

Performance Evaluation and Economic Analysis of Stepped Solar Still with Wire Mesh

Vaishally Dogra, Chandra Kishore, Deepak Verma

Abstract: Pure and distilled water is now serving as a basic daily necessity for human being functionality. Solar energy is widely being used for purifying the salt water with basic fundamental of evaporation and condensation through a solar still which captures the sunrays, evaporates the seawater, condensate the vapors and purifies the water. This method is the widely used green method for water distillation via set ups. This paper concentrates at water purification by modified stepped solar still with wire mesh and comparing it with a conventional still. Still with 4 steps with depth of 5 mm and 120 mm wide were fabricated on modified still. The efficiency of stepped stiller was altered up to 30.72% and the amount of distillate obtained was 1932 ml/m²/day in case of conventional distiller and 2800 ml/m²/day was for stepped one.

Keywords: Stepped Solar Still, Efficiency, Flat Plate Collector, Economic Analysis, Distillation

I. INTRODUCTION

Solar distillation is one amongst the best renewable methods for purifying water by evaporating and condensing the brackish water via sunrays concentrating on the brackish water through a glass cover. Novel seawater solar desalination system with an integration of static collector based solar thermal field and multi-effect membrane distillation technology was simulated by (Manas et al., 2002) showing that annual range of distillate output ranged between 41.7 and 70.5 m³ and maximum for 35.9 m² solar field. Economic and thermal performance of stepped double slope solar still in integration with linen wicks and carbon black nanoparticles was improved by (Sharshi et al., 2020) leading to increase in productivity of freshwater and exergy efficiency by 80.57 and 110.5% respectively. The fractional exergy of evaporation was highest when linen wicks were used on steps and nanoparticles in the basin saline water.

(Sharon et al., 2020) Viability assessed solar distillation used for desalination in coastal locations of Indian sub-continent with the help of mathematical model and results showed that yearly condensate production varied from 745.84 to 1346.38 L/Yr with energy efficiency of 44.06%. Highest desired production of 3.38 kWh/USD was noticed for Porbandar and the lowest for Port Blair with 1.60 kWh/USD. Simultaneous transfer of heat in hollow fiber membrane modules for sweeping gas membrane distillation unit was studied by (Gupoei et al., 2020) and a mathematical model was established in outdoor weather conditions for the same.

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Different parameters of membrane structure like pore size, porosity and tortuosity for the membrane pore were experimentally validated for the mathematical model with results stating that system performance was no longer raised for pore diameters above 150 nm with an optimal porosity of about 0.75.

(Quiming et al., 2020) Designed a desalination unit on a small scale for drinking water production in remote places with a simultaneous strategy of heat recovery and permeate condensation by heat pump and photovoltaic power capacity for per unit water production almost ranged between 4.2 to 5.0 W/L. Further results revealed that freshwater production of 3.7 L on daily basis for tiny module of 0.18 m² with 17 W electric consumption and for a large scale module of 3 m² 96L of freshwater consuming 449 W.

A comparative study between modified stepped still containing black and cotton absorber with conventional still was performed (Agouz et al., 2014) leading to a conclusion that efficiency of stepped still was 20% more than basic one at water flow rate of 1 LPM and 3 LPM for sea water and salt water respectively. (Z.M. Omara et al., 2014) carried a study on stepped still with external and internal reflectors and indicated results showed that efficiency for stepped still with reflectors was 125% more than conventional still. 1 l of distillate costed approximately 0.031\$ for stepped still and 0.049\$ for conventional still. Experimental study of distance between evaporator and condensate of inclined multistage desalination plant was installed (Mirzaev et al., 2019) and results declared that maximum mass condensate occurred for 4 to 8 cm condensate and evaporator distance, 5.21 cm to be precise.

Nomenclature

α' = fraction of solar flux absorbed

$I(t)$ = intensity of solar radiation over inclined surface of still (W/m²)

$q_{c,w-g}$ = convective heat transfer rate from water to glass cover (W/m²)

$q_{e,w-g}$ = evaporative heat transfer rate within still from water to glass cover (W/m²)

L_g = thickness of glass cover (m)

K_g = thermal conductivity of glass cover (W/m°C)

$q_{r,g-a}$ = radiative heat transfer rate from glass cover to ambient (W/m²)

$q_{c,g-a}$ = convective heat transfer rate from glass cover to ambient (W/m²)

q_b = heat transfer rate from basin liner to ambient (W/m²)

q_w = convective heat transfer rate from basin liner to ambient (W/m²)

m_{ew} = hourly output from solar still (kg/m²h)



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h_b = overall heat transfer coefficient from basin liner to ambient ($W/m^2\text{ }^\circ C$)

$h_{e,w-g}$ = evaporative heat transfer coefficient from water to glass cover ($W/m^2\text{ }^\circ C$)

T = temperature ($^\circ C$)

A = (m^2)

L = latent heat of vaporization (J/kg)

Subscripts

g	glass
gi	inner glass cover
go	outer glass cover
b	basin liner
w	water
s	solar still
c	solar collector

Greek

η efficiency (%)

Borosilicate vacuum tubes with heat pipes inside distiller was studied (Saetooone et al., 2017) for productivity enhancement for stepped still and was further compared with stepped still without vacuum tubes. Results proved that output distillate of freshwater was more in sunny days than and stepped still with vacuum tubes was 32.4% more enhanced to stepped still without vacuum tubes.

Evaluation of cost parameters with exergy and energy analysis was done by Ibrahim et al. (2017). In addition to this, key variable effect on exergoeconomic cost of freshwater production was also investigated and a graphical approach was used for the same. The results revealed that exergy destructions cost was decreased by 36% leading to 45% deduction in exergoeconomic cost of the freshwater produced.

Ali.F.Muftah et al. (2018) integrated a superior design concepts like using internal reflectors, absorbers, etc. into one design and energy balance analysis for multiple parameters was conducted for the proposed model. Thermal performance was increased for modified stepped distiller and results led to 29% enhancement in the modified still for daily productivity. Sallami et al. (2017) aimed at improving solar still yield by improving the performance of absorber using an added inner heat storage system for which absorber surface was covered with layers of blackened sponge and then tested. The results depicted that yield was increased by 57.77% for a sponge thickness of 0.5 cm with no blackened sponge while sponge thickness of 1.5cm showed that the yield decrease by 29.95%.

A desalination complex based on wind energy marine units was suggested by V.V.Cheboxarov et al. (2019) and concluded that this particular unit partially solved the problem of water for the places which lack the centralized power supply. A stepped solar still of 1.8 m x 1.2 m x 0.20 m dimensions with a copper inclination containing 28 trays of 1.2 m length and 0.6 m height was fabricated (Abujazar et al., 2017) and results conveyed that the environmental parameters highly affected the still than operational ones which showed that best hourly efficiency was 58% approximately with 4383 mL/m²d. Experimental and numerical analysis was performed on stepped still coupled with photovoltaic thermal water collector (Naroei et al., 2018) taking into consideration the energy balance for

different still components. End results unveiled that energy efficiency was two times more and freshwater productivity was elevated by an amount of 20%. The photovoltaic water collector was able to additionally supply 1.06 kW/day electric powers.

Herrena et al. (2017) developed favorable designs for reactive distillation systems for producing trichlorosilane, dichlorosilane and silane. The system was developed and optimized problem was formulated for finding best common system structure with operating conditions of product and use of genetic algorithms as optimization tool was effective tool proved. The results depicted that there was only minor effect on steady state values of maximum production temperatures of three products.

Experimental investigation of solar thermal driven membrane distillation-based desalination system was carried out by Kabeel et al. (2017) leading to a system efficiency of 49.01% with increase in water mass flow rate and more air mass flow rate with a maximum productivity of 33.55 L/day. The gained output ration of the system reached to a value of 0.49 and the cooling unit used led to a significant increase of almost 1.25 times in productivity to that without the use of cooling unit.

Performance study on a photovoltaic thermal stepped solar still with a bottom channel was done by Lan Xiao et al. (2019). A theoretical model was established and validated for the study and assessed results revealed that absorber plate to saline water heat transfer rate was altered by 44% for 0.01 m bottom channel depth leading to 51.7% increase in freshwater productivity. Similarly average thermal and exergy efficiency was escalated by 17% and 3% respectively.

Multi-Tray Evaporator was used as an additional evaporation area by integrating with rear wall of still (Saddi et al., 2018) to enhance daily productivity and was comparatively compared with conventional still with different meteorological conditions in Adrar-Algeria region. The modification led to a conclusion that productivity was about 47.18-104.73% higher than for conventional still and estimated cost of distillate was 0.01\$/kg.

Radiation shape factor for hot saline water and glass cover for stepped type solar still for 10° to 70° inclination of glass cover and 200 to about 1200 W/m² solar insolation was computed by Samadony et al. (2016) on still productivity and revealed that still productivity of 18.8% considering radiation shape factor was resulted for low insolation of 200 W/m² and 70° glass cover inclination.

Different water depth with different sensible heat storage mediums such as wick, rock and sponge affecting the efficiency of stepped solar still adjoining with flat plate collector was analyzed and compared with conventional (Aalaudeen et al., 2014) which showed that maximum and minimum productivity was obtained respectively for 2 cm and 4 cm water depth. Wick and sponge combination in 2 cm water depth gave a maximum output of 1305 kg/m² and a payback of about 320 days was required for the stepped still.



Al-Nimur et al. (2016) proposed a hybrid solar-wind distillation system consisting of conventional basin still and a simultaneous operative wind-water heater which led to a production of large output of distill water because of its operative ability at day and as well at night and on cloudy days too. Construction and simulation of simple model equations were done resulting in significant increase in output with three to four times more as compared to conventional stills.

A triangular solar still using cheap and durable materials was designed by Ehsan et al. (2014) and relationships between daily production amount, daily solar irradiation and initial water depth were attained by changing water depth with climatic conditions. Inverse relationship between production and water depth was seen and water quality parameters were within the accepted drinking water range.

Installation of reflective mirrors for stepped solar still were investigated theoretically (Omara et al., 2013) which increased the thermal performance of modified still and was approximately 75% more productive with reflectors and 57% productive without reflectors when compared to conventional still. Modified stepped still was moreover 22% more efficient than the conventional. V.Sivakumar et al. (2013) reviewed various efficiency improvement techniques for solar still and results showed that annual yield will be maximum for glass inclination angle same as place latitude and evacuated tube collector coupled with still led to 77% increase in productivity with comparison to conventional one. Also daily output was increased by 29% when black paint in basin liner was replaced by asphalt. Vacuum tube collector was used by A.E.Kabeel et al. (2012) for varying temperature of feed water to stepped still and studying the tray depth influence and width on still performance. The study revealed that maximum productivity about 57.3 % higher was obtained for a tray of 5mm depth and 120 mm wide than that in case of conventional still. Aayush Kaushal et. al. (2010) reviewed different solar stills and summarized that still efficiency can be enhanced by around 20 % when cooling film parameters are properly combined and productivity decreases by 15% if diffusion gaps in multi-effect diffusion model are increased from 5 to 10 mm. Effluent settling tank was fabricated with a payback period of 727 days (Velmurugan et al., 2009) for desalinating textile effluent using them as raw material and performance analysis was carried out. 50 trays of two different depths were used for better performance and pebble, sponge and fin combination was used for increasing productivity. Results revealed that rates of production were increased by 53.3%, 68% and 65% for fins, sponge and pebbles respectively. Combination of sponge and pebble in fin type stepped increased the productivity by 98% with reference to conventional still.

A new flat-sheet cross flow membrane module fitted with a hydrophobic polyvinylidene-fluoride (PVDF) microfiltration membrane was used by Manna et al. (2010) for removing the arsenic from contaminated groundwater and resulted that it produced almost 100 percent arsenic-free water. Resulted data showed that feed flow rate of 0.120 m³/h for 0.13µM PVDF membrane led to a yield of 74 kg/m²h of flux at 40°C feed water temperature and 95 kg/m²h for 60°C feed water temperature. Simulation calculations for the membrane

distillation units with derived module characteristics from several experimental investigation for different potential installation units were done by Koschikowski et al. (2003) with results depicting that the simple compact system with collector area for less than 6m² without heat storage can give an output of 120 to 160 L in a day for summer in the southern country.

II. EXPERIMENTAL DESIGN AND SETUP

Two solar distillers, one conventional type, Fig.1, with a basin area of 1 m² and other stepped type with wall heights of 450 mm on high-side and 610 mm on the other side, Fig.2, were constructed and their performance is compared. The effect of feed water temperature on the stepped solar still was examined by using flat plate solar collector, Fig.3. Galvanized steel sheets are used in fabrication of stills and coating of black paint is done for basin surface so that more amounts of solar radiations are absorbed. To reduce the side and bottom heat losses, sawdust is used for insulation. A 3 mm thick glass is used inclined at an angle of nearly 30° horizontally, which is the latitude of Solan, Himachal Pradesh to raise the amount of insolation. Basin area of stepped is similar to conventional one and 5 steps of absorber plate each with size of 0.1 m x 2 m containing wire meshes are made. For temperature measurements of water and glass, Iron-constantan thermocouples are used at different places including absorber steps. A calibrated solar pyranometer is used for measuring global radiation, digital anemometer for wind velocity and a 2 litre capacity flask for collection of distillate.



Fig.1. Conventional solar still



Fig.2 Stepped solar still

The experimental setup for stepped solar still comprises of the following specifications:

Wooden box = $2 \times 0.5 \text{ m}^2$
Height of box at rear end = 0.61 m
Height of box at front end = 0.4 m
Gap between the sides of tray and wooden box =

0.2 m

Number of steps = 4
Total area of tray = 240 cm^2
Thickness of tray = 2 mm
Tray depth = 5 mm
Width of tray = 120 mm
Thickness of glass cover = 9 mm

Wire mesh= 4 wire mesh of (0.1 m x 2 m) for the steps and one wire mesh of (2m x 0.5m) for basin



Fig.3 Flat Plate Collector

III. EXPERIMENTAL PROCEDURE

The conduction of experiment is done at the Department of Mechanical Engineering, Shoolini University, Solan, Himachal Pradesh. At an interval of thirty minutes, temperatures of saline water, basin plate, glass cover is measured with ambient temperature and solar insolation. Saline water depth is maintained the same for experiment and accumulated distillate is measure. Saline water affecting stepped still with wire mesh is investigated. The temperature effect of feed water on stepped distiller is investigated using flat plate collector.

A. Instruments

Standard calibrated and accurate instruments are used to capture the required data of Solar Irradiation, water temperature and glass cover temperature, pH of distillate yield output and wind velocity. Thermocouples, pyranometer, and anemometer are the accurate instruments used for collecting the experimental data. In addition water quality was checked before and after performing the experiment using a pH meter.

B. Solar Radiation

Intensity of solar radiation is one of the most important variable or factor in solar energy applications and needs to be measured very accurately and precisely for thermal testing in case of solar stills. In the performed experiment, Lutron Pyranometer, measuring the solar radiation intensity ranging between 400-1500 W/m² is used.

C. Temperature

Iron-Constants thermocouples are used for measuring the temperature at different ends of both the conventional and stepped still. Different ends of the still for temperature measurement are basin water, outer glass cover and the inner glass cover.

D. Speed of surface wind

Rate of loss of heat from still is influenced by the speed of wind and it needs to be measure at the utmost. As the experiment is ground-based, so anemometer with 1°C/1.8°F air temperature accuracy, 0.1°C/0.1°F air temperature

resolution and air velocity ranging between 0.3 to 90.0km/h is used.

Table.1 Characteristics of Anemometer

Air Velocity	Range	Resolution	Accuracy
m/s	0.1 to 25.0m/s	0.01m/s	±5% ±0.1m/s
km/h	0.3 to 90.0km/h	0.1km/h	±5% ±0.1km/h
ft/min	20 to 4925ft/min	1ft/min	±5% ±1ft/min
MPH	0.2 to 55.8MPH	0.1MPH	±5% ±0.1MPH
Knots	0.2 to 48.5knots	0.1knots	±5% ±0.1knots
Air Temperature	0°C to 50°C 32°F to 122°F	0.1°C/0.1°F	1°C/1.8°F

E. Quality of water

Quality of water before and after distillation needs to be measured and this was done by the pH meter with an operational range of 0-13.99 and accuracy of ±0.02.

Table2. Instruments used during experimentation

Parameter	Instrument/ Equipment	Model	Accuracy
Solar Intensity	Pyranometer	Model CMP-3, Kipp and Zonen BV, Rontgenweg, Holland (10–1500 W/m ²)	± 0.5 W/m ²
Temperature	Thermocouple	Iron-constants (type J)	±0.75 %
Surface wind speed	Anemometer	Model AV6, 100 mm Hg, Air Flow Instruments, England: Range: 0–30 m/s	± 0.01 m/s
Quality of water	pH meter	PCE-PH 22	±0.02 pH

IV. THEORETICAL ANALYSIS

Energy balance equation for still as given by Tiware et al. (2009) are:

For inner glass cover, eq.(1)

$$\alpha'_g I(t)_s + q_{r,w-g} + q_{c,w-g} + q_{e,w-g} = \frac{K_g}{L_g} (T_{gi} - T_{go}) \quad (1)$$

For outer glass cover, eq.(2)

$$\frac{K_g}{L_g} (T_{gi} - T_{go}) = q_{r,g-a} + q_{c,g-a} \quad (2)$$

For basin liner

$$\alpha'_b (1 - \alpha'_g) (1 - \alpha'_w) I(t)_s = q_w + q_b \quad (3)$$



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Internal heat transfer rates for still inculcates the following equations (Tiwari et al., 2008):

$$q_{r,w-g} = h_{r,w-g}(T_w - T_{gi}) \quad (4)$$

$$q_{c,w-g} = h_{c,w-g}(T_w - T_{gi}) \quad (5)$$

$$q_{e,w-g} = h_{e,w-g}(T_w - T_{gi}) \quad (6)$$

External rate of heat transfers which includes bottom and top heat transfer losses occurs as follows (Badran et al., 2007):

$$q_{t,g-a} = h_{t,g-a}(T_{go} - T_a) \quad (7)$$

$$q_b = h_b(T_b - T_a) \quad (8)$$

Hourly output distillate is calculated by eq. (4):-

$$m_{ew} = \frac{h_{e,w-g}(T_w - T_{gi})}{L} \times 3600 \times A_s \quad (9)$$

Thermal efficiency for the stills is calculated by eq. (5):-

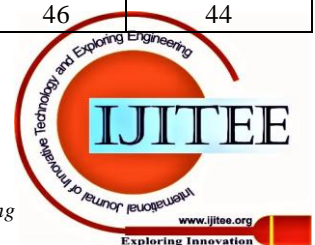
$$\eta = \frac{m_{ew} \times L}{I(t)_s \times A} \quad (10)$$

V. RESULTS AND DISCUSSION

A. Meteorological Data

Table 3. Meteorological data collected

Test day	Time (h)	Ambient air Temp. (°C)	Solar Irradiance (W/m ²)	Feed water Temp. (°C)	Temp. of outer glass cover		Temp. of inner glass cover	
					(T _{go})		(T _{gi})	
					Stepped	Conventional	Stepped	Conventional
6/7/2019	10:30 AM	30.4	708	72	36	35	37	38
	11.00 AM	31.6	698	63	39	37	39	39
	11.30 AM	29.5	678	60	38	35	42	41
	12.00 AM	31.5	867	83	44	41	48	45
	12.30 AM	34.5	809	80	42	40	45	43
	1.00 PM	32.6	799	79	42	38	43	40
	1.30 PM	31.9	764	72	41	36	40	39
	2.00 PM	29.4	646	68	40	39	39	37
	2.30 PM	29.9	523	53	38	37	37	35
7/7/2019	10:30 AM	29.6	990	89	44	40	46	44
	11.00 AM	27.6	325	40	32	31	39	36
	11.30 AM	30.5	590	58	33	34	47	45
	12.00 AM	29.4	482	41	32	30	41	39
	12.30 AM	31.9	906	85	42	40	44	42
	1.00 PM	29.2	232	39	31	31	32	30
	1.30 PM	27.9	365	45	30	29	32	31
	2.00 PM	24.4	206	33	29	28	29	27
	2.30 PM	26.8	780	75	35	32	39	37
8/7/2019	10:30 AM	27.8	899	84	41	39	44	42
	11.00 AM	25.4	423	41	33	31	38	37
	11.30 AM	30.1	509	56	35	33	40	39
	12.00 AM	27.7	497	43	39	36	46	42
	12.30 AM	30.2	997	90	42	40	46	44
	1.00 PM	27.9	254	31	29	27	32	30
	1.30 PM	26.6	401	40	32	30	41	40
	2.00 PM	25.6	303	35	33	31	40	39
	2.30 PM	27.1	769	74	36	34	42	41
9/7/2019	10:30 AM	31.1	509	51	37	36	39	38
	11.00 AM	30.5	599	59	40	39	40	40
	11.30 AM	29.9	610	58	42	41	43	42
	12.00 AM	30.4	765	74	40	39	42	41
	12.30 AM	33.7	929	87	43	42	46	44



	1.00 PM	31.8	831	80	40	39	43	40
	1.30 PM	29.9	856	82	41	38	42	41
	2.00 PM	28.4	812	81	40	37	38	37
	2.30 PM	30.9	734	74	39	39	37	34
10/7/2019	10.30 AM	27.1	476	49	36	35	37	35
	11.00 AM	27.6	567	50	40	39	39	37
	11.30 AM	28.9	613	59	42	41	40	40
	12.00 AM	29.4	891	84	41	39	38	41
	12.30 AM	31.8	903	86	44	43	46	45
	1.00 PM	31.8	845	83	42	40	43	41
	1.30 PM	30.5	674	61	41	40	41	41
	2.00 PM	29.4	532	50	42	40	37	40
	2.30 PM	31.9	435	49	40	36	39	38

B. Accumulated productivity of some days

Table 4. Data for daily productivity of conventional and stepped still

Date	Daily Productivity (ml/m ² /day)		Daily productivity rise (%)
	Conventional Solar Still	Stepped Solar still with mesh	
6/7/2019	1501	1700	13.25
7/7/2019	1932	2800	3.52
8/7/2019	2056	2152	4.66
9/7/2019	1417	1610	13.62
10/7/2019	1312	1362	3.81

Fig.4 shows that the daily productivity rise is more in case of stepped still with mesh as compared to that of the conventional solar still.

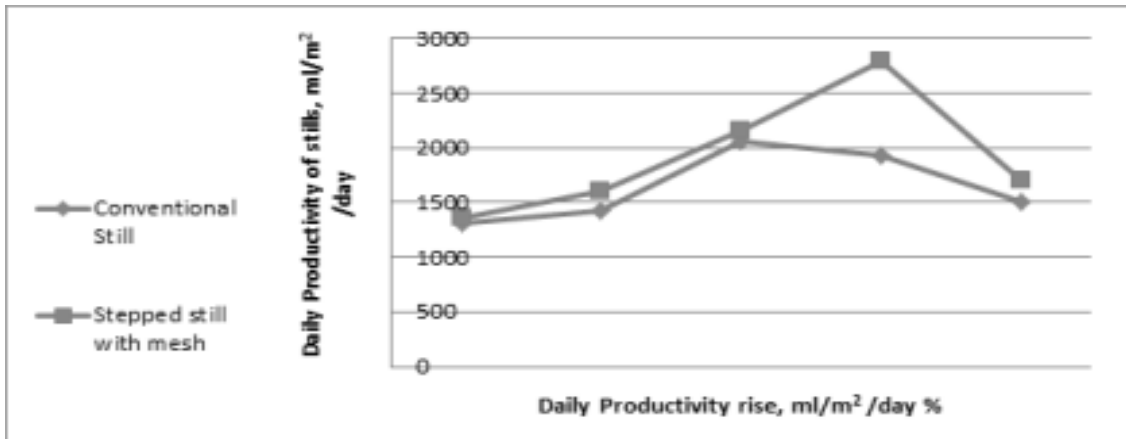


Fig.4. Daily productivity of stepped and conventional solar stills

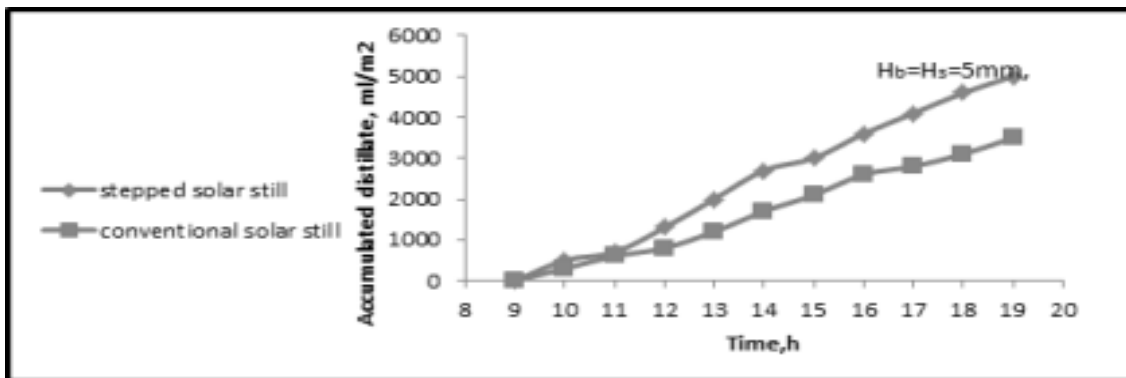


Fig.5. The accumulative variation of fresh water for the stepped and the conventional still for feed water temperature of 60°C

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Fig.5 displays that production rate on daily basis reached approximately 3200 and 4900 ml/m²/day respectively for conventional and stepped still which further reveals that distillate production of stepped still is 53.12% higher than conventional desalination unit.

C. Daily efficiency of the stills

Daily efficiencies of both the stills is calculated by the following equation-

Where, m is the mass of the accumulated distillate, L is latent heat of vaporization, k cal/kg, I is intensity of solar radiation, $W/m^2/day$ and A is area of the basin of still. The value of latent heat of vaporization of water is taken as 594.5 kcal/kg.

Table 5. Data showing daily efficiency of conventional and stepped still

Date	Daily Efficiency, %		Intensity of solar radiation (W/m^2)
	Conventional Still	Stepped still with mesh	
6/7/2019	17.95	20.3	497
7/7/2019	21.19	30.72	541.8
8/7/2019	37.4	39.2	326
9/7/2019	17.19	19.53	490
10/7/2019	19.94	20.7	391

Fig.6 shows the variation of daily efficiencies of the stills for some particular days with variation in solar irradiance. From this figure it is found that the maximum efficiency is for the maximum solar radiation on 7 July, 2019 with maximum efficiency of 30.72% for stepped solar still with mesh and 21.19% for conventional still with solar radiation of 541.8 W/m^2 .

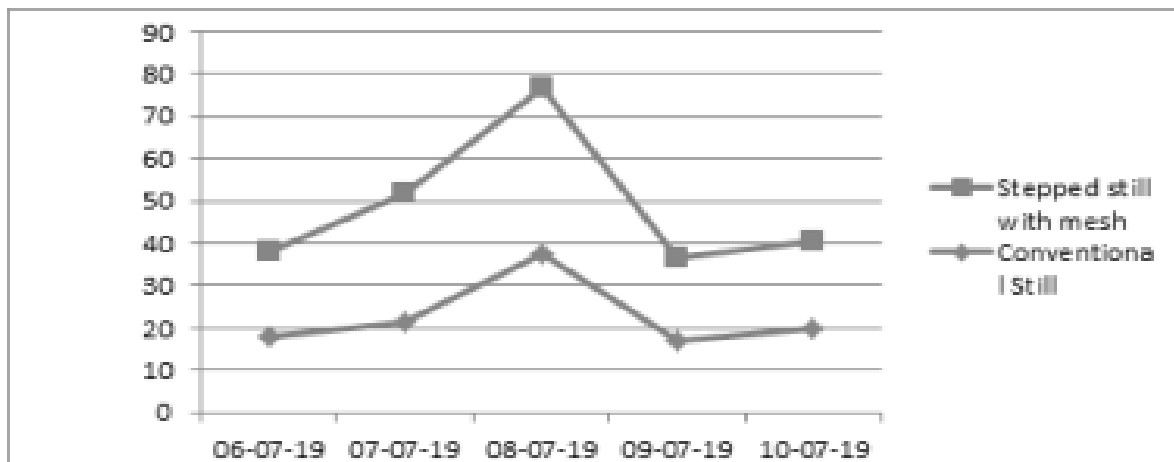


Fig.6 Variation of daily efficiencies of conventional and stepped stills with varying solar radiations

Fig.7 shows the variation between temperature, time and solar radiation and indicates that solar radiation and

temperature has a maximum value at the noon time and starts decreasing after that.

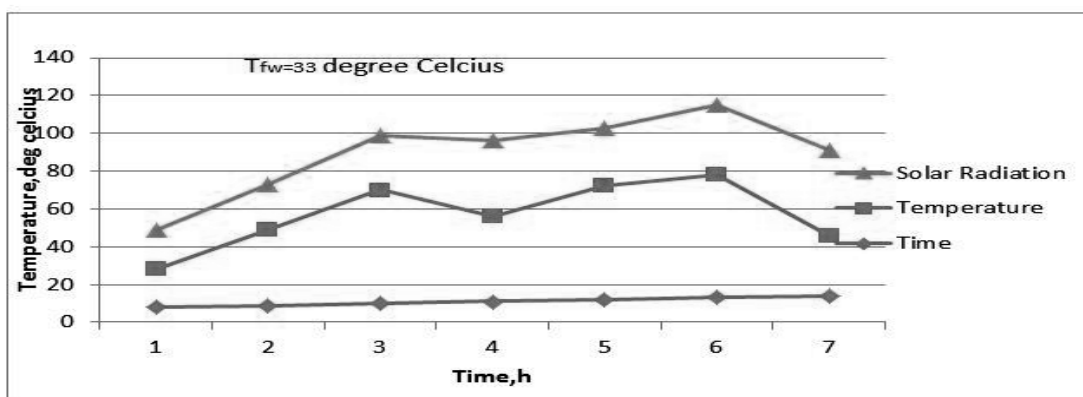


Fig7. Variation between temperature ($^{\circ}C$), Time (h) and Solar radiation (W/m^2)

D. pH of sample and the distilled water

A sample of the distilled water was tested in the laboratory at the Biotechnology department, Shoolini University. The testing parameters were pH and salinity pH measure was made with pH meter.

Table 6. Distilled Water Analysis

	Sample Water	Distilled Water	Drinking Water Standards
pH	8.4	8.0	6.5-9.2
Salinity	0.2	0.15	<0.25

The pH of water sample that was to be distilled was 8.4 before distillation experiment and afterwards was 8.0 which lie in the drinking water standards range. Also the salinity was reduced from 0.2 to 0.15 and which ranges in standards.

E. Economic analysis

Payback period for stepped solar distiller was calculated as follows including the cost of fabrication, maintenance, operation.

Overall cost of fabrication = Rs.18,000

Per litre distilled water cost = Rs.10

Solar still (considering maximum) productivity = 2.8 l/m²/day

Per day cost of water produced = Rs.28

Cost of maintenance = Rs.5/day

Net earning = Per day cost of water produced – Cost of maintenance

$$= \text{Rs. } (28 - 5)$$

$$= \text{Rs. } 23$$

Payback period = Investment / Net earning

$$= 18,000 / 23$$

$$= 782 \text{ days}$$

VI. CONCLUSION

In this work, the experimental results are obtained and the effect of wire mesh on the still productivity has been contrived and following points can be concluded according to the performed experiment:

- Wire mesh was also painted black so that more amount of solar irradiation is absorbed by the water thus elevating the absorption rate.
- Productivity for the still was inflated at the point where solar insolation was maximum.
- Maximum solar insolation of 541.8 W/m² was observed on 07.07.2019 which resulted in maximum amount of distillate on the particular day.
- The wire mesh used in the stepped solar still hiked daily efficiency up to 30.72%.
- The maximum amount of distillate obtained as on 07.07.2019 are 1932 ml/m²/day for conventional and 2800 ml/m²/day in case of stepped solar still.
- Payback period for stepped still was calculated as 782 days with overall fabrication cost amounting to Rs.18000.

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