used for those purposes by still solar conversion into distilled water [1].

The energy which is affluent, never ending, zero pollution and easily approachable is only the solar energy. This is simplest form of technique to make water usable from its raw form, several investigators have done lot of effort to make it worth full, to make the production as much as the capacity of the solar radiation incident on the top surface of still by adapting alteration in technology during its all favorable surrounding. Nafey et al. [2] stated the use of the effect of the cooling water flow rate on the desalination system productivity at the variable values of cooling water inlet temperature. The water purification by solar power is an option to cope this challenge. The water purification by solar power is cheaper in construction, no maintenance and solar energy is affluent, never ending, and reachable in different potential at a specific location, with zero pollution in spite of this the water purification by solar power struggling for its status due to the reason for its low productivity. The basin with black coating bottom filled with contaminated water

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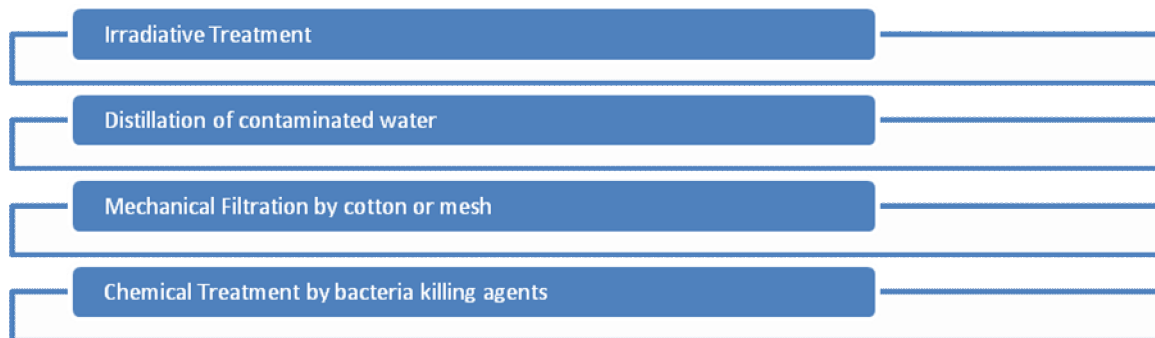
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which is enveloped totally airtight covered with wood or metal structure and a glass cover at its exposed face. The black coated surface gain much more radiation out of the received radiation through the glass cover. The main objective of this study is to increase the productivity of distill water by using absorber materials.

ALTERNATES FOR WATER DISTILLATION



II. LITERATURE REVIEW

Although there are many types of solar still plants which are conventional in construction as single basin still. Their yields are very less of the order of 1.5 to 4.5 liters per day per m^2 [3,4]. The various design of still with respect to geographical locations where drinking water can be obtained by solar energy, have been proposed by many investigators [3-6]. Single slope still is very popular, and work on this is going on rigorously [3-11]. Alnaser had studied about the outcome and its efficiency in the context of single and double basin [8]. Alnaser did two tests one for still insulation and other has no insulation. They found that insulation gives comparatively good result to produce potable water, mainly with two basins still, which around 41% higher than single basin system [8].

The technologies are existing for water distillation used, are basically run on thermal engineering concept for distillation as phase conversion or by membrane filtration, which can include categories in two groups. In the first group which is based on thermal technology such as multi-state flashing (MSF), other as multi effective distillation (MED), vapour compression (VC) and the cheapest simple in construction still distillation (SD). The Reverse osmosis (RO) is the most popular technique, along with electro dialysis (ED) [12]. Due to the running cost of energy consumption these technique and environmental hazards as the use of fossil fuels, they need for reconsideration [13]. El-Sebaili investigated computer aided modelling of wind flow effect on still productivity daily basis, which termed as passive solar stills, he experience that active as well as passive productivity can be enhanced by flowing wind up to a reasonable velocity [4]. Nijmeh investigate the key parameter of solar still generation, absorptive nature of material at the bottom of basin, how much radiation it capture which transform in to heating water, he is mainly focussed on the different material absorption capacities with single basin system like dissolved salts, violet dye, and charcoal etc. [14]. He notified that around 25% of still water generation can be improve with salts and violet dye gives better result up to 29%.

Since the last few years of decades, thermal distillation mainly dependent on solar power has been appreciated by inventors [13]. But the performances of this type of setup required for more improvement by advancing the cooling and evaporative technology. Thermo-electric refrigeration technique can be utilized as a solid state heat pump which are based on the Peltier effect [15,16]. The main feature of this device have no moving parts, and therefore its more reliable, noiseless, compact in size, easy operation, and environmentally good [17-18]. Due to the appreciation performance of thermo-electric devices, it has become more popular one.

The water level in the basin is another parameter to consider by others authors concern their research on convective heat transfer coefficient in between under glass and above water surface in the basin [20]. The sponge medium inside water may contribute to enhance still water generation suggested by Abu-Hijleh and Rababa'h [21]. Single sloped solar still was recommended by some researchers with the logic that the solar radiation directly fall on the incident glass

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plate [6]. Many researchers have focused on enhancing the performance of solar stills. Rahin et al. [22] used to support this type of techniques to improve still yield. This was done by putting away the evaporating and condensing envelopes, with the help of copper tube for condensation, while using the black aluminum plate at the basin bottom for water evaporation. The efficiency of the was increased by 31.1%. Abu-Arabi et al. [23] of a solar desalination design model by using double glass collector. If water and glass temperature differences are increased the productivity of distilling water will increase. This is by many people are taking an interest in the field of solar still.

The performance of concave wick evaporation of solar had been studied by still Kabeel [1]. The still produces 4.1 L/m² as the average daily production of his still which has 30% average efficiency. The productivity of a weir-type inclined solar still studied by Sadineni et al. [25]. This still's daily production was 5.5 L/m² if thin water films uses and temperature difference of evaporation and condensation increased. Phadataré et al. [26] used the same data to observe the effect of water depth. From last few years more people are coming forward to take part in improving solar still performance and to get more productivity they have made a simple still. Mirza et al. [28] proposed a design of simple basin solar still, properties were measured and its still efficiency was 30% and its daily productivity was 3.1 L/m². His research said that the outcome of the solar still varies with the factor of insulation and surrounding temperature. Srihar [29] quoted the still productivity increases if wick, fin and sponge can enhance the outcome of the sill, he reported that the productivity of the still increased by 45.5 %, 15.3% and 29% with fin, sponge and wick, respectively.

III. WORKING PRINCIPLE

Sunlight is collected in a variety of ways in which the saltwater located on it is converted into vapour. In this study, we have also used a reflector with single basin solar still. When sunlight strikes on the glass of solar still, the water in the basin becomes warm. The use of parabolic reflectors increases the rate of warm. The hot water turns into the vapour, and this vapour goes the inner surface of glass upwards. This vapour is collected under the glass as small droplets. By which almost all the impurities remain in the basin; steam gets condensed and convert into water droplet/like a sheet of water. Due to the gravity or slope the glass, these droplets begin to fall and collect it in one place.

In this experiment, black coated aluminium sheet, Coal powder, Jute cloth and concrete materials for increasing the evaporation of the solar still.

In this experiment the slope of the glass fixed. Which is 32° in this case and it is mainly appropriate for capture radiation. Fig 1, show the arrangement of the experiment.

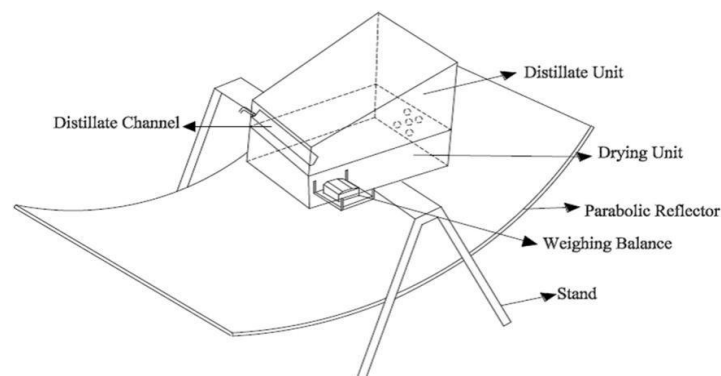


Figure.1 Experiment unit

IV. EXPERIMENT

The experiment on Single Basin Solar Distillation with Parabolic Reflector is conducted at morning at 6.30 a.m. to 5.30 a.m. during the month of Sept-Oct, 2018.

Parameters of Single Basin Solar Distillation with Parabolic Reflector:

Distillation unit efficient area = 0.25 m²

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Width of Glass = 5mm

Dimension of Drying unit = 0.5 m × 0.5 m × 0.15 m

Size of Parabolic reflector = 1.5m x 0.5m (polished stainless steel material)

Slope of glass cover = 32°



Figure.2 Arrangement of Still

V. OPERATION

The experimental setup was placed on the top of the college, Sachdeva Institute of Technology, Farah, Mathura, Uttar Pradesh, building (Boy's Hostel). The experimental procedure started at 6:30 am. The water level in this unit was constant 4cm by deliver of brackish water regularly.

The following parameters measured during the experiment:

1. Intensities of Solar
2. Temperature of Water inside the still
3. Still bottom Temperature
4. Glass Temperature

The experiments have been done in two methods

1. Top of glass is kept dry
2. Thin film of water on top surface of glass

The following materials were located for every set of reading.

Material	Properties	
	Thermal conductivity	Density
Aluminium Sheet	0.21 to 1 W/mK	1.11 to 2.31 g/cm ³
Coal	0.81 W/mK	2.41-2.81 kg/m ³
Jute	0.4127 W/mK	1.416 g/cm ³
Concrete	0.61 W/mK.	1.140 kg/m ³

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VI. RESULT

Material	Solar Distilled Water ml/8 Lt of brackish water (Dry surface of Glass)	Solar Distilled Water ml/8 Lt of brackish water water.(wet surface with Water of Glass)
1-Al Sheet	355	554
2-Coal	405	705
3-Jute	455	655
4-Concrete	330	580

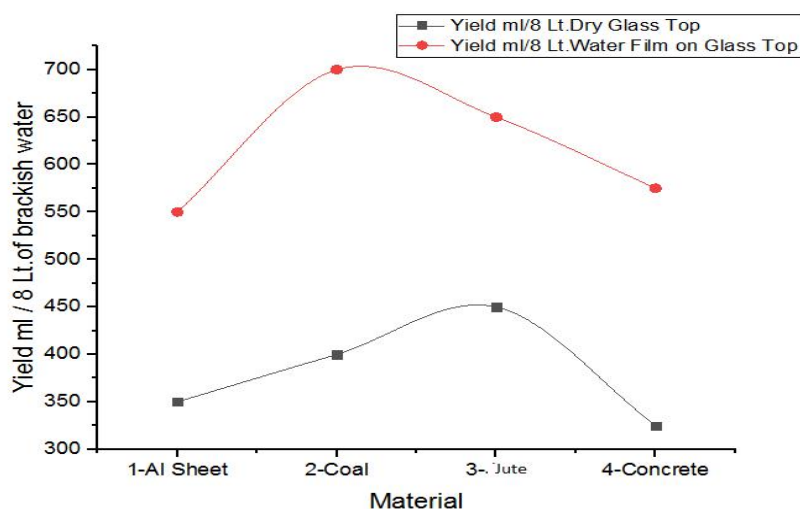


Figure.3 Solar Distilled for different materials

VII. CONCLUSION

There are following observations from the experimental study as

1. Maximum still water is obtained in case of coal is used in still with water film on glass.
2. From the experiments, it is clear that when the temperature difference will increase, rate of distillation will be increase.
3. The Distillation water for Jute is 455 ml per 8 liters of brackish water a day and for coal gives 405 ml per 8 liters of brackish water a day in dry state of operation.

With water film application yielding was improved 705 ml per 8 liters of brackish water of still water was generated by coal and 655 ml per 8 liters of brackish water a day by Jute.

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REFERENCES

1. A.E. Kabeel, Performance of solar still with a concave wick evaporation surface, *Energy* 34 (2009) 1504–1509.
2. A.S. Nafey, H.E.S. Fath, S.O. El-Helaby, A.M. Soliman, Solar desalination using humidification dehumidification processes, part I: a numerical investigation, *Energy Convers. Manag.* 45 (2004) 1243–1261.
3. Al-Hayek and O.O. Badran, The effect of using different designs of solar stills on water distillation, *Desalination*, 150 (2004) 230–250.
4. A.A. El-Sebaii, Effect of wind speed on active and passive solar stills. *Energy Convers. Mgmt.*, 45 (2004) 1187–1204.
5. M.A.S. Malik, G.N. Tiwari, A. Kumar and M.S. Sodha, *Solar distillation*. Pergamon press Ltd Oxford, 1982, 20–150.
6. A.S. Nafey, M. Abdelkader, A. Abdelmotalip and A.A. Mabrouk, Parameters affecting solar still productivity, *Energy Covers. Mgmt.*, 41 (2001) 1797–1809.
7. B.A. Abu-Hijleh and H.A. Mousa, Water film cooling over the glass cover of a solar still including evaporation effects, *Energy*, 22 (1997) 43–48.
8. A.A. Al-Karaghoul and W.E. Alnaser, Performance of single and double basin solar-stills, *J. Appl. Energy*, 78 (2004) 347–354.
9. Hanson, W. Zachritz, K. Stevens, L. Mimbela, R. Polka and L. Cisneros, Distillate water quality of a single-basin solar still: Laboratory and field studies, *Sol. Energy*, 76 (2004) 635–645.
10. K. Voropoulos, E. Mathioulakis and V. Belessiotis, Analytical simulation of energy behavior of solar stills and experimental validation, *Desalination*, 153 (2002) 87–94.
11. K. Voropoulos, E. Mathioulakis and V. Belessiotis, Experimental investigation of the behaviour of a solar still coupled with hot water storage tank, *Desalination*, 156 (2003) 315–322.
12. Sharon H, Reddy KS. A review of solar energy driven desalination technologies. *Renew Sustain Energy Rev* 2015;31(41):1080–118.
13. Mahian O, Kianifar A, Jumholkul C, Thiangtham P, Wongwiset S, Srisomba R. Solar distillation practice for water desalination systems. *J. Therm. Eng.* 2015;1(4):287–8.
14. S. Nijmeh, S. Odeh and B. Akash, Experimental and theoretical study of a single-basin solar still in Jordan, *Int. comm. Heat Mass Transfer*, 32 (2005) 565–572.
15. Rowe DM, editor. *CRC handbook of thermo-electrics*. London: CRC Press; 1995 (Jul14).
16. Goldsmid HJ. *Electronic refrigeration*. London: Pion; 1986.
17. Lv H, Wang XD, Meng JH, Wang TH, Yan WM. Enhancement of maximum temperature drop across thermo-electric cooler through two-stage design and transient supercooling effect. *Appl Energy* 2016;1(175):285–92.
18. Dizaji HS, Jafarmadar S, Khalilarya S, Moosavi A. An exhaustive experimental study of a novel air-water based thermo-electric cooling unit. *Appl Energy* 2016;1(181):357–66.
19. Zhao D, Tan G. A review of thermo-electric cooling: materials, modeling and applications. *Appl Therm Eng* 2014;66(1):15–24.
20. R. Tripathi and G.N. Tiwari, Effect of water depth on internal heat and mass transfer for active solar distillation, *Desalination*, 173 (2005) 187–200.
21. B.A. Abu-Hijleh and H. Rababa'h, Experimental study of a solar still with sponge cubes in basin, *Energy Convers. Mgmt.*, 44 (2003) 1411–1418.
22. N.H.A. Rahim, Utilisation of new technique to improve the efficiency of horizontal solar desalination still, *Desalination* 138 (2001) 121–128.
23. M. Abu-Arabi, et al., Modeling and performance analysis of a solar desalination unit with double-glass cover cooling, *Desalination* 143 (2002) 173–182.
24. A.E. Kabeel, Performance of solar still with a concave wick evaporation surface, *Energy* 34 (2009) 1504–1509.
25. S.B. Sadinini, et al., Theory and experimental investigation of a weir-type inclined solar still, *Energy* 33 (Jan 2008) 71–80.
26. M.K. Phadatar, S.K. Verma, Influence of water depth on internal heat and mass transfer in a plastic solar still, *Desalination* 217 (2007) 267–275.
27. N.H.A. Rahim, Utilisation of new technique to improve the efficiency of horizontal solar desalination still, *Desalination* 138 (2001) 121–128.
28. M.A. Samee, et al., Design and performance of a simple single basin solar still, *Renewable and Sustainable Energy Reviews* 11 (2007) 543–549.
29. V. Velmurugan, et al., Single basin solar still with fin for enha.