Global Conference on Energy and Sustainable Development
24-26 February, 2015- Coventry, United Kingdom
GCESD 15

EXPERIMENTAL INVESTIGATION ON SINGLE SLOPE SOLAR STILL DURING MONSOON AND POST MONSOON SEASON

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CONTENTS

1. INTRODUCTION

- The solar water purifier is used for drinking water and the household purposes specially in villages and remote areas.
- The most positive feature about solar water purification is that there is no requirement of the electricity.
- Solar stills are cheap and having low maintenance cost.
- Today's majority of the health issues are owing to the non-availability of clean drinking water.
- Solar still are cheep and having low maintenance cost but the problem of solar still is the low productivity.
- There is almost no water left on Earth that is safe to drink without purification.
- The collected water has been purified drinking the process and can be used as drinking water.
- A solar still consist of an airtight basin, in which saline water is evaporated and condensed on the top cover for collection.
- Solar still are working on the process of distillation of brackish/saline water by utilizing solar thermal energy.

2. OBJECTIVE OF WORK

- Design of single slope solar still
- Fabrication of single slope solar still.
- A high feed water temperature.
- Heat losses from the floor and wall are kept low.
- Low vapor leakage.
- Low effective cost.

To investigate the thermal performance analysis of single slope solar still under various condition During monsoon and post monsoon season :-

- 1. Water depth (5,10 and 15 cm).
- 2. Rainy, cloudy and slightly cold weather.

3. EXPERIMENTAL SETUP & DESIGN PARAMETER

Figure : 3.1 Experimental Setup of Single Slope Solar Still

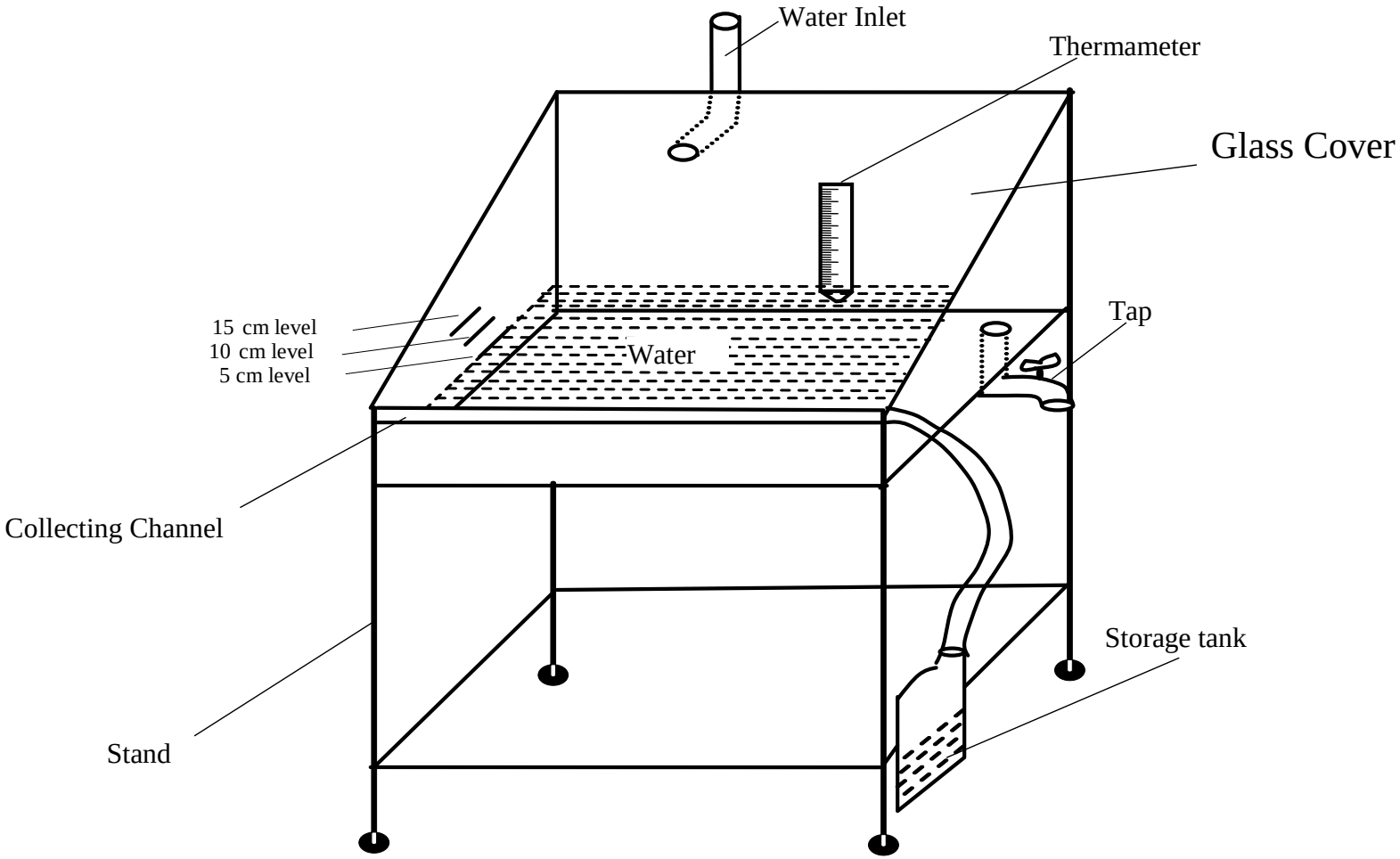


Figure: 3.2 Sketch Setup of Single Slope Solar Still

DIMENSION AND DESIGN PARAMETER OF NOVEL SOLAR DESALINATION UNIT

S. No.	Parameters	Values
1.	Area of collecting surface	1 m^2
2.	Inclination of cover glass(latitude angle)	23º
3.	Thickness of cover glass	0.004 m
4.	Height of back side	0.61 m
5.	Height of front wall	0.18 m
6.	Thickness of plywood	0.012 m
7.	Thickness of color coated sheet metal	20 gauge (0.6071×10^{-3}m)
8.	Thickness of insulation (Thermacole)	0.018 m
9.	Water holding capacity	180 liters

4. METHODOLOGY

1. Figure: 3.1 show experimental setup of single slope solar still.
2. It is an airtight basin.
3. The top cover of transparent glass.
4. The inner surface of the square base is blackened to efficiently absorb the solar radiation incident at the surface.
5. The brackish or saline water is feed into the basin for purification.
6. The solar radiation that passes through the transparent plane glass heats water in the blackened basin, thus evaporating water which gets condensed on the cooler underside of the glass and gets collected in channel as distilled attached to wooden frame.

5. OBSERVATION OF SINGLE SLOP SOLAR STILL

The experiments have been conducted in monsoon (September 2013) and post monsoon (October 2013) months. Global radiation, ambient temperature and yield have been recorded from 08:00 to 17:00 on hourly basis. Experiments is left for continue the distillation. The distilled water from 18:00 hr to next day 07:00 hr is collected and measured in next morning.

This practice is repeated for three different depth of water namely 05, 10 and 15 cm and for the month of September and October 2013.

Table: 1 Observation for single slope solar still for the month of September 2013						
S.No.	Time(Hours)	I_g (W/m^2)	T_a (°C)	Yield (ml)	Total Yield (ml)	Efficiency (η) (%)
Water Level 15 cm						
1	08-09	072.10	23	0	2312	46.40 %
2	09-10	085.32	25	0		
3	10-11	191.60	27	4		
4	11-12	268.75	27	16		
5	12-13	276.50	29	37		
6	13-14	249.49	30	95		
7	14-15	141.37	27	175		
8	15-16	121.25	28	275		
9	16-17	076.22	28	230		
10	17-08	000.00	-	1480		
Water level 10 cm						
1	08-09	119.72	25	0	2266	31.60 %
2	09-10	183.12	24	5		
3	10-11	362.20	25	9		
4	11-12	443.57	28	36		
5	12-13	443.10	28	90		
6	13-14	436.52	29	173		
7	14-15	342.25	29	257		
8	15-16	213.77	27	192		
9	16-17	067.70	28	167		
10	17-08	000.00	-	1337		
Water level 5 cm						
1	08-09	125.12	24	4	2179	28.96 %
2	09-10	338.65	25	6		
3	10-11	457.82	27	28		
4	11-12	426.30	28	57		
5	12-13	434.42	27	110		
6	13-14	473.20	29	245		
7	14-15	400.25	30	205		
8	15-16	182.25	30	177		
9	16-17	077.12	29	150		
10	17-08	000.00	-	1197		

Table: 2 Observation for single slope solar still for the month of October 2013						
S.No.	Time (Hours)	I_g (W/m^2)	T_a (^{o}C)	Yield (ml)	Total Yield (ml)	Efficiency (η) (%)
Water Level 15cm						
1	08-09	366.60	24	0	2406	23.79 %
2	09-10	384.57	26	0		
3	10-11	546.52	26	5		
4	11-12	709.22	26	18		
5	12-13	759.10	29	49		
6	13-14	694.50	32	98		
7	14-15	433.12	31	183		
8	15-16	248.87	29	277		
9	16-17	123.87	28	233		
10	17-08	000.00	-	1543		
Water level 10 cm						
1	08-09	410.50	24	0	2329	16.20 %
2	09-10	465.00	25	6		
3	10-11	553.95	27	11		
4	11-12	603.45	29	40		
5	12-13	632.22	29	94		
6	13-14	731.27	32	180		
7	14-15	500.02	30	263		
8	15-16	308.65	30	195		
9	16-17	198.95	29	170		
10	17-08	000.00	-	1370		
Water level 5 cm						
1	08-09	469.50	24	3	2237	14.15 %
2	09-10	550.01	25	7		
3	10-11	624.20	26	30		
4	11-12	631.80	28	63		
5	12-13	650.65	29	113		
6	13-14	561.40	31	248		
7	14-15	479.25	31	208		
8	15-16	359.47	30	180		
9	16-17	228.62	28	158		
10	17-08	000.00	-	1223		

Thermal Performance Analysis of Single Slope Solar Still

Thermal efficiency of solar still

$$\eta = m L / I A_g t$$

Where,

m - Mass of evaporator water (liters)

L - Latent heat of evaporation (2260KJ/Kg)

I_g - Global solar radiation (W/m^2)

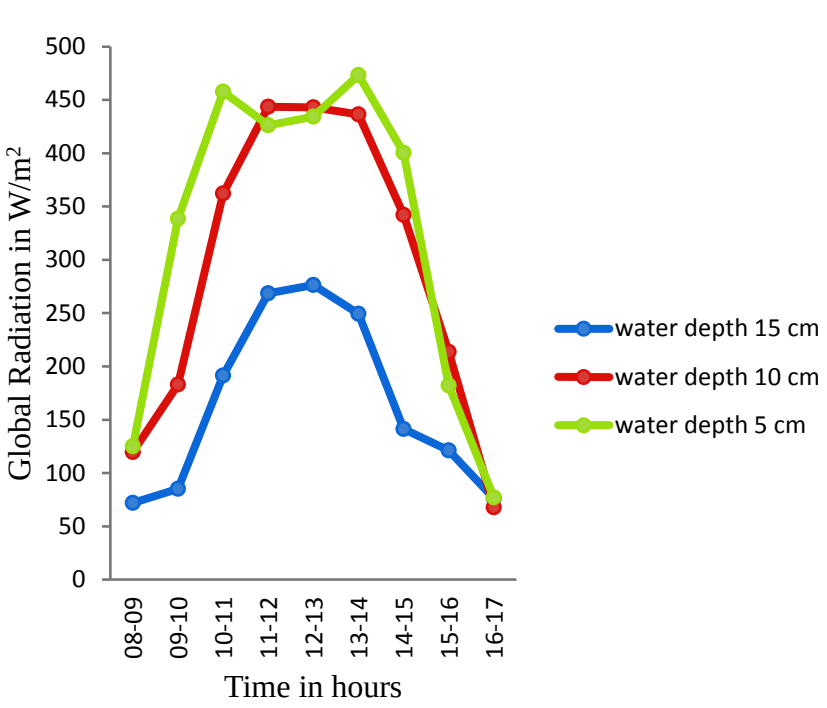
A_g = Surface area of glass (m)

t = Time (s)

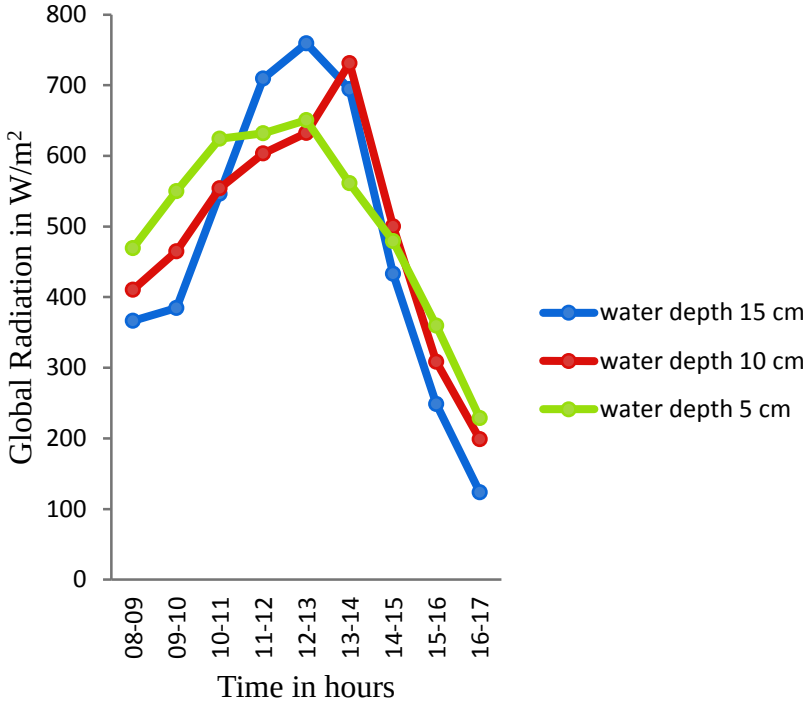
6. RESULTS AND DISCUSSIONS

The observation of ambient parameters such as Global Solar Radiation and ambient temperature and yield are recorded hourly to study the effect of each parameter on the yield.

In this study yield is examine for various operating conditions such as global solar radiation, ambient temperature, water depth, monsoon and post monsoon month. Thermal efficiency is also determined for various dept and for different climatic conditions.

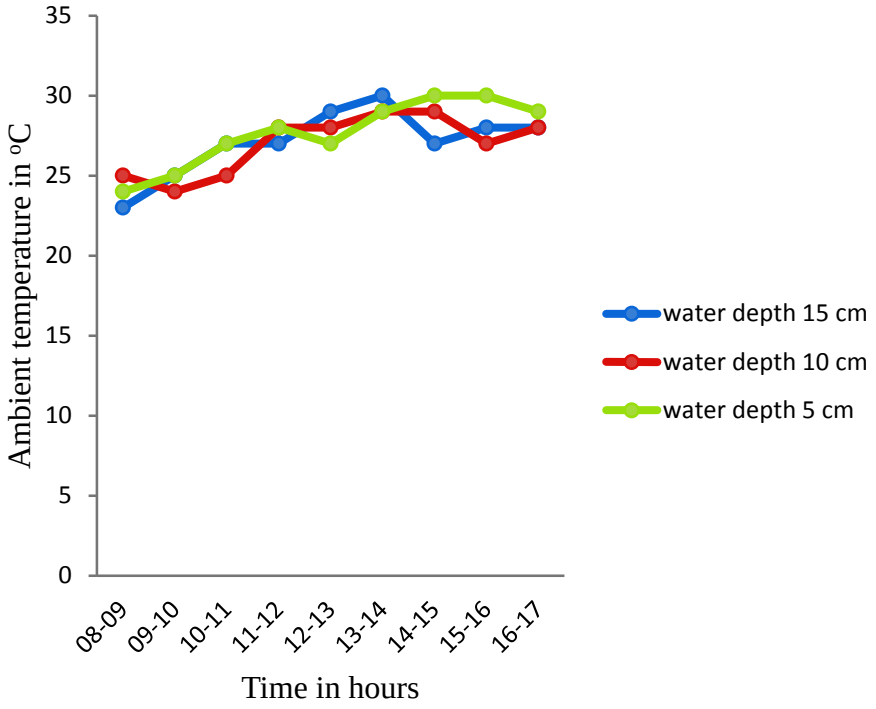


(a) September 2013

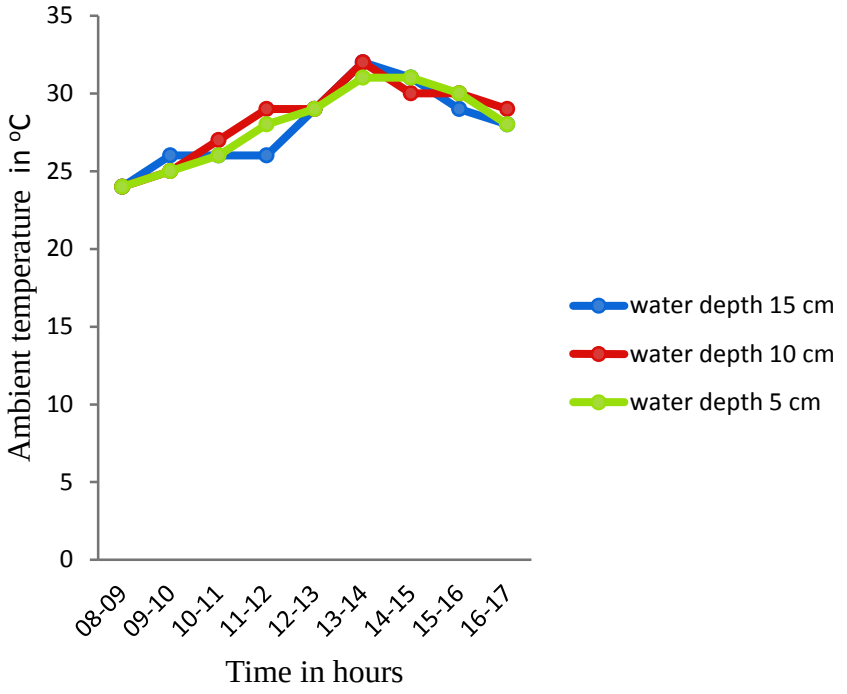


(b) October 2013

Figure: 6.1 Variation of Global solar radiation with respect to time of the day

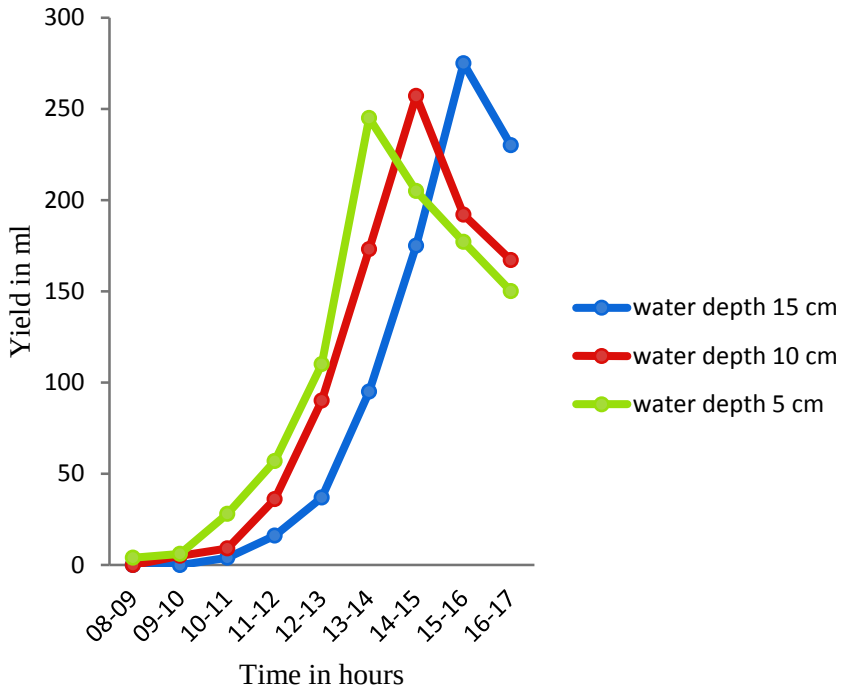


(a) September 2013

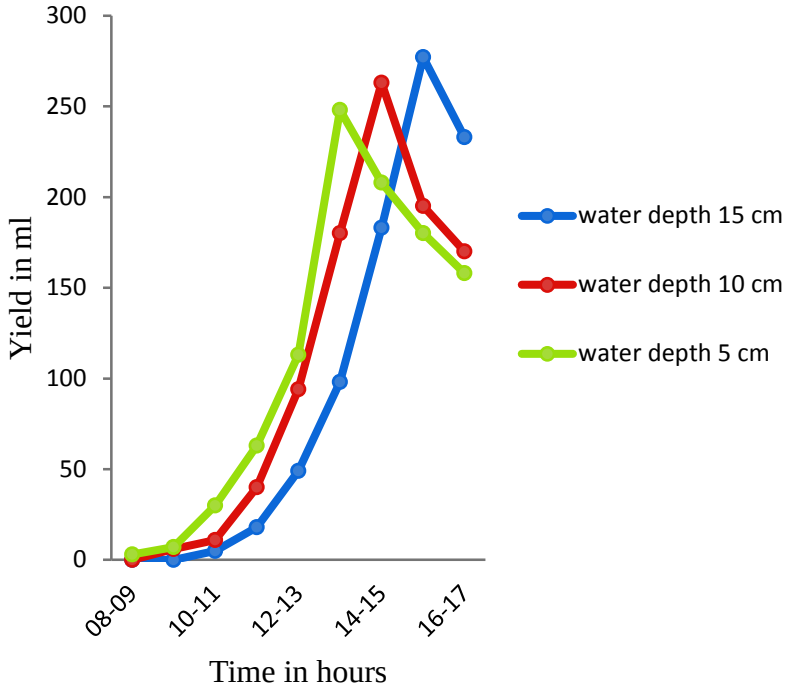


(b) October 2013

Figure: 6.2 Variation of Ambient temperature with respect to time of the day

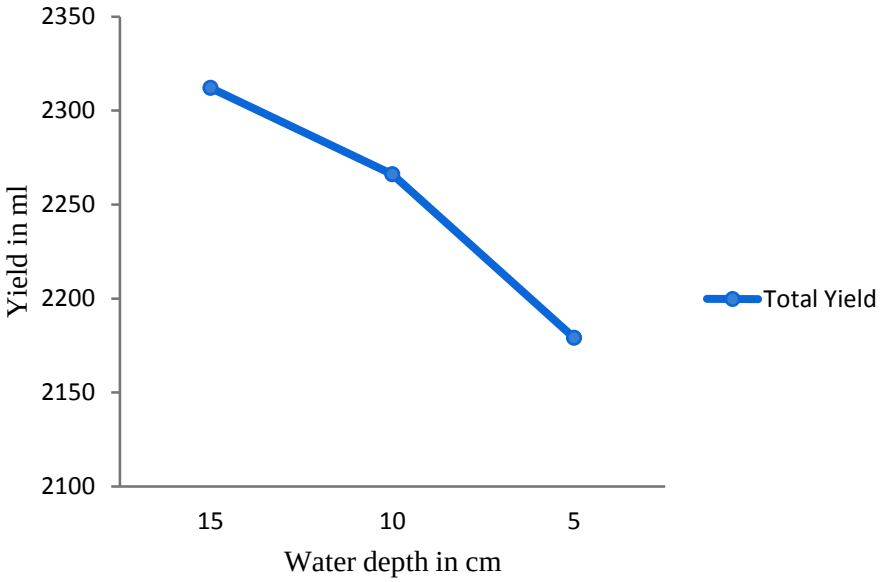


(a) September 2013

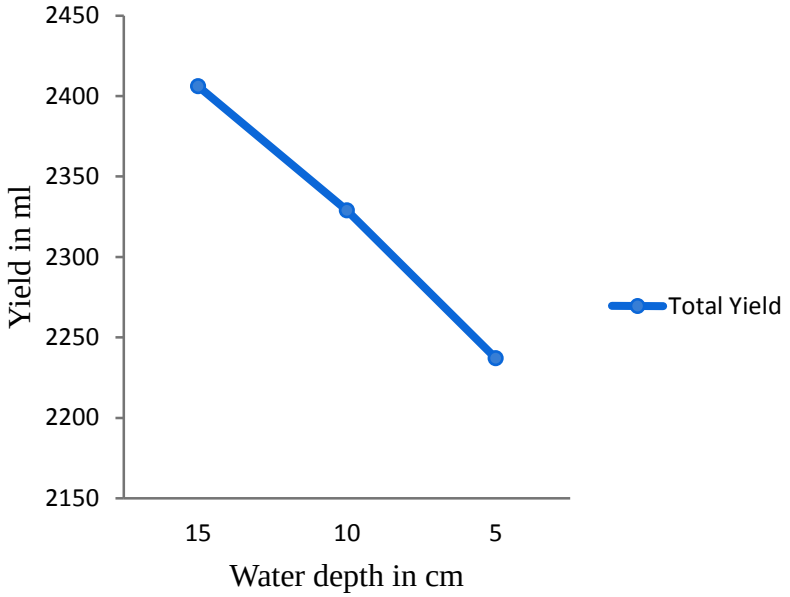


(b) October 2013

Figure: 6.3 Yield with respect time of the day for various depth of water

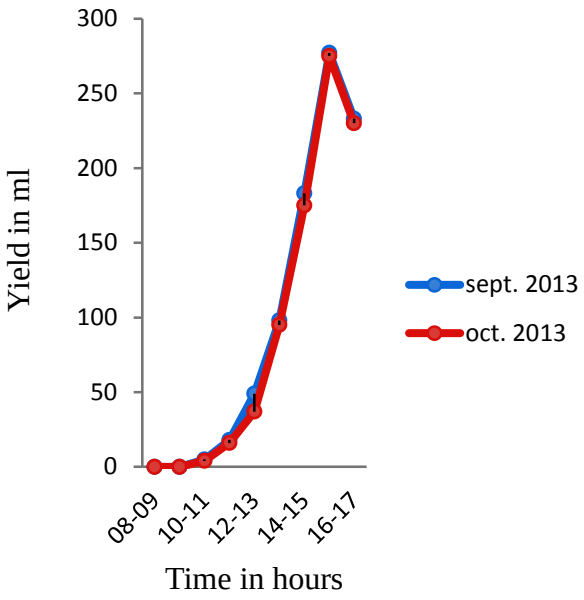


(a) September 2013

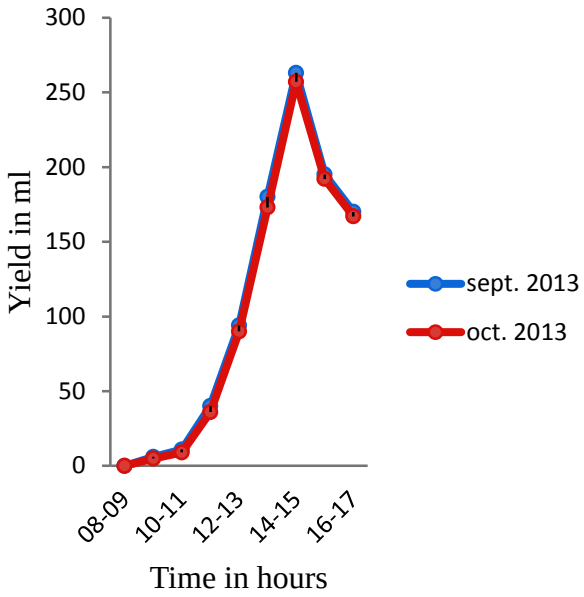


(b) October 2013

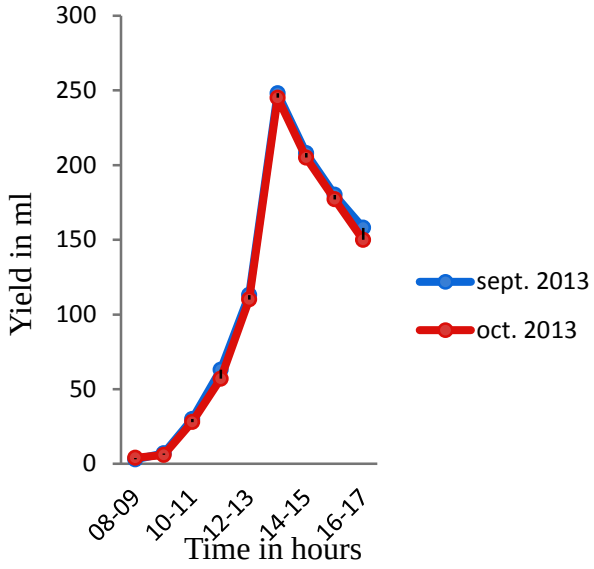
Figure: 6.4 Total Yield for different depth of water during 24 hours of single slope solar still



(a) Water depth 15 cm

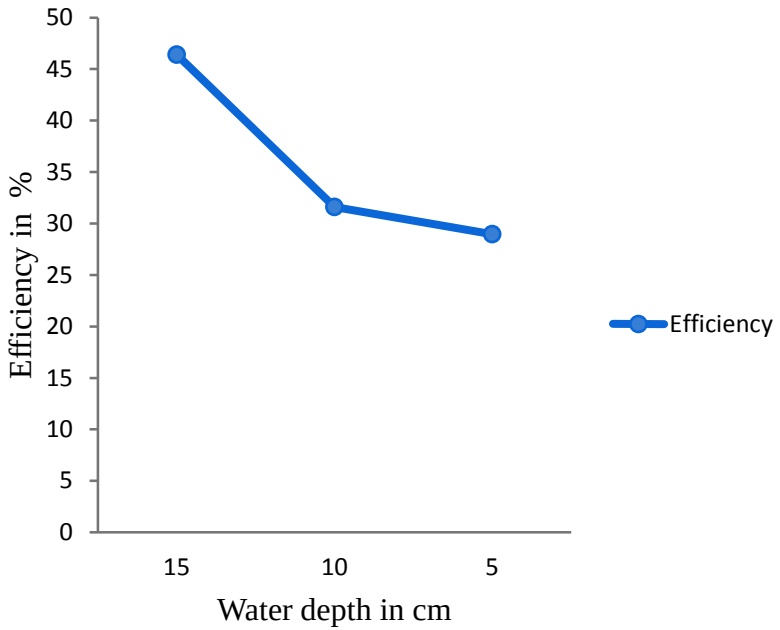


(b) Water depth 10 cm

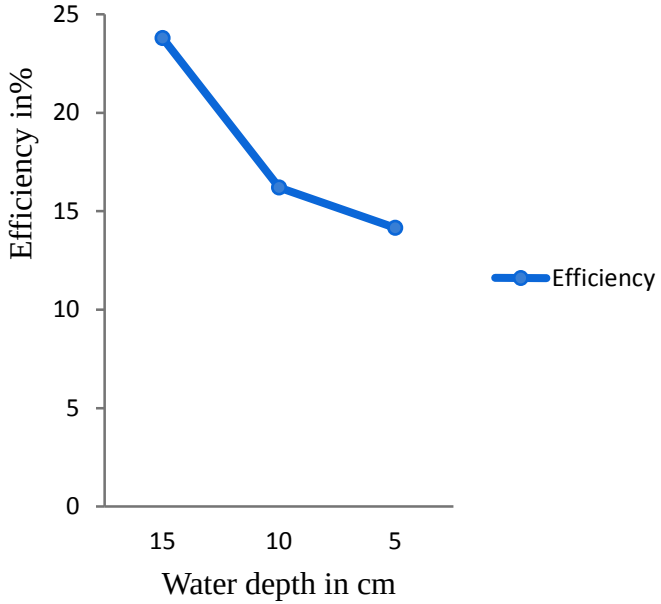


(c) Water depth 5 cm

Figure: 6.5 Varying of yield with respect to time of day for monsoon and post monsoon month



(a) September 2013



(b) October 2013

Figure: 6.6 Varying thermal efficiency with respect to water depth for monsoon and post monsoon month

7. CONCLUSIONS

A solar still has been designed, made and tested successfully. It is readily convert impure water such as bore and river water into pure drinking water with TDS 1500, pH 7.0. And the overall thermal efficiency is 46.40%. Insolation values of about 700 W/m² result in output of about 2.0-2.5 liters per day at Jabalpur, India, Latitude angle is 23º10'. It is moveable, lightweight and portable.

It is also concluded that climatic condition and depth of water plays significant role in output of single slope solar still. The still continues to produce the pure water even after sunset due to storage of solar thermal energy.

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THANK YOU