Productivity Improvement of Single Basin Solar Still Having Heat Pipe Arrangement: An Experimental Study for Jaipur

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Abstract : Solar still is a device to purify the dirty water by application of solar thermal energy. It is a device for generating pure water without using any conventional energy. In solar still various factors are affecting the productivity of this device like solar intensity, water depth, external arrangement for condensation improvement etc. In present research work a circular tube arrangement is installed for this device setup. The experiments are conduct for Jaipur from 1st June to 10th June for full day field experiments. In this research work effect of water depth is studied for full day analysis. The results show that by application heat pipe, productivity of solar still is increased by 10 to 20% for these experiments which are good agreement for this research work

Keywords- Solar thermal energy, solar still device, heat pipe, water depth.

1. INTRODUCTION

Energy and water are two imperative substance for human advancement and required to use in administrator way; every one of them assume vital job inside the change of the economy over the entire world. In a few places, the ongoing and moveable water is not sufficient and request surpasses the arrangement to supply potable water by utilizing warm technique warm is required the benefit of using sunlight [1,2].

2. THEORY

In present study, experimental investigation has been carried out for hot dry and humid both environment of Jaipur, Rajasthan. Thermal Investigation with simple solar still and solar still with heat pipe arrangement has been done at different depth of potable water source. 10 L, 20 L, 30 L water depth is experimentally and numerically investigated for present research work. The surface area of solar still is 1 m2 for both arrangement of experimental solar still. Proper scientific instrument calibration is performed for this research work. The field experiments for solar still are performed from date 1st June, 2018 to 10th June, 2018 for full day from 7 AM to 7 PM.

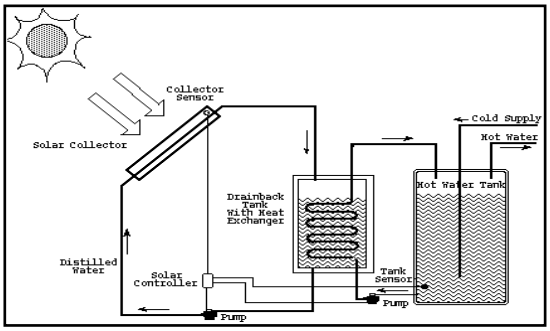

Figure 1: Line diagram of Domestic Solar Water Heating Systems [3]

2.1 Fabrication of setup

The setup is made by local available material like MS sheet, thermocol sheet, black paint, glass sheet etc. The setup has $1m^2$ surface area in bottom with 26 inclination angle for glass sheet and the real images of a simple solar still and solar still with heat pipe is present in figure 2. Heat pipe is made of cu circular tube having mechanical pump for coolant fluid circulation. For collection of purified water, trench is made using sheet metal plate.

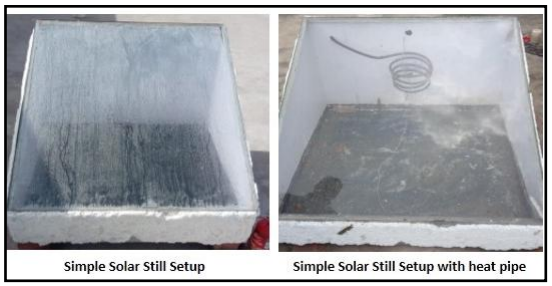

Figure 2: Actual setup of solar still

2.2 Measuring Instruments

Measurements of various data such as temperature of the glass, inside temperature of solar still, set up base temperature, wind velocity, TDS

and distilled water yield etc., has been taken from the following calibrated instruments [4,5].

Main measuring instrument is temperature scanner, which

record the data from J-type thermocouple, which are installed in solar still at fixed locations selected by researcher. Total five measuring thermocouple are installed in this setup. All thermocouple are calibrated with hot and cold water bath process. All measuring instrument are present in figure 3 [6,7].

Figure 3: Measuring Instruments

2.3 Data reduction analysis

10 L, 20 L, 30 L and 10 L with heat pipe water depth are considered for this research work and present in table 1 to table 4 for full day analysis. In these table solar radiation as well as temperature with hourly yield data of purified water.

3. RESULT AND DISCUSSION

As seen in table 1, 10 L water depth base results are present, as seen in table the maximum yield is found at 12 AM equal to 231 ml and minimum yield is found at early morning at 7 am equal to 31 ml. Like 10 L depth, in 20 L water depth, the maximum yield is 183 ml at 12 am and the same minimum is found at early morning.

Like 20 L the same results are recorded for 30 L water depth. But when a heat pipe is installed in solar still, the maximum yield is increased when compare with previous water depth conditions. Like yield results primary data temperature also show the temperature profile from minimum temperature to maximum temperature at mid noon and then decreases again till evening for all water depth conditions which are present in table 1 to table 6.

A comparative study of solar still taking various

water depth as 10 L, 20 L, 30 L and solar still with heat pipe installed at 10 L, 20 L, 30 L water depth is shown in the figure 4.

4. CONCLUSION

Experimental work is performed for the single slope solar still (SS-SS) under hot and humid climatic conditions of Rajasthan (Jaipur) having heat pipe installation in it. The following conclusions are observed

1) It is found from the experimental analysis that increasing the system temperature from 35°C to 64°C will increase the productivity by approx 45.05% (min.) to 79.39% (max.).
2) Solar still having heat pipe, efficiency of single slope solar still was increased by 61.35 % (max).
3) Increase in the solar radiation from 102 W/m2 to 770 W/m2 has increased the productivity of the solar still by 15 to 30 %.

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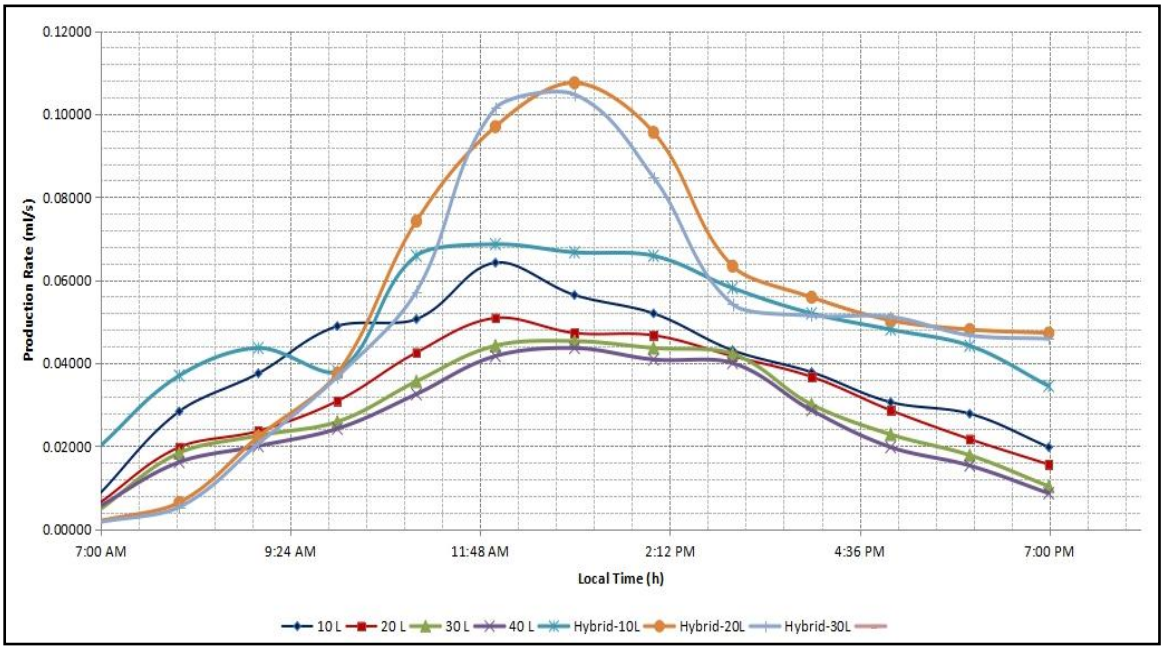

Figure 4: Comparison of different type of SS

Table 1: 10 L water depth results for simple SS (01/06/2018)

Time(h)	Solar Radiation (W/m^2)	T1	T2	T3	T4	T5	Distilled water collected per hour (ml)
7:00	151.00	31	45	31	37	33	31
8:00	303.00	30	49	34	39	35	102
9:00	465.00	32	50	35	43	39	135
10:00	589.00	37	52	37	47	43	176
11:00	678.00	39	53	40	54	49	182
12:00	703.00	45	55	41	56	54	231
13:00	718.00	48	57	45	59	57	203
14:00	622.00	47	51	45	54	51	187
15:00	559.00	39	48	44	55	53	155
16:00	398.00	35	47	43	49	48	136
17:00	241.00	34	43	38	47	46	110
18:00	88.00	31	41	35	43	44	100
19:00	23.00	28	41	30	38	40	71

Table 2: 20 L water depth results for simple SS (02/06/2018)

Time(h)	Solar Radiation (W/m2)	T1	T2	T3	T4	T5	Distilled water collected per hour (ml)
7:00	134.00	37	41	35	40	35	23
8:00	262.00	40	43	38	44	36	71
9:00	401.00	43	47	40	48	39	85
10:00	524.00	45	49	44	51	41	111
11:00	622.00	46	53	48	55	43	153
12:00	675.00	49	56	48	55	46	183
13:00	673.00	49	56	46	54	48	170
14:00	611.00	48	52	45	59	51	168
15:00	519.00	47	50	44	57	49	150
16:00	387.00	46	48	43	53	48	132
17:00	235.00	44	47	41	51	46	103
18:00	85.00	41	45	39	47	44	78
19:00	63.00	38	41	37	40	42	56

Table 3: 30 L water depth results for simple SS (03/06/2018)

Time(h)	Solar Radiation (W/m^2)	T1	T2	T3	T4	T5	Distilled water collected per hour (ml)
7:00	159.00	35	43	37	39	37	17
8:00	280.00	40	45	37	41	37	66
9:00	488.00	42	48	42	46	40	81
10:00	596.00	44	50	44	49	42	93
11:00	680.00	45	52	45	53	44	128
12:00	732.00	48	55	46	52	46	159
13:00	728.00	46	58	43	51	48	163
14:00	669.00	45	51	44	57	51	157
15:00	566.00	45	48	41	54	51	152
16:00	418.00	44	47	39	50	49	108
17:00	256.00	44	45	40	48	47	82
18:00	93.00	42	44	37	44	46	64
19:00	61.00	40	39	36	38	43	37

Table 4: 10 L water depth results for simple SS having heat pipe (05/06/2018)

Time(h)	Solar Radiation (W/m^2)	T1	T2	T3	T4	T5	T6	Distilled water collected per hour (ml)
7:00	170.00	37	40	30	36	37	26	7
8:00	334.00	39	43	34	38	44	30	19
9:00	483.00	40	55	37	40	52	31	76
10:00	606.00	42	59	35	42	57	32	132
11:00	599.00	44	60	41	37	59	30	300
12:00	664.00	44	58	39	54	60	30	367
13:00	734.00	44	58	43	55	58	29	420
14:00	672.00	45	56	44	58	58	28	372
15:00	567.00	42	54	38	57	60	28	225
16:00	411.00	41	52	39	54	57	27	201
17:00	211.00	39	51	36	53	54	26	181
18:00	120.00	37	47	35	50	43	28	169
19:00	51.00	40	43	32	47	40	25	167

Table 5 20 L water depth results for simple SS having heat pipe (07/06/2018)

Time(h)	Solar Radiation (W/m^2)	T1	T2	T3	T4	T5	T6	Distilled water collected per hour (ml)
7:00	124.00	29	39	27	35	38	27	7
8:00	340.00	33	38	31	35	42	32	23
9:00	435.00	34	50	32	49	52	33	80
10:00	232.00	36	58	34	57	61	33	135
11:00	704.00	38	65	36	61	69	31	267
12:00	770.00	38	67	37	64	71	32	349
13:00	639.00	37	58	35	59	71	30	387
14:00	640.00	37	56	36	55	68	29	344
15:00	561.00	35	51	33	50	61	29	228
16:00	488.00	35	51	33	49	61	29	201
17:00	300.00	33	48	31	47	57	27	181
18:00	187.00	30	44	29	42	54	30	173
19:00	102.00	34	43	33	39	51	27	170

Table 6 30 L water depth results for simple SS having heat pipe (09/06/2018)

Time(h)	Solar Radiation (W/m^2)	T1	T2	T3	T4	T5	T6	Distilled water collected per hour (ml)
7:00	170.00	34	38	33	35	39	28	6
8:00	334.00	36	39	35	36	43	33	19
9:00	483.00	38	51	36	49	54	33	74
10:00	606.00	40	58	39	57	63	34	132
11:00	599.00	41	64	40	62	69	30	206
12:00	664.00	42	66	40	63	72	33	365
13:00	734.00	42	59	41	58	71	34	377
14:00	672.00	42	56	41	54	68	31	305
15:00	567.00	39	52	37	51	63	30	195
16:00	411.00	39	51	37	49	61	30	185
17:00	211.00	37	47	35	46	59	29	184
18:00	120.00	35	44	34	41	55	28	168
19:00	51.00	38	43	36	40	51	30	165

Nomenclature

T1: Glass Upper (°C) T2: Glass Lower (°C) T3: Ambient Air (°C) L: Liter
T4: Mid Section (°C) T5: Absorber Plate (°C) T6: Heat pipe temperature (°C)
SS: Solar Still SS-SS: Single Slope Solar Still TDS: Total Disolved Solids