An Experimental Study And Performance Analysis of Double Slope Solar Still Filled With Aluminum And Granite At Different Depth of Water

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Abstract— Two major challenges for human society today are shortage of fresh water and limited resources of conventional energy. Solar still is one of the methods to convert saline, brackish water into fresh water using the unconventional source of energy, i.e. solar energy which is free and abundantly available in planet earth. The common method using in the solar still is active and passive solar still According to the basics of design solar still are classified into single slope solar still and multi slope solar still. In the active type solar still the external sources are used while in the case of passive solar still there is no need to use external sources. Most important design parameters influencing the productivity are optimally of glass inclination, the intensity of solar radiation, absorber plate area, thickness of glass cover, the basin filled with different materials, Nano particles mixed with water in the basin, a free surface area of water and depth of water etc. The main difficulty with conventional still is maintaining minimum depth and large surface area of water. Researchers have put efforts to develop various designs of solar stills to maintain the minimum depth of water using different types of materials in the stills to increase the productivity. In the present work, experiment was carried out on double slope, single basin passive solar still filled with water, water with aluminum and water with granite to study the performance analysis of a solar still at different depth of water. During the experiment, it was observed that the maximum productivity and thermal efficiency were obtained in the case of granite with respect to others.

Key words-Solar still, Solar energy,Potable water, Double slop, Solar Distillation

I. INTRODUCTION

Water is a basic need of human life for various purposes. Potable water resources are generally available in the form of lakes, rivers and underground reservoirs. About 71% of the earth's surface is covered with water, yet all of that 97% of the planet's water is found in the oceans, 1.65% in glaciers and the ice caps, 1.8% in ground water, and 0.0012% in the form of vapor and clouds. Less than 1.5% of all fresh water is in the available resources.

Because of the growth of industries the fresh water gets affected. There are various methods available for purifying the saline water. Distillation process is the cheaply available process for water purification. Solar distillation is one of the most renewable methods. Solar distillation is used to provide potable water or to provide water for batteries, laboratories and in hospitals. It can be used in any place because it is portable. It is also used in deserts and in brackish areas where pure water is not available. The drawback of using solar still is its productivity .The main aim is to increase the productivity.

Solar distillation is a thermal desalination method where solar energy is used to distill fresh water from saline and brackish water. A distillation is one of many processes available for water purification, and sunlight is one of several forms of heat energy that can be used to power that process. Sunlight has the advantage of zero fuel cost, but it requires more space for its collection. It is a great practical alternative, which offers life to those regions where the lack of fresh water hinders development [5]. Solar water distillation is a solar technology with a very long history, and installations were found to be built over 2000 years ago, to produce salt rather than drinking water. An early large-scale solar still was built in 1874 to supply drinking water to the mining community in Chile. Mass production occurred for the first time during the Second World War [6].

II. LITERATURE REVIEW

1. **Kamel Rabhi et al. [2017]** In this work a modified single-basin single-slope solar still is developed. A pin fins absorber and a condenser are integrated in the modified solar still. A detailed still design and still functioning description is carried out. An experimental comparative performance study is conducted between the conventional still, the still with condenser, the still with pin fins absorber and the still with both condenser and pin fins absorber. A gain of water production in the order of 32.18% is recorded for the still with condenser (using air flow and external condenser) compared to the conventional still. For the case of the still with simple pin fins absorber, the water production gain is only 14.53% compared to the conventional still.
2. **Hitesh Panchal et al. [2017]** The still solar technology has been serving the humanity for a very extended period of time. There have been many modifications since decades to improve the productivity of the same. One of the significant improvements which have been done is the use of fins at the base of the still. Integration of fins in the basin plate of the solar still increases the basin exposure area and thus leads to the higher heat transfer rate and higher evaporation rate.

Hence, distillate output of conventional solar still is enhanced. In a series of comparative experiments done before, V. Velumurugan et al. observed that when the wick was used in a single basin solar still, the productivity increased up to 29.6% as compared to the use of sponges which increased the productivity by 15.3%. In the same still, when fins were used, the increment observed was 45.5%.

3. Zakaria Haddad et al. [2017] A schematic description of the proposed solar still. It consists mainly of a basin type, single slope solar still in which the VRW is integrated against the rear side of the still. The basin area of the still is 0.36 m2 (0.9 m × 0.4 m) fabricated using 1.0 mm thickness galvanized iron and painted with black spray paint to increase solar ray's absorption. The basin is placed inside a rectangular wooden box of 4 cm thickness and the bottom space between them is filled by 8 cm of glass wool to reduce bottom thermal losses.

4. Basharat Jamil et al. [2017] The present work was carried out at Heat Transfer and Solar Energy Laboratory, Mechanical Engineering Department, Aligarh Muslim University, Aligarh, India (27.89°N, 78.08°E). The actual view of experimental setup i.e. conventional single slope basin type solar still. Galvanized Iron sheet of gauge 22 was used for the construction of solar still. Basin area was kept 1m² with an aspect ratio of 2:1. This is in accordance to the fact that an absorber aspect ratio of 2:1 gives optimal collection of solar energy in the solar still.

5. Ravishankar Sathyamurthy et al. [2017] It is clearly seen that the effect of integrating solar still improves the yield of fresh water from both solar still. A constant gravity feed method was used to cool the cover of tubular solar still and the extracted heat by the water is sent to the basin of pyramidal solar still. The heat extracted from the solar still (Tubular) was utilized for evaporating water from the single basin pyramidal solar still. Experimental results also showed that the flow rate of water for cooling the external cover of the tubular solar still is limited from 10 to 100 ml/min as the extraction of heat from the cover was minimum at the increased mass flow rate.

III. EXPERIMENTAL SETUP

An experiment was carried out on single basin, double slope, solar still of basin area 1× 0.5 m² and fabricated with glass. During experiment four still were fabricated one of the still having slopes of the roof inclined with length, whereas roof of the other three stills are inclined with width.

Two stills of different geometry are filled with water and another two modified solar stills were filled with pieces of aluminum and granite with water.

List of parts with descriptions of the solar still

- Glass
- Inlet pipe
- Outlet pipe
- Temperature measuring instruments
- Solar power meter
- Majoring jar
- Aluminum
- Granite

Fig.1- Experimental Setup

IV. RESULT AND DISCUSSION

Where,

T_1 = Temperature of water in basin T_2 = Air temperature inside the solar still

T_3 = Inside glass surface temperature T_4 = Outside glass surface temperature

T_5 = Atmospheric temperature

Calculation of Efficiency

Efficiency = (yielding × latent heat)/ (basin area × solar intensity)

Yield = kg/second

Latent heat = latent heat of vaporization, (J/kg); Area = m² Solar intensity = W/m²

Table-1 1 CM WATER DEPTH

Time	I	T_1	T_2	T_3	T_4	T_5	Yield	Efficiency
Hr	w/m^2	°C	°C	°C	°C	°C	ml	%
08:00	829	29	28	31	30	30	00	00
09:00	912	33	35	34	33	32	20	2.93
10:00	1044	38	40	40	38	34	30	3.82
11:00	1090	42	44	43	41	35	45	5.47
12:00	1110	59	62	58	49	36	75	8.80
01:00	1150	62	64	59	50	38	**90**	**10.71**
02:00	1128	58	60	56	48	38	85	9.95
03:00	1038	48	50	49	43	47	75	8.69

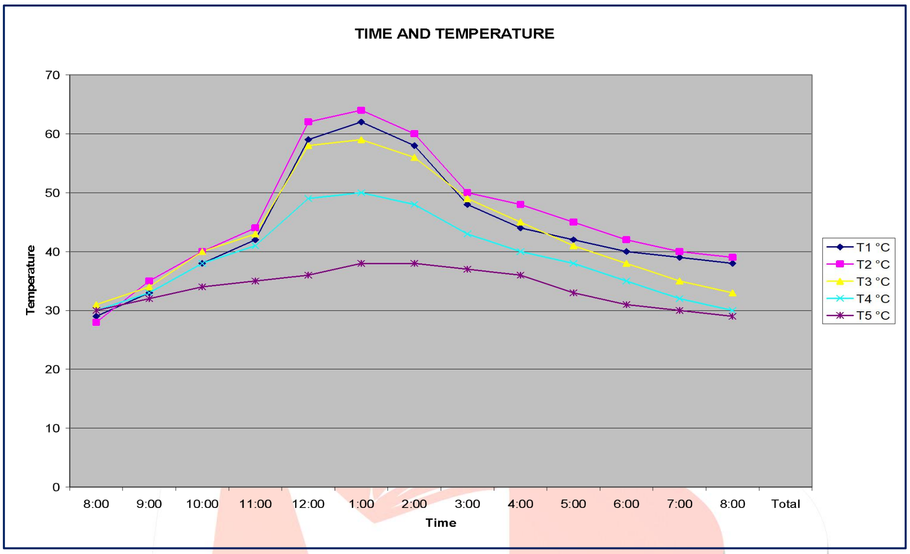

Figure-1 Graph between Time Vs raise of Temperature 1 cm depth of water

Table-2 2 CM WATER DEPTH

Time	I	T_1	T_2	T_3	T_4	T_5	Yield	Efficiency
Hr	w/m^2	°C	°C	°C	°C	°C	ml	%
08:00	833	29	28	31	32	30	00	00
09:00	972	32	33	33	34	31	15	2.07
10:00	1017	35	36	34	35	32	25	3.28
11:00	1083	40	42	39	40	33	40	4.91
12:00	1123	48	50	45	45	35	60	7.04
01:00	1157	58	61	55	54	37	70	7.89
02:00	1135	56	57	53	51	37	**80**	5.23
03:00	1010	50	54	52	48	36	75	**9.75**

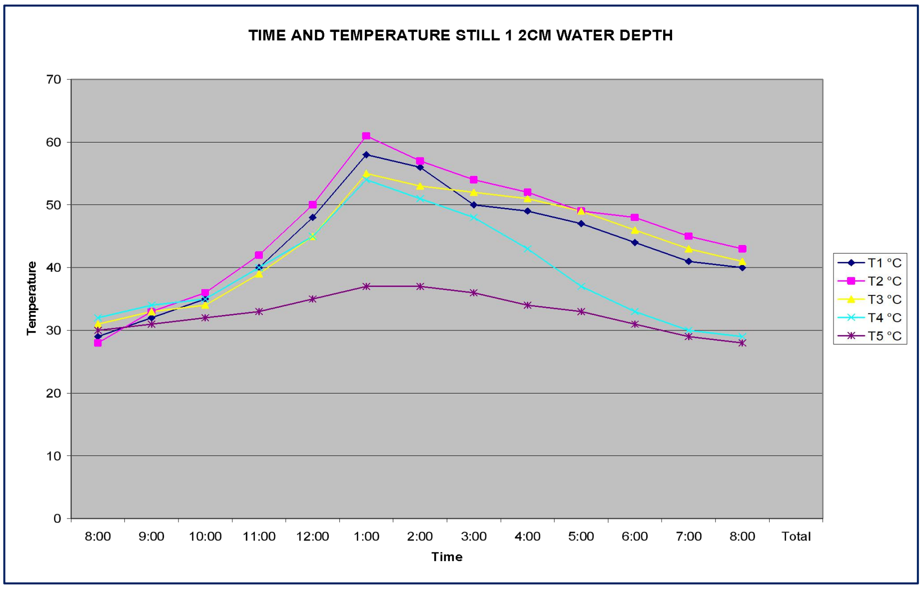

Figure-2 Graph between Time Vs raise of Temperature 2 cm depth of water

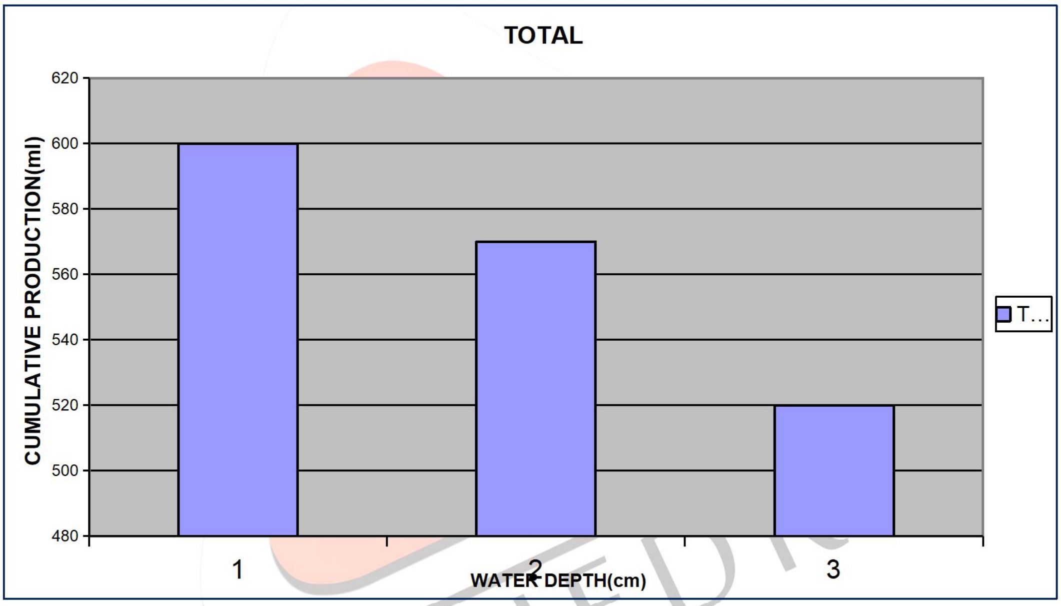

Figure-3 Graph between depth of water and cumulative production

CONCLUSION

- ✓ A single basin, double slope solar still with an inner glass basin size 1 m x 0.5 m has been fabricated with transparent glass of 8 mm thickness which is insulated with thermacol. Top cover of the basin is closed with transparent glass of 4 mm thickness. The inner surface of the solar still was black painted for more absorption.
- ✓ In the present work four number of double slope passive solar still were used to measure productivity and thermal efficiency of solar still. Conventional and one of the modified solar stills were filled with only water whereas second modified solar still filled with aluminum and water while third modified solar still filled with granite and water.
- ✓ It was observed from the experiments that productivity of water increases with decrease in depth of water and maximum productivity were observed at 1 cm depth of water in all the cases.
- ✓ It was observed that the total productivity at 1 cm depth of water was obtained in case of modified still filled with Granite which was 860 ml and it was 36.50% greater than the conventional solar still,43.33% greater than the modified still which was filled with only water and 2.38% greater than the modified still filled with Aluminum.
- ✓ It was observed that in case of modified solar still filled with only water the maximum efficiency of still was maximum at 02.00 pm which was 10.38% at 1 cm depth of water and conventional still, the maximum efficiency of still was at 01.00 pm at 1 cm depth of water which was 10.71%, In case of modified still filled with Granite, the maximum efficiency of still was maximum at 06.00 pm which was 15.58% at 3 cm depth of water and the still filled with Aluminum the maximum efficiency of still was at 06.00 pm at 2 cm depth of water which was 14.75%.
- ✓ It was observed that the maximum efficiency obtained in case of still filled with Granite which was 15.58% that is 45.47% greater than the conventional still,50.09% greater than modified still filled with only water and 5.62% greater than the still filled with Aluminum.

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