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RESEARCH ARTICLE

Low cost of solar still

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ABSTRACT : Different solar stills were developed and evaluated for comparison with other solar stills available in market. Comparatively more distilled water was obtained from the solar still having an area of $1m^2$ fabricated in fibre or metal body with glass glazing like single slope, double slope and wick type solar still. Average maximum temperature and humidity was more in double slope, single slope and wick type solar still and hence, the average quantity of distilled water obtained as 1350 ml/day, 1550 ml/day and 2450 ml/day, respectively. The plastic made up of W-shape solar still provided with 3 channels produce maximum distilled water as 2104 ml/day where as W-shape solar still with two channels erected on concrete and ground produced only 1012ml/day and 1443 ml/day, respectively. L shape solar still produce average distilled water was 925 ml/day which was very low among the all type of solar still. Comparative cost of compact nature of solar stills like single slope, double slope and wick type solar still was more than Rs.7000/- which is four times more than newly developed W-shape 3 channel solar still. Comparative output from newly developed solar still was low but it has several advantages that it is cheapest, cost efficient and easy to clean. Concentration of pH, EC, TDS and ions in solar distilled water was found to be similar as conventional distilled water. The cost of W shape three channel solar still is recovered within 4 months 6 days only.

KEY WORDS : Solar stills, Chemical analysis, Economics

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INTRODUCTION

Distilled (Evaporated and condensed) water is requisite for various (inverters) laboratories *viz.,* Soil chemistry, Agronomy, Biochemistry, Soil analysis laboratory, Post-harvest and Food Processing, Winery etc. and also at central workshop in University. Generation of distilled water for laboratory work and toping up of the batteries is costlier and difficult due to constant supply of electricity and water supply. The theoretical minimum work needed to desalt seawater at 25^0C is $0.7kWh/m^3$. The cost of 1lit-distilled water is Rs 17/-. Similarly the saline water can be converted into potable water with desalination unit using solar energy. The Konkan region is endeavored with solar energy of 450 –600 W/m^2 available for 7 to 8 hours in a day. The single slope single basin type desalination unit is commercially available which uses the solar energy for production of desalinated water. The average size of solar desalination unit is 1 sq.m with average output of 1 to 1.5 lit per day. The available solar stills are costlier and difficult to clean from inside and hence the study was undertaken with design and development of low cost solar stills.

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EXPERIMENTAL PROCEDURE

Wick type, W shape and L shape of solar stills were designed on the basis of solar declination angle, slope of collector and available insolation. During theoretical design calculations of solar still (Plate A), peak winter season was considered. In winter season, December month was selected for finding the solar declination angle (δ), slope of collector (β), intensity of insolation on horizontal and vertical surface and value of Cos θ is shown in Table A. The newly developed solar stills were evaluated for load test and compared with the output of single and double slope solar still available in market.

Table: A. Details of design calculations for even type solar still

Sr. No.	Particulars	Symbol	Design parameter of solar still
1.	Solar declination angle	δ	$\delta = 23.45 \sin [0.9863(284 + n)]$ $\delta = -23.3$
2.	Slope of collector	β	$\beta = (\Phi - \delta)$ $\beta = 40^{\circ} 48'$
3.	Intensity of insolation on horizontal	I_c	$I_c = I_h \times \cos \theta$ $I_c = 450$ W/m^2
4.	Intensity of insolation on sloping surface	I_s	$I_s = I_h \times \cos \theta / \cos \theta_h$ $I_s =$ 594.5 W/m^2
5.	Cosine of θ_h	θ_h	$\theta_h = 40^{\circ}.8'$

Plate A: Basin prepared in soil for W-shape solar still on soil

Low cost (W-shape) solar still :

Low cost (W-shape) solar still frame was design and fabricated at the central workshop of the College of Agricultural Engineering and Technology (CAET), Dapoli. This still was fabricated using 25 mm diameter M.S. pipe to make the frame as shown in Plate A. The pipes and corners were well polished and laminated in order to avoid corrosions as well as to protect the polythene sheet from damage. The size of basin was 2 m x 2 m was prepared with black plastic covered basin in soil (Plate B), in which water was impounded. The UV stabilized 200 micron polythene sheet of size 4 x 2.5 m was wrapped properly over the frame so that it became leak proof. The distilled water-collecting channel made from GI sheet wrapped with plastic was attached below to the frame with the help of non-corrosive wires. The collecting channels were fabricated so as to catch the condensed droplets of water inside the solar still. The material used for the fabrication of this unit is presented in Table B. This (W-shape) solar still frame along with UV

Plate B: Third channel from all bottom sides for W-shape solar still on ground

Table B : Material used for fabrication of solar distillation unit

Sr. No.	Items	Specification	Quantity required	Rate of item	Total cost
1.	M.S. pipe (low grade)	25 mm diameter	15.8 m	40/m	732/-
2.	Polythene film		4 x 2.5 m	50/m^2	500/-
3.	GI sheet	18 gauge	0.3 x 2.2 m	220/m^2	150/-
4.	Red paint		100 g	600/kg	60/-
5.	Black paint		500 g	240/kg	120/-
6.	Cement	53 grade	5 kg	10/kg	50/-
7.	Sand	Fine	10 kg		40/-
8.	Welding rod	Short length	8 rods	12/rod	96/-
9.	Labour charge		2 days	Rs.100/day	200
Total					1848/-

stabilized plastic as glazing kept over the basin dug on ground (Plate B) and making it leak proof by using soil cover. The water present in basin got evaporated due to higher temperature inside the heating chamber. Water vapour inside the heating chamber got condensed in the form of small droplets of water due to lower temperature on inner side of polythene. Condensed droplets of evaporated water were collected through three channels. Surrounding condensed water was collected through third channel from all sides at bottom (Plate B). First two channels which fixed inside solar still (Plate C).

W shape two channels solar still was also erected over the cement block (Plate D) for performance of distilled water. The cost required to erect W shape solar still on ground and cement were Rs. 1848/- and 4000/-

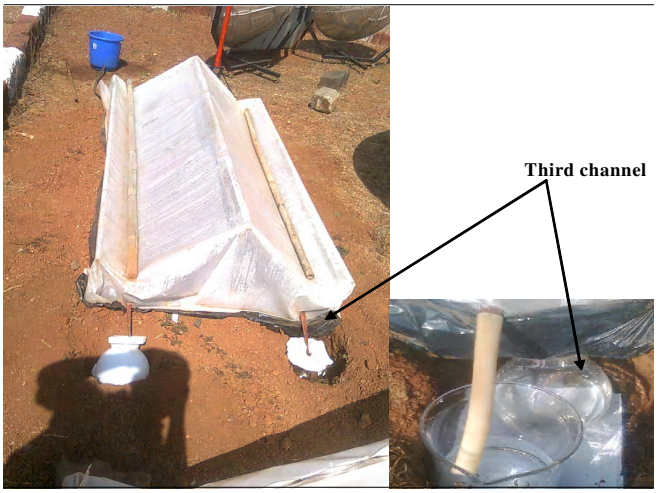


Plate C: Two channel provision for W-shape solar still, third channel

(a)

(b)

Plate D: W-shape solar still on concrete with two channel

EXPERIMENTAL FINDINGS AND ANALYSIS

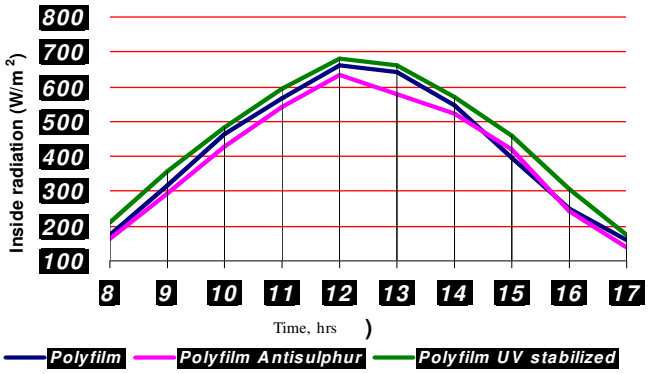
The results of the present study as well as relevant discussions had been presented under following sub heads:

Performance evaluation :

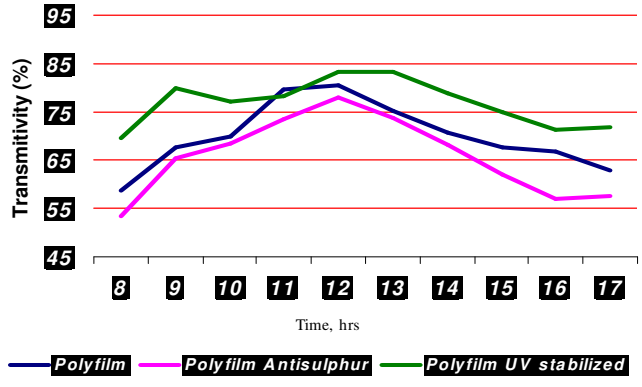
Developed solar stills were evaluated for winter and summer months with load test at 40^0 angle. Devices were tested for comparison with the output of distilled water from single and double slope still units available in market.

Selection of poly film materials :

Before using poly film as glazing material, it checked for its maximum transmitivity of solar radiation. Transitivity of polyfilm was checked out by using solarimter readings in W/m^2. The three type of polyfilm like plain polyfilm (silpolin), polyfilm antisulphur and UV stabilized polyfilm were selected for better transmitivity. The inside and outside solar radiations at same height were observed in clear sky condition for all selected polyfilm. It was observed that 76.83 per cent solar radiation were transmitted from UV stabilized 200 micron white polyfilm where as 65.73 per cent transmitivity observed in polyfim antisulphur and 69.97 per cent in plain polyfil (silpolin) shown in Fig.1a and b.



(a)



(b)

Fig.1 : Transmitivity of solar radiation inside poly film

W -shape solar still on concrete two channels :

No load test :

The low cost W-shape solar still with area of 2 m^2 (2m x 1m) was evaluated for no load test. The maximum average temperature was observed during no load test was 49^{0}C at 1 p.m. and the same time solar intensity was 553 W/m^2, ambient temperature was 29^{0}C, and outside relative humidity was 46 per cent. The trend obtained in no load test during performance testing is as shown in Fig. 2 and Table 1. It is revealed from Fig. 2 that the temperature inside the still increased with solar intensity in morning hours up to 1 P.M., and then started decline as day progressed.

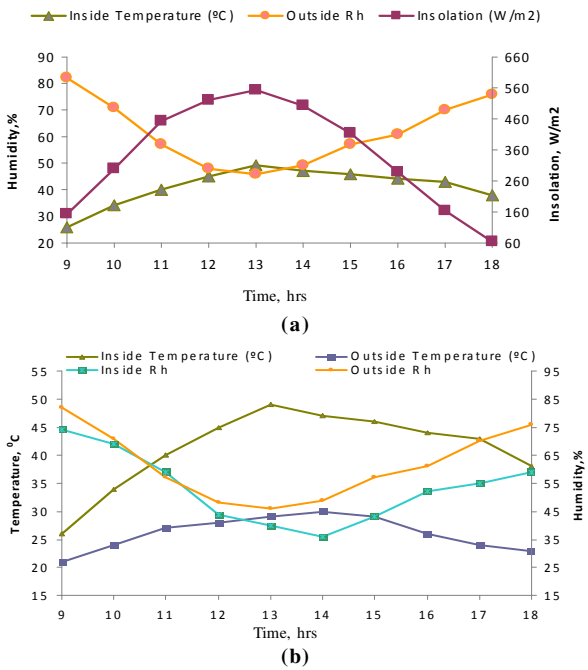


Fig. 2 : Performance of W-shape solar still on concrete two channels with no load test in winter

Table 1 : Performance of W-shape solar still on concrete two channel with no load test in winter

Time (Hrs)	Insolation (W/m^2)	Inside Temp. (ºC)	Ambient Temp. (ºC)	Inside Humidity (%)	Outside Humidity (%)
9.00	152	26	21	74	82
10.00	301	34	24	69	71
11.00	454	40	27	59	57
12.00	521	45	28	44	48
13.00	553	49	29	40	46
14.00	502	47	30	36	49
15.00	415	46	29	43	57
16.00	287	44	26	52	61
17.00	163	43	24	55	70
18.00	63	38	23	59	76

Load test :

W-shape solar still with two channels was tested with impounding water depth in cement basin. The hourly cumulative distilled water obtained was observed with solar intensity, ambient temperature, relative humidity and inside temperature shown in Table 2 and Fig. 3.

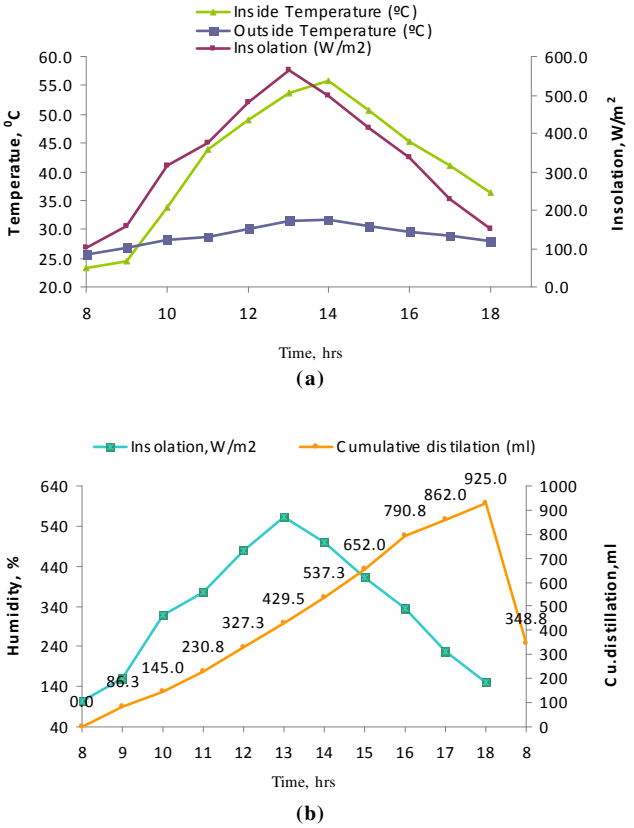


Fig. 3: Performance of W-shape solar still on concrete two chanels during load test in summer

It is observed from Table 2 that maximum average temperature was observed at 1 p.m., when solar intensity was 523 W/m^2 and ambient temperature was 31.9^{0}C, ambient R.H. was 48 per cent. Trend observed in load test during performance is shown in Fig. 2. It was observed that inside temperature increased as the solar intensity increased and hence, rate heat utilization for heating the water was more in noon time and accordingly evaporation was observed more after noon hours and then rate of condensation was increased than noon time as solar intensity decreased. Cumulative distilled water obtained from solar still in summer month was 1274 ml including day and night condensation. It was observed that maximum distillation rate obtained between 3 pm to 4 pm which was highest as 138 ml. Average overnight distillation observed in even type solar still unit was 348 ml which was due to higher condensation rate in night.

Table 2: Performance of W-shape solar still on concrete two channels during load test in summer

Time (Hrs)	Insolation (W/m^2)	Inside temperature (ºC)	Outside temperature (ºC)	Outside R.H. (%)	Cumulative desalination (ml)
8.00	103.3	23.3	25.7	75.3	0.0
9.00	159.3	24.5	26.8	68.5	86.3
10.00	317.5	33.8	28.2	65.6	145.0
11.00	376.8	43.8	28.7	61.6	230.8
12.00	480.8	49.0	30.0	57.6	327.3
13.00	523.1	53.8	31.4	52.1	429.5
14.00	499.0	55.8	31.6	50.4	537.3
15.00	413.3	50.8	30.6	54.8	652.0
16.00	336.3	45.3	29.5	59.9	790.8
17.00	228.3	41.1	28.8	63.8	862.0
18.00	150.5	36.3	28.0	67.4	925.0
Overnight distillation up to 8.00 a.m.					348.8
Total					1273.8

The maximum cumulative distillation obtained in summer season was 1273 ml, solar intensity played vital role in rate and quantity of distillation through the plant.

W- shape solar still on soil two channels :

No load :

W-shape solar still with two channels was erected on ground and the collected distilled water with two channels was periodically observed along with solar energy, ambient temperature. Inside and outside humidity. The still was evaluated in summer for no load. In summer, maximum inside temperature reached in solar still was 45.1^{0}C where ambient temperature, solar radiation and relative humidity were found as 35.2,612 and 35.2, respectively shown in Table 3 and Fig.4.

Table 3: Performance of W-shape solar still on ground two channels during no load test in summer

Time (Hrs)	Insolation (W/m^2)	Inside temperature (ºC)	Outside temperature (ºC)	Inside Rh	Outside Rh
8.00	208	28.2	26.6	70.5	72.1
9.00	268	33.1	29.9	59.2	65.4
10.00	355	35.8	31.5	52.4	61.5
11.00	487	45.4	33.6	43.8	58.7
12.00	549	47.2	34.5	37.2	55.2
13.00	612	45.1	35.2	35.2	52.9
14.00	502	46.8	33	45.4	50.4
15.00	355	44.4	32.2	51.7	54.6
16.00	306	44.2	30.2	52.6	57.8
17.00	177	43.4	31	51.4	61.4
18.00	102	42.1	28.5	55	62.5

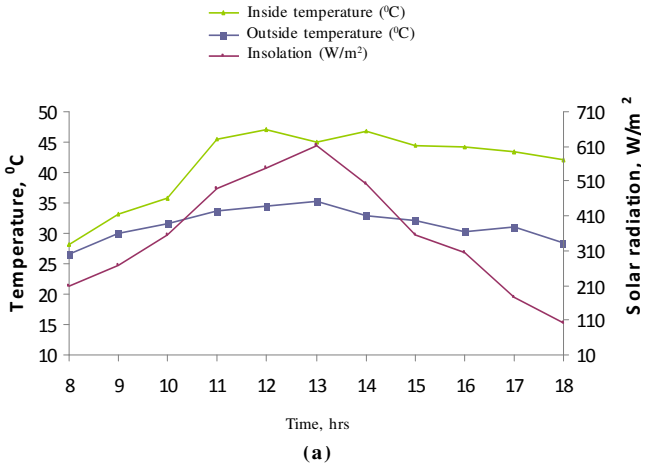


Fig. 4 : Performance of W-shape solar still on ground two channels during no load test in summer

With load :

W shape solar still erected on ground with a provision of two channels for collections was evaluated for winter and summer depicted in Table 4 and Fig.5 and Table 5 and Fig.6, respectively. In winter maximum distilled water collected from 24 hour was only 950 ml which was very less comparing to distilled water obtained in summer as 1936.5 ml from same unit.

Table 4: Performance of W-shape solar still on ground two channels during load test in winter

Time (Hrs)	Insolation (W/m^2)	Inside temp. (^0C)	Outside temp. (^0C)	Inside Rh (%)	Outside Rh (%)	Cu.dist.-pot-1 (ml)	Cu.dist.-Pot-2(ml)	Total Cu.dist. (ml)
8.0	114.3	22.4	19.8	76.6	75.6	0.0	0.0	0.0
9.0	232.0	29.5	21.3	73.8	69.8			
10.0	362.5	34.6	23.1	58.1	62.3	58.8	64.4	123.1
11.0	474.4	38.2	28.6	53.7	52.3			
12.0	522.1	44.7	30.5	48.8	49.5	82.5	95.6	178.1
13.0	538.8	44.2	29.7	50.1	48.6			
14.0	445.8	45.9	29.2	47.6	49.5	130.6	143.8	274.4
15.0	362.9	40.8	28.4	47.0	51.5			
16.0	284.1	40.1	28.0	50.1	54.4	183.8	205.6	389.4
17.0	132.1	35.4	25.9	58.0	56.3			
18.0	40.0	30.1	24.7	67.5	65.9	219.4	238.8	458.1
Overnight distillation up to 8.00 a.m.						239.2	252.8	491.9
Total								950

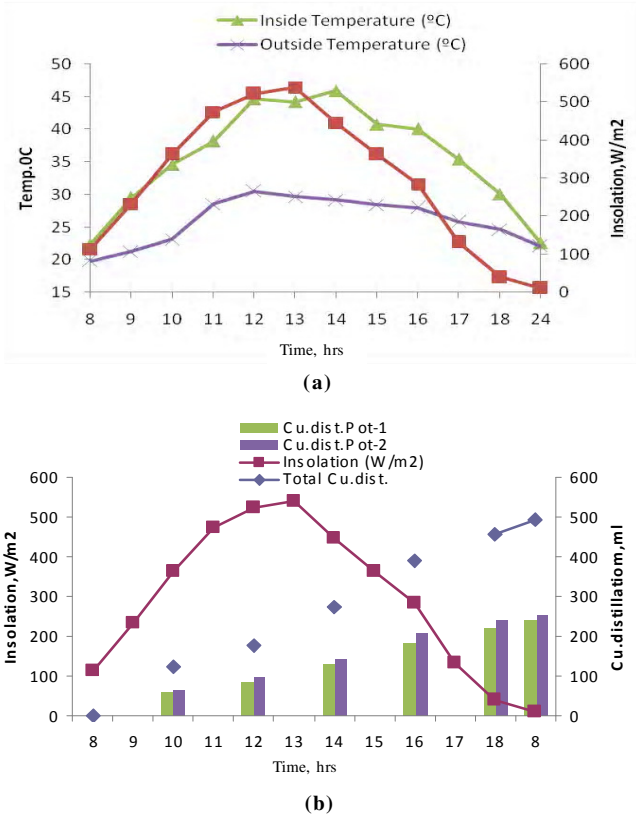


Fig. 5: Performance of W-shape solar still on ground two channels during load test in winter

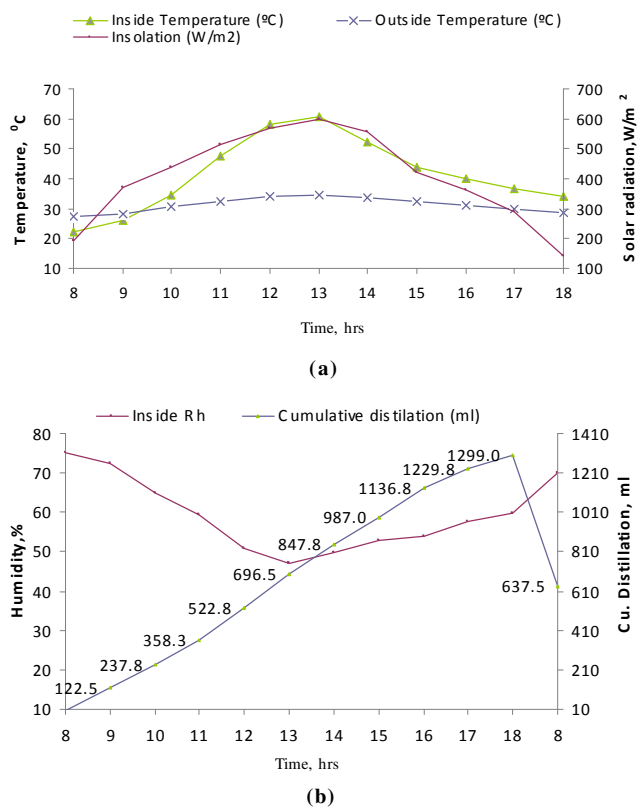


Fig. 6: Performance of W-shape solar still on ground two channels during load test in summer

Table 5: Performance of W-shape solar still on ground two channels during load test in summer

Time (Hrs)	Insolation (W/m^2)	Inside temperature (ºC)	Outside temperature (ºC)	Inside Rh (%)	Cumulative distillation (ml)
8.0	195.0	22.2	27.3	75.1	0.0
9.0	371.0	26.2	28.4	72.6	122.5
10.0	438.0	34.7	30.7	64.9	237.8
11.0	516.0	47.4	32.3	59.4	358.3
12.0	568.0	58.2	34.0	50.8	522.8
13.0	600.0	60.7	34.6	47.0	696.5
14.0	555.0	52.4	33.8	50.0	847.8
15.0	420.3	43.8	32.3	52.9	987.0
16.0	364.0	40.0	31.1	54.0	1136.8
17.0	291.0	36.6	29.7	57.6	1229.8
18.0	140.8	33.9	28.6	59.7	1299.0
Overnight distillation up to 8.00 a.m.					637.5
Total					1936.5

Single side (L- shape one channel) solar still on soil :

With load :

L- shape solar still was erected on ground with single channel for collection provision. The still was evaluated in winter for load condition. In winter, maximum inside temperature reached in solar still was 63.8 ºC where ambient temperature, solar radiation and relative humidity were found as 30.3, 540 W/m^2 and 51.8 per cent, respectively shown in Table 6 and Fig. 7. The Maximum distilled water collected from this unit in winter was only 850 ml in 24 hours.

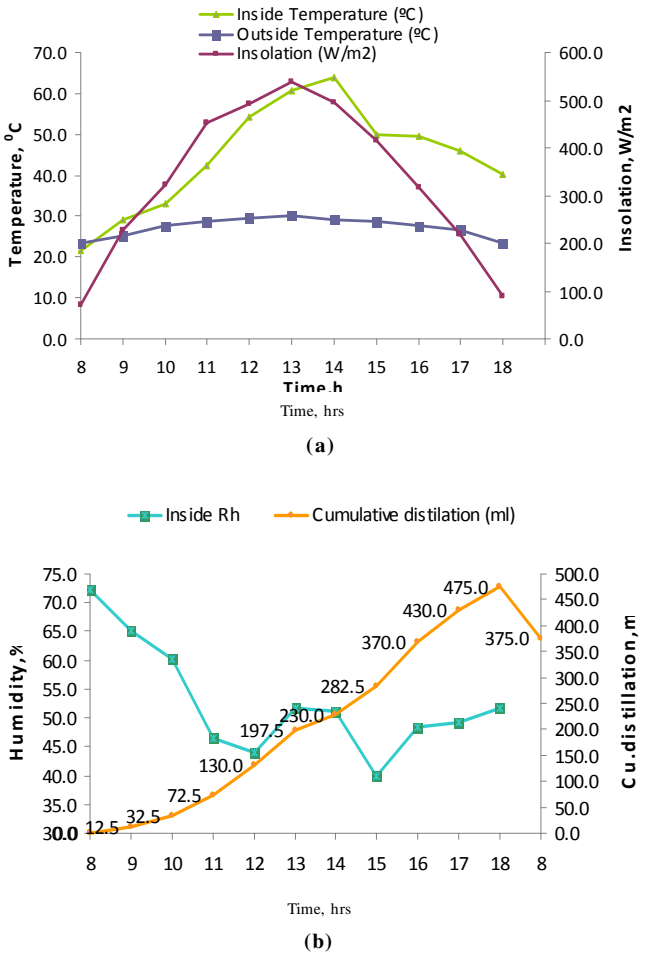


Fig. 7 : Performance of L type solar still on ground during load test in winter

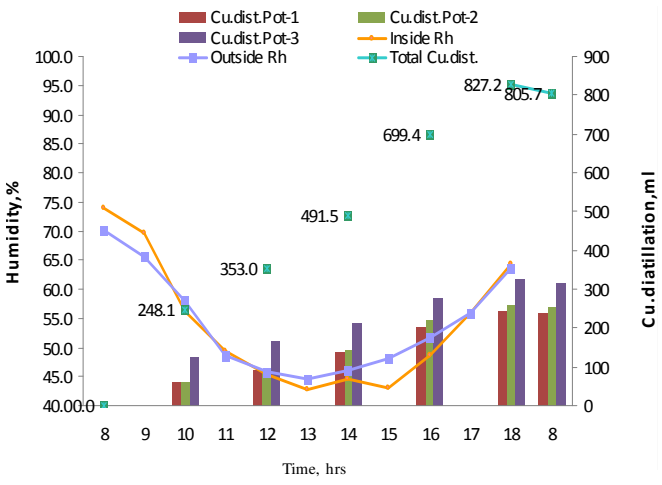
Table 6: Performance of L type still on ground during load test in winter

Time (Hrs)	Insolation (W/m^2)	Inside temperature (^{0}C)	Outside Temperature (^{0}C)	Inside Rh	Cumulative distilation (ml)
8.0	70.0	21.5	23.4	72.4	0.0
9.0	229.0	28.9	25.2	65.2	12.5
10.0	324.0	33.0	27.5	60.3	32.5
11.0	453.5	42.4	28.6	46.4	72.5
12.0	493.0	54.4	29.5	44.0	130.0
13.0	540.0	60.5	30.3	51.8	197.5
14.0	495.0	63.8	29.0	51.0	230.0
15.0	416.5	50.1	28.7	39.8	282.5
16.0	317.5	49.7	27.7	48.3	370.0
17.0	218.5	46.0	26.5	49.1	430.0
18.0	88.5	40.2	23.4	51.7	475.0
Overnight distillation up to 8.00 a.m.					375.0
Total					850.0

W- shape solar still on ground three channel :

Load in winter :

W-shape solar still erected on ground with three channels for collection was evaluated in winter and summer for load test and respective data is depicted in Table 7 and Fig. 8. Maximum distilled water collected from solar still erected on soil with three channels was 1633 ml/day. The maximum average solar radiation available in winter during study was 556 W/m^2 and maximum average inside temperature, inside relative humidity were found as 46^{0}C, 73.8 per cent, respectively. By providing one extra collection channel surrounding the bottom sides of solar still, 65 per cent increased was observed in total cumulative distillation.



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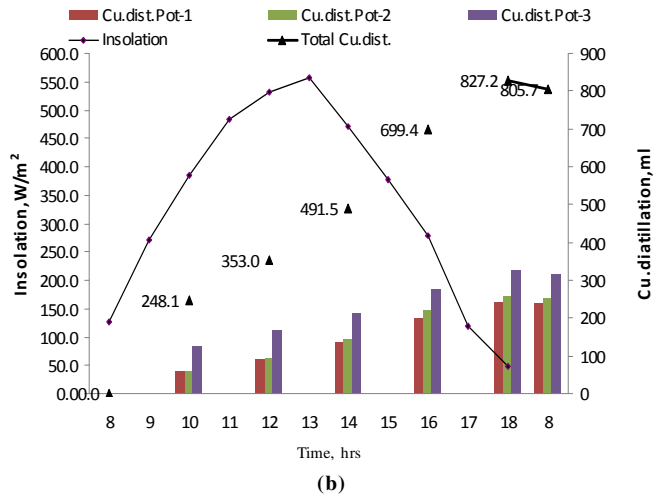

(b)

Fig. 8: Performance evaluation of W-shape solar still on ground with three channels in winter

Table 8 : Performance of W-shape solar still on ground with three channels during load test in summer

Time (Hrs)	Insolation (W/m^2)	Outside temp.(°C)	Cu.dist. Pot-1 (ml)	Cu.dist. Pot-2 (ml)	Cu.dist. Pot-3 (ml)	Total Cu. dist.
8.00	193.2	28.7	0.0	0.0	0.0	0.0
10.00	490.8	31.8	73.0	53.0	122.0	248.0
12.00	561.6	32.2	164.0	120.0	243.0	527.0
14.00	510.6	32.5	349.0	292.0	458.0	1099.0
16.00	304.0	31.2	518.0	453.0	647.0	1618.0
Overnight distillation up to 8.00 a.m.			384.0	303.0	270.0	957.0

Load test in summer :

W -shape solar still erected on ground with three channel provision was evaluated in summer for load test and respective data are depicted in Table 8 and Fig. 9. Maximum distilled water collected from solar still erected on ground with three channels was 2575 ml/day. By providing one extra collection channel surrounding the bottom side of solar still, 55 per cent rise was observed in total cumulative distillation in summer.

Comparison of different solar distillation units :

After evaluating the different solar stills, their results of cumulative distillation are compared and depicted in Table 9. Comparatively more distilled water was obtained from the solar still having an area of $1m^2$ fabricated in fibre or metal body with

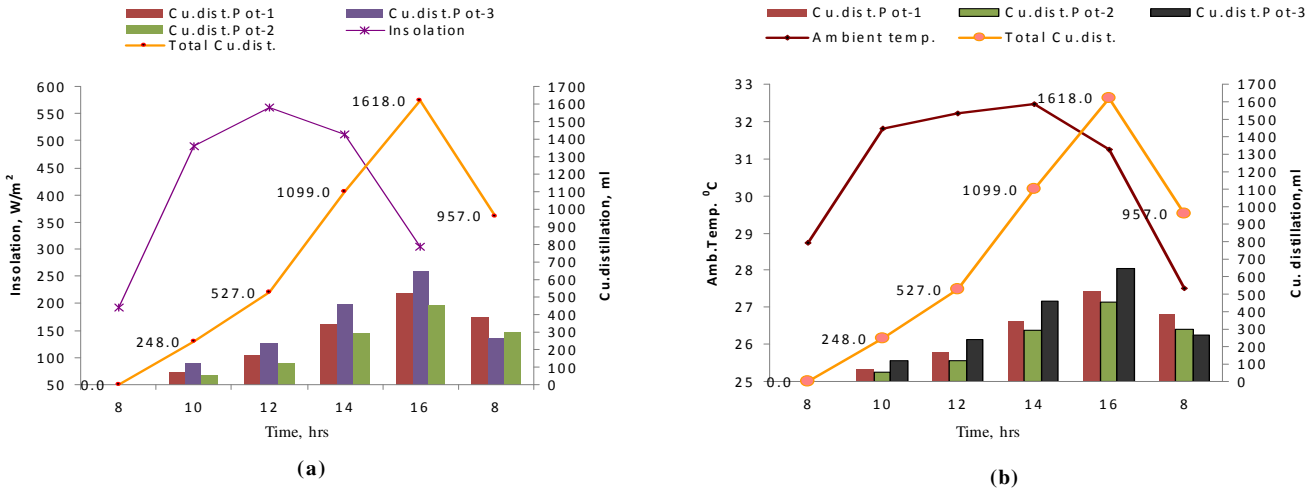

Fig. 9: Performance evaluation of W-shape solar still on ground with three channel in summer

Table 9: Average performance of solar stills in year

Sr. No.	Type	Distilled water (ml/ day)	Inside temperature (°C)	Inside humidity (%)	App. cost (Rs.)
	Available in market				
1.	Single slope ($1m^2$)	1350	60	78	8000/-
2.	Double slope ($1m^2$)	1550	70	82	7500/-
	Newly developed				
1.	Wick type ($1m^2$)	2425	83.6	95	7241/-
2.	W shape-2 channel on concrete ($2 m^2$)	1012	50.5	74.5	4000/-
3.	W shape-2 channel on ground ($2 m^2$)	1443	53.4	75.5	1848/-
4.	L shape ($2 m^2$)	925	64.6	72	1000/-
5.	W shape-3 channel on ground ($2 m^2$)	2104	53.5	74.9	1848/-

glass glazing like single slope, double slope and wick type solar still. Table 9 shows that average maximum temperature and humidity was more in double slope, single slope and wick type solar still and hence, the average quantity of distilled water obtained as 1350 ml/day, 1550 ml/day and 2450 ml/day, respectively. Reason behind the maximum output from single slope ,double slope and wick type solar still was proper insulation and glass glazing where as another solar stills made with plastic wrapping over the frame which itself acted as body of solar still and glazing for maximum energy collection.

When jute cloth was spread above the absorber in wick type solar still, it increased the evaporation rate than single and double slope still and hence, comparatively more distilled water was obtained in wick type solar still.

This plastic made up of W-shape solar still provided with 3 channels produce maximum distilled water as 2104 ml/day where as W-shape solar still with two channels erected on concrete and ground produced only 1012ml/day and 1443 ml/day, respectively. L shape solar still produce average distilled water was 925 ml/day which was very low among the all type of solar still.

Comparative lower distillation was observed in W-shape polythene based solar still though it has 2 m^2 areas. It might be due to the use of polythene as a glazing area and more heat loss through the unit. Comparative cost of compact nature of solar stills like single slope, double slope and wick type solar still was more than Rs.7000/- which is four times more than newly developed W-shape 3 channel solar still. Comparative output from newly developed solar still was low but it has several advantages that it is cheapest, cost efficient and easy to clean.

Chemical analysis :

Chemical analysis of impure and pure water obtained from W-shape three channel solar still was carried for pH, EC, TDS and ions (Mg^{++}, Ca^{++}, Na^{+}, CO_3^{-}, HCO_3^{-}, Cl^{-}) concentration. The concentration of these substrates before and after desalination is given in Table 10.

Table 10: Chemical analysis of impure and pure water sample

Chemical properties of water	Tap water	Distilled water obtained from millipore unit	Distilled water obtained from solar distillation unit
pH	7. 8	7.0	7.0
EC (µS/cm)	100	0.5	0.8 (0.520 mg/l)
TSS (%,^{0}Brix)	0.02	0	0
Mg^{++} (ppm)	0.00088	0	0.00036
Ca^{++} (ppm)	0.00090	0	0.00032
$Mg^{++} + Ca^{++}$ (me/lit)	0.0018	0	0.00040
Na^{+} (me/lit)	3.5	0	0.1
CO_3^{-} (me/lit)	0.6	0	0
HCO_3^{-} (me/lit)	0.2	0	0.15
Cl^{-} (me/lit)	1.6	0	0

It was observed from the results of chemical analysis of pure and impure water, given in Table 10 that there was drastic reduction in the pH, EC, Mg^{++}, Ca^{++}, Na^{+}, CO_3^{-}, HCO_3^{-} ions carbonate, bicarbonate etc. in the distilled water.

Cost economics :

During evaluating performance of solar distillation unit, different direct benefits were derived. These benefits were indicators of technical feasibility of plant. Subsequently the economics of the plant was evaluated in the term of cost per litre of distilled water through electrical backup in distillation unit. Hourly benefits of the plant are considered and payback period of distillation unit was made. The total cost that of the investment spread over the entire useful life of the plant, including initial cost, operation cost, maintenance and interest are taken in consideration for payback period.

Considering the average distilled water obtained from even type W- shape solar still as 2.1 litre for 250 days a year. It produced 526 litres of distilled water yearly. By considering the wholesale market value of distilled water (Rs.10/l) and total income generated while producing 526 litres of distilled water is tabulated in Table 11.

Table 11 : Details about cost analysis of solar still

Sr. No.	Particulars		Amount (Rs.)
1.	Total revenue		5260
2.	Cost of device		1848
3.	Cost of energy		Nil
4.	Cost of polythene		` 500
5.	Cost of labour, operation	Per year	` 300
	and maintenance for	After	` 800
	trouble free operation of	every 5	
	unit	year	

It was observed from the Table 13, the cost of unit is recovered within 4 months 6 days only, *i.e.* the payback period of the unit was only 1/3rd year and after that period the unit will produce net profit. Area of newly developed solar still is double than other two distiller but pay back period is minimum it may due to the lower cost of unit. All economic indicators are summarized in Table 13, as benefit cost ratio (BCR) was 2.56, whereas net present worth (NPW) was Rs.38958. Mukherjee and Tiwari (1986), Rai and Tiwari (1982) and Kothari and Sengar (2007) have also made investigation on the related aspects of the present research work.

Table 12: Payback period analysis of distillation unit

Year	Cash outflow	PW of cash outflow (at 12 % discount rate)	Cash inflow	PW of cash inflow (at 12 % discount rate)	NPW
A	B	C	D	F	F-C
0	1848	1848	0.0		-1848.0
1	300	270.3	5260.0	4738.7	4468.5
2	300	243.5	5260.0	4269.1	4025.6
3	300	219.4	5260.0	3846.1	3626.7
4	300	197.6	5260.0	3464.9	3267.3
5	800	474.8	5260.0	3121.6	2646.8
6	300	160.4	5260.0	2812.2	2651.8
7	300	144.5	5260.0	2533.5	2389.0
8	300	130.2	5260.0	2282.5	2152.3
9	300	117.3	5260.0	2056.3	1939.0
10	800	281.7	5260.0	1852.5	1570.7
11	300	95.2	5260.0	1668.9	1573.7
12	300	85.8	5260.0	1503.5	1417.8
13	300	77.3	5260.0	1354.5	1277.3
14	300	69.6	5260.0	1220.3	1150.7
15	800	167.2	5260.0	1099.4	932.2
16	300	56.5	5260.0	990.4	933.9
17	300	50.9	5260.0	892.3	841.4
18	300	45.8	5260.0	803.8	758.0
19	300	41.3	5260.0	724.2	682.9
20	0	0.0	5260.0	652.4	652.4
Total		2929.1		41887.1	38958.0

Table 13: Economic indicators for solar distillation units

Type	Cost (Rs.)	Net present worth	BCR for first year	PBP
Even type distillation unit	1848/-	38958	2.56	4 months 6 days

Conclusion :

- Newly developed W-shape solar still with three channel erected on soil was economical for the average output of 2104 ml/day distilled water.
- Concentration of pH, EC, TDS and ions in solar distilled water was found to be similar as conventional distilled water.

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