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Performance Study on Hexagonal Solar Still Using Wick Materials

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ABSTRACT

The provision of clean drinking water to the population is a major concern in developing nations. Various methods are used, but the challenge is to make them sustainable over time and cost-effective. Distillation is one of the traditional and practical methods used in this inversion, where sunlight is used as the process energy source because raising the temperature of saline water is sufficient for distillation and also because it is readily available for free in the majority of developing countries. People don't have to worry about the obtained water being purified, and solar still distilled water is far less expensive than the traditional way of obtaining water from saline water. Due to the increasing need for clean drinking water, numerous analyses on improving the performance of solar stills are needed to boost production. In this experiment, a novel hexagonal shaped solar desalination system has been proposed and the performance also verified. Compared to conventional solar still, the still with wick materials is very poor. Hence in this project, an attempt has been made to improve the thermal conductivity of the wick materials by adding high thermal conductivity materials in the wick.

Keywords –Solar Intensity, Solar Radiation, Vaporization, Distillation, Thermocouple.

INTRODUCTION

Importance of Pure Water in Present Scenario:
Water is essential to life. Next to oxygen, fresh water is the most important substance for sustaining human life. Access to water is a basic human right. However, the increased use and misuse of this resource by the growing population and increasing industrial activities may lead to a situation whereby countries need to reconsider their options with respect to the management of its water resources.

Today freshwater demand is increasing continuously, because of the industrial development, intensified agriculture, improvement of standard of life and increase of the world population. Only about 3% of the world water is potable and even this is not evenly distributed on the earth. A.S Nafey et al. [1] the distilled water productivity of the single basin solar still is very limited. Some methods have to be developed to improve this productivity. Mohammed shadi et al. [2] the different parameters that affect solar still productivity when the solar still productivity is very low compared with other desalination systems, such as other thermal processes or membrane processes. These parameters include environmental, design and operational parameters. The results show that productivity was highly affected by environmental parameters due to the unpredictability of metrological factors. When design and operational parameters were varied, increases in productivity were observed. The results indicated that the solar still was inversely affected by evaporation area, water depth, a minimization in the angleof the solar still cover during summer seasons and maximization during winter seasons. Hanane et al. [3] today, seawater desalination is a subject of concern to many researchers all over the world. Solar energy is available, free of cost and non-extinguishing in nature. The experiment is carried out at different conditions. It is found that the distillate production increases when the difference between the temperature of water and glass decrease. Distillated water was also, influenced by the presence of wind and the climate changes which decrease the amount of diffuse solar energy. Muhammad Ali Samee et al. [4]A simple single basin solar still was designed for 33.31 N latitude. The optimum inclination of glass cover was calculated to be 33.3o for both summer and winter. The average daily output of solar still based on data of 8 days in July 2004 was found to be 1.7 liters/day for basin area of 0.54 m2 Efficiency of the still was calculated as 30.65% with a maximum hourly output of 0.339 liters/hr at 1300 hrs. Sasilatha T et al. [5] Solar still is the ancient low cost device to distillate the saline water .There are some challenges, such as the thermo physical properties of basin material, flow rate, insulation material and thickness that must be overcome in order for this technique to be useful in practice. Hikmet S Aybar[2][3][4][5]r et al. [6] It includes basic principle of solar distillation, and the quality of distilled water. A classification of the solar still system was made to explain the types of solar still system. V. Sivakumar et al. [7] A technique used to convert brackish or saline water into potable water is called as solar desalination. The demand of consumable water keeps on increasing due to high population density and automation. Solar energy is used for the conversion phenomenon and the device used for desalination is known as a solar still. Dsilva Winfred Rufus D et al. [8] The demand for fresh water production is growing day by day with the increase in world population and with industrial growth. Solar stills require low maintenance and are readily affordable however the productivity is limited. Yogesh S. Kapnichor et al. [9] The purification of water is energy intensive process. Solar distillation is attractive alternative as it uses solar energy. It is also easy in construction, simple in operation, has low maintenance and operating cost. But they have disadvantages of high initial cost, large land requirement for installation and have output dependent on the available solar radiation. Imad Al-Hayek et al [10] Solar distillation is one of the important method of utilizing the solar energy for the supply of potable water to small communities where the natural supply of fresh water is inadequate or of poor quality, and where sunshine is abundant. It shows that the temperature at the water surface is closely related to the incident of solar radiation, and productivity of the still can be increased with decreasing water depth, and by the addition of depth.

Why Solar Desalination:

Desalination has become increasingly important in providing an economically viable solution to the problem of decreasing fresh water resources. There are many factors to take into consideration to make a new technology sustainable. As we begin the 21st century, we must look towards cleaner sources of energy. Fossil fuel resources will soon be exhausted due to alarming rate of consumption. Cleaner energies such as natural gas, solar power, and photovoltaic technology must be integrated into desalination technology.

Hexagonal Solar Still:

In the inclined type solar still, the entire basin is placed at an angle, so that the water flows from the top bottom of the absorber surface. Further to increase the distillate productivity. Wick material is placed over the inclined absorber surface which maintains the uniform thickness of water and increases the area of evaporate. In an active solar still, the basin temperature is increased by supplying the thermal energy form various external sources. Active stills are further classified into three types of follows:

Active Still with Auxiliary Heating:

In this method preheated water is used to increase the basin water temperature. The waste hot water and effluents rejected from various external sources such as chemical industries and power plants may be used to increase the thermal efficiency of active solar still. The wastewater may be supplied directly into the basin or indirectly through heat exchangers.

Active Stills with Collectors:

In this method, solar collectors are coupled with conventional passive solar still to enhance a higher temperature distillation. Here, the basin water temperature increases to 80 degrees C, by absorbing the additional thermal heat energy supplied by the solar collectors.

Active Stills with Nocturnal Production:

Nocturnal production is the working of solar still in the absence of sunlight, during the rainy seasons or night time. This may be achieved by using energy storage materials, which store energy during the daytime and liberate the same during nighttime. This can also be achieved by feeding hot wastewater available from the external sources other than so BASIN STILLS. In a basin still, water will be stagnant on a flat absorber plate, whereas in an inclined still water flows down along an inclined absorber plate. The longer flow of feed water increases the evaporation rate and distillate productivity in an inclined still, when compared with a basin still.

Design of the Hexagonal solar Still:

The actual fabrication of the hexagonal inclined solar still is shown in the below figure. The area of the basin is 0.649 square meters, and the volume of the basin is 0.129 cubic meters, fabricated using galvanized iron sheet of 18-gauge thickness. The bottom and sides of the basin are insulated by 3cm thick thermos pore sheet surrounded by a wooden frame of 2cm thickness. The surface of the basin is painted black to absorb maximum solar radiation because it is an established fact black dye is the best solar radiation absorbing material. uncertainties, experimental precautions, and experimental method. The equipment used in the hexagonal inclined solar still are wick materials, TDS & EC meter PH meter, solar intensity meter and 12-point temperature indicator, basin covered with aluminum sheets.

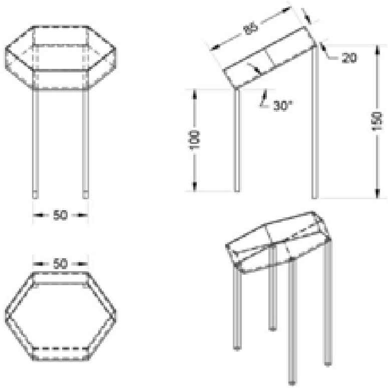

Figure 0:1 Design and Views of Hexagonal Solar Still

Experimental Setup:

The experimental setup deals with the design aspects of different modes of solar stills, experimental setup, measurement parameters, description of measuring instruments, experiments

Figure 0:2 Wick material for Water absorption

Figure 0:3 Sheet Metals

Figure 0:4 Experimental Setups

Figure 0:5 Glass with vapor droplets

S.No	Time	Solar Intensity (W/m^2)	Basin Temperature (^oC)			Temperature b/w Glass & Basin	Top Glass Temperature			Atmospheric Temperature
			T1	T2	T3		T5	T6	T7	
1	10:00	980	31	31	31	48	35	35	34	32
2	11:00	1150	32	32	32	49	36	35	36	33
3	12:00	1250	35	34	35	49	36	36	37	35
4	1:00	2000	39	39	39	50	37	37	37	36
5	2:00	1500	39	39	39	50	37	38	38	36
6	3:00	1000	40	40	39	52	38	36	36	36
7	4:00	890	42	42	43	52	35	35	35	35

The outdoor experiments were conducted at the campus of Aditya college of engineering and technology, surampalem, Andhra Pradesh , India, with test facility located at the roof of mechanical engineering department, during the month of April 2023. The schematic drawing of the integrated solar still setup used in this experimental study.

Time	10:00 am	11:00 am	12:00 pm	1:00 pm	2:00 pm	3:00 pm	4:00 pm
Day 1(Saturday)	974	1100	1050	2000	1200	900	815
Day 2 (Monday)	980	1150	1250	2000	1500	1000	890
Day 3 (Tuesday)	900	1100	1700	2000	1800	1200	800
Day 4 (Thursday)	880	956	1500	1700	2050	1500	780
Day 5 (Monday)	980	1200	1786	2086	1788	1500	800

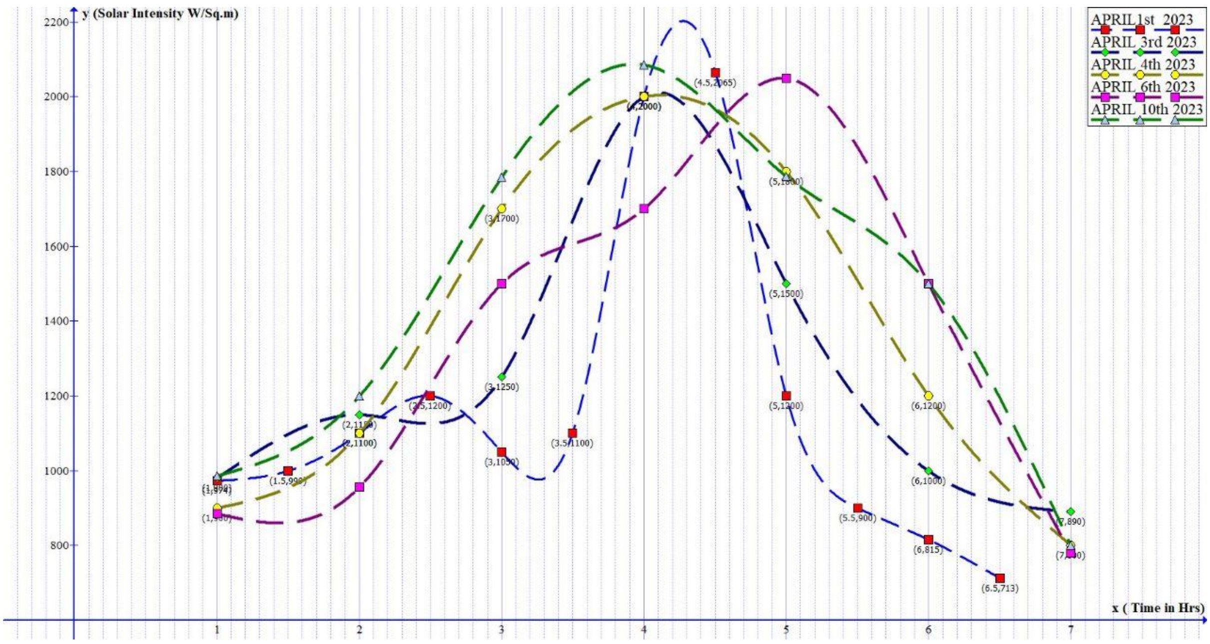

Figure 6 Variation of Solar Intensity with Respect To Time

CONCLUSIONS

Parametric studies were carried out to select the parameters for the reference still on the basis of productivity. This reference still was later employed for further improvements and comparison. The optimal parameters identified through a set of experiments include north-south orientation, 20^0 cover till angle from among 9 angles in the range of 15^0 to 30^0, 0.01m basin water depth in the range 0.01m to 0.02m and 0.251/min. The still size was 1.5m x 0.7m. The productivity of the reference still thus selected for further investigation was 2.5 1/day/m^2 without cooling.

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