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Experimental study of the effect of sun tracking system on the productivity of solar still

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Abstract: This paper presents evaluation of performance of solar still with sun tracking system. In this paper, experimental investigations were carried out on basin type solar still with solar tracking system. The importance of employed solar tracking in solar still is, to increase the quantity of solar incident radiation throughout the day, to increase overall distilled output of the solar still. An automatic solar tracking system employed, to track maximum possible solar radiation by rotating solar still with the rotation of the sun. Experimental results were carried out between the hours of 8:00 to 6:00 pm for a period of 10 days. The result clearly shows that the greater distilled found between 12:00 pm to 3:00 pm in a day. It was observed that the distilled of basin type solar still (tracked) is about 650 ml/day as compared to solar still (fixed) 420ml/day with increase in overall efficiency from 42.92 % to 63.55 %.

Keywords: Solar energy, solar tracker, solar still, Distillation, renewable energy

1. Introduction

Water is a precious natural gift and is being polluted by human activities, urbanization and industrialization. The ground water is often over exploited to meet the increasing demand of the people. Less than 1% of earth water is available for human consumption and more than 1.2 billion people still have no access to safe drinking water. Over 50% of the world population is estimated to be residing in urban areas, and almost 50% of mega cities having population over 10 million are heavily dependent on ground water, especially in the developing countries like India[1].

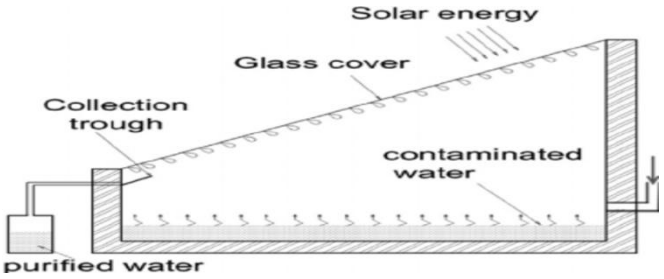
2. Principle of Solar Still

Solar still is the one of the instrument which is generally used to convert the brackish water in to drinkable water. In solar still due to heating of water it undergoes phase change and vaporization is occurred then, vapour rises and comes into cooler transparent, inclined surface and here vapour once again undergoes phase change. The water then condensed and runs in to collection channel. The main factor for condensation process in solar still is difference between glass temperature and water temperature as the difference is more the speed of condensation is increases [2].

Thermal/Overall Efficiency (η) in %

= Water output x Latent heat of evaporation of water x 100
Basin Area x Total solar radiation

$$\eta = \frac{M_w \times h_{vap}}{A_b \times \Sigma I} \times 100$$



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3. Experimental setup

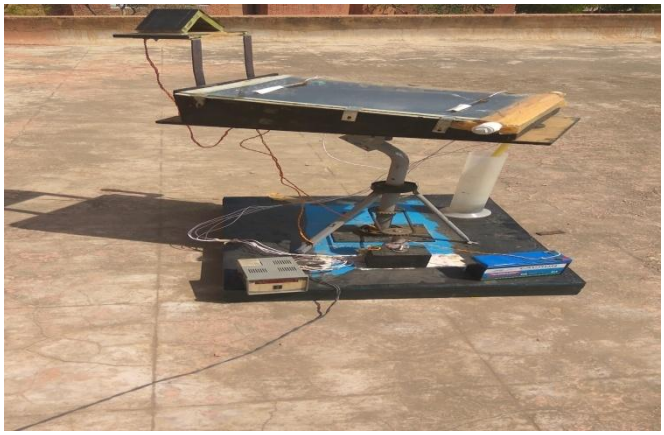
3.1 Solar still

It consists of basin liner which is the major part of solar still. It absorbs incident solar radiations that are transmitted through the glass cover. The outer of the solar still is made of plywood of 8 mm thickness and it has an area of 0.500 m x 0.375 m. Basin liner is made of GI sheet of 1mm thickness and it has an area of 0.465 m × 0.325 m with vertical side height of 0.045 m. The heat losses from bottom and side walls of solar still are prevented by using Thermocol of 10 mm thickness and plywood. Condensing cover of solar still is made of glass of 5 mm thickness and it is placed on vertical walls of solar still at an inclination of 16°. The condensed water gets collected in a distillate channel. A plastic pipe is connected to distillate channel to drain distillate water to measuring jar and a drainage pipe is connected to remove wastes inside the solar still. Double sided tapes are provided between glass cover and vertical walls to prevent heat loss and support. Thermocouples are fixed in to the solar still to measure basin, glass and water temperature and these thermocouples are connected to a digital temperature indicator to indicate the reading. Solar meter is used to measure incident solar radiations.

3.2 Sun tracking system

Sun is the oldest primary source of energy. It is clean, renewable and abundant in every part of the world. Almost all energies are derived from solar energy. Sun tracking system is designed to track solar azimuth angle on a single axis or to track the solar azimuth and zenith angles on two axes. The east-west of the tracker will be called the "horizontal tracking" while the angular tracker will be referred as "vertical tracking".

A solar tracker is basically a device on to which solar still is fitted which tracks the motion of the sun across the sky ensuring that the maximum amount of sun radiation strikes the solar still throughout the day. After finding the sunlight, the tracker will try to navigate through the path ensuring the best sun radiation detected.



3.3 Measuring instruments

Many types of measurement instruments were used such as:

- Solar meter: To measure the total radiation.
- Measuring Jar: To collect the distillate water.
- Thermocouples: to measure temperature of many points in the still. The accuracy of this device is in the range of 1°C.

4. Figures and Tables

Table 1: Observations of fixed still

Total Production: 420 ml

Time (hr)	Temperature (^{0}c)				Solar Intensity (W/m^2)	Distilled Output (ml)
	Basin	Still Inside	Still Outside	Glass Cover		
	T_1	T_2	T_3	T_4		
8:00 AM	26	25	29	30	910	0
9:00 AM	28	27	32	32	948	0
10:00 AM	41	41	34	44	1041	10
11:00 AM	55	53	35	49	1075	20
12:00 AM	63	62	37	53	1088	40

1:00 PM	70	70	43	55	1098	110
2:00 PM	72	75	43	57	1059	170
3:00 PM	70	76	42	58	1024	270
4:00 PM	67	74	41	55	972	310
5:00 PM	65	71	39	53	951	340
6:00 PM	62	68	36	50	930	380

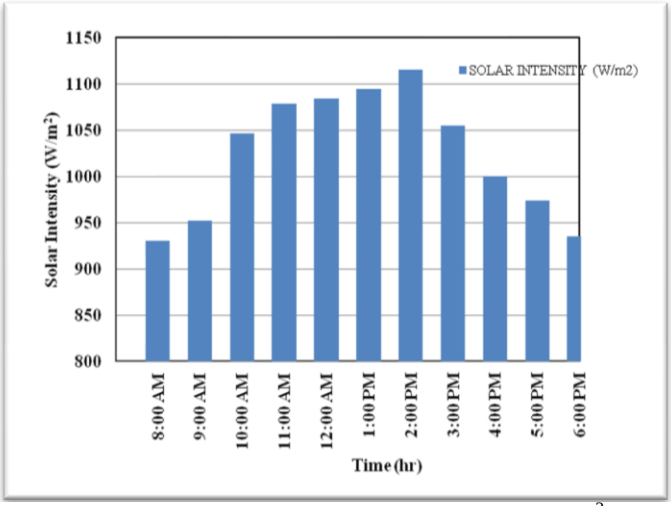


Figure 1: Hourly variation of solar radiation (W/m^2)

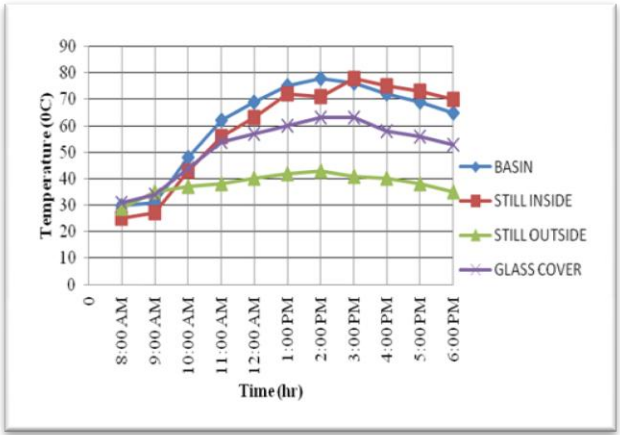


Figure 2: Hourly variation of temperatures (^oC)

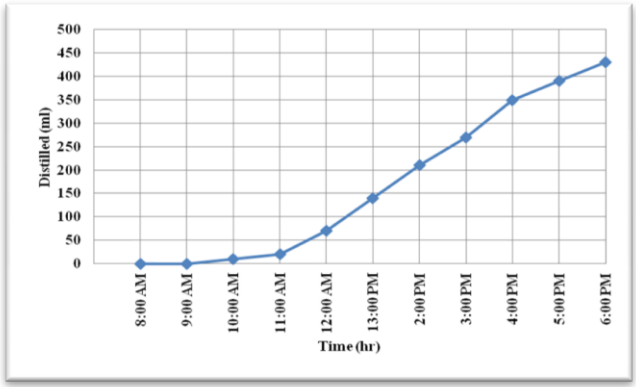


Figure 3: Hourly variation of distilled output (ml)

Table 2: Observations of Sun tracked still
Total Production: 650 ml

Time (hr)	Temperature (^{0}C)				Solar Intensity (W/m^2)	Distilled Output (ml)
	Basin	Still Inside	Still Outside	Glass Cover		
	T_1	T_2	T_3	T_4		
8:00 AM	30	34	27	32	970	0
9:00 AM	35	38	31	37	1009	10
10:00 AM	51	47	35	41	1082	30
11:00 AM	62	56	37	45	1102	70
12:00 AM	70	61	41	48	1106	160
1:00 PM	72	64	44	52	1105	240
2:00 PM	71	62	46	50	1096	330
3:00 PM	69	61	45	48	1086	400
4:00 PM	64	59	46	46	1012	460
5:00 PM	62	58	45	44	1000	490
6:00 PM	58	56	43	41	994	520

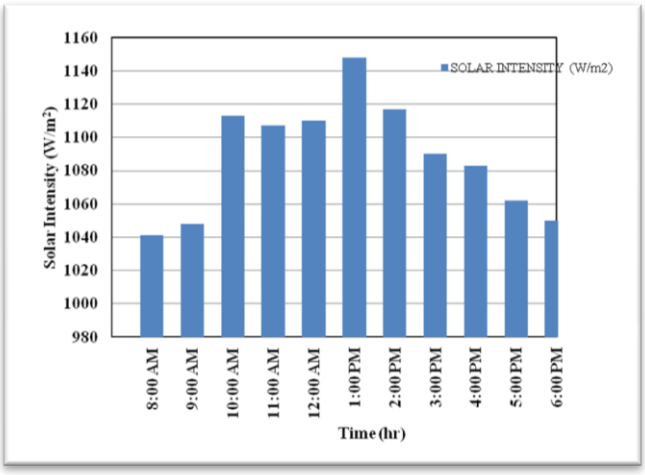


Figure 4: Hourly variation of solar radiation (W/m^2)

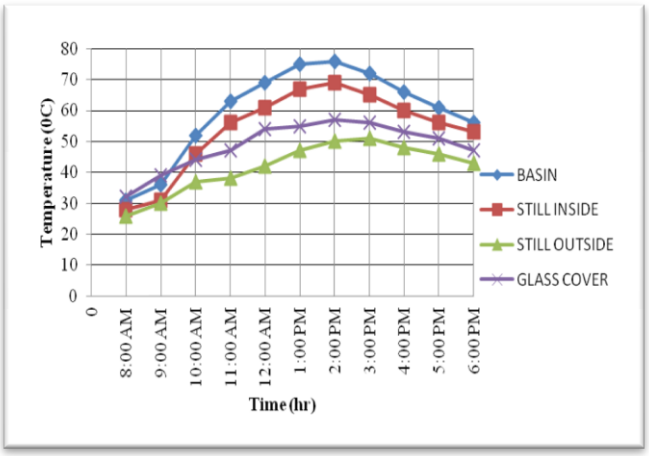


Figure 5: Hourly variation of temperatures (^{o}C)

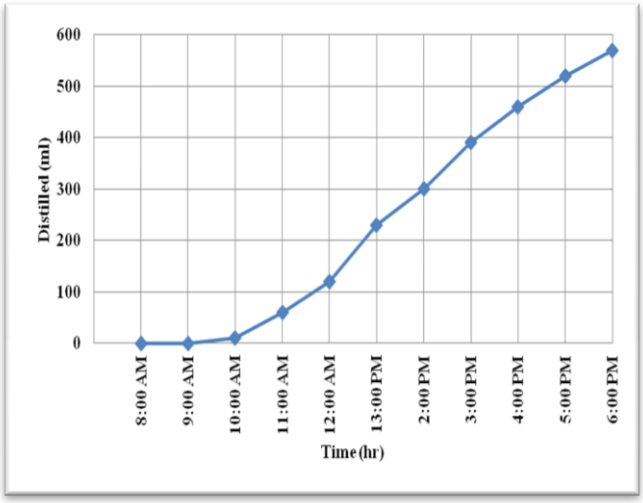


Figure 6: Hourly variation of distilled output (ml)

5. Result analysis and conclusion

The experiments were conducted in the month of April, 2017 to get better result through experiments. The experiments were performed for several days of the months. The readings of the various temperatures of the still were recorded using thermo couple sensors and solar intensity was recorded by solar meter which are shown in tabular form. Further, graphs of the solar intensities, various temperatures and distilled output with respect to time were also shown. Along with this, the thermal efficiencies of the solar still without and with use of sun tracking system were calculated. The efficiencies of solar still without using tracking system was 42.92 % with distilled water output of 0.420 liters. Whereas with the use of tracking system in solar still, the efficiency was found 63.55 % with distilled water output of 0.650 liters.

As we can see from the distilled water output results, every time with tracked system solar still production increased with some amount compared to untracked (fixed) still. The distilled outputs of the whole day were presented on the table.

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