

EXPERIMENTAL INVESTIGATIONS ON A SINGLE BASIN DOUBLE SLOPE SOLAR STILL

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Abstract - The India is a country of villages and some interior location where drinking water is the major problem, and they really facing the problem of usable water for human living. For the need of drinking water, water for irrigation and some industrial purposes, fresh water source must be explored. But demand for industry and large cultivation, cannot be meet out to solve this problem solar desalination could be an appropriate solution. Solar distillation is one of the simplest techniques used in water desalination. The present study is based on experimental investigation on double slope solar still. This alternative is best suited for the place which has cost free solar energy, for the plant installation and its less maintenance of the set up. The project is aimed to use renewable solar energy as a source for producing drinking water of local source. The conversion of raw water to purify water has been done by a solar still system. The purpose of solar still system designing and its fabrication is very simple to avail water free from impurities. In India impure water resources are available everywhere, to make it useful a high energy potential is required. Potable water is the biggest problem in the coastal areas where salty water is abundant. To remove impurities and making water usable for drinking, this can be done by natural phenomenon of evaporation and condensation.

blocks having external dimensions of 12.66 m_12.11 m with capacity of 5000 L/day and gave their operation experiences at Awania village distillation plant.

A first double slope solar distillation unit was installed with capacity of 85 L/day at IIT, Delhi, in January 1981, to meet the requirements of the Chemistry Department. The unit consists of 28 multi wick solar stills each of 1 m² effective area with four stills in a row. Each row of stills has independent feeding water pipes connected to a small storage tank. Due to high wind speed, power shortage, algae formation, etc., the plant was dismantled in June 1982 and reinstalled in October 1982 with some improvements.

1. WORKING PRINCIPLE

The operation of the still is very simple. The incident solar radiation is passes through the double sloped transparent and reaches to base of still basin which is filled with water, that is heated with the solar heat incident on it, so water get evaporate and reaches to glass surface but due to temperature difference it condense on this surface of glass layer and flows down along the sloped glass cover to the channels, where it can be storage in a distillation vessel or tank.

Key Words: Single Basin Double Slope Solar Still, Solar Energy, Active techniques, etc.

1. INTRODUCTION

Drinking water is still a big problem in most arid and remote areas. Single basin solar still is a valuable solution for this problem. This type of still is capable of producing clean potable water from available brackish or waste water throughout the year. Single slope still is suitable at higher latitude place, while at lower places double slope still is preferred.

The first largest solar distillation plant was installed by Central Salt and Marine Chemical Research Institute (CSMCR), Bhavnagar to supply drinking water in Awania village and Chhachi lighthouse in 1978. Awania is a non electrified village about 12 km from Bhavnagar with a population around 1400. It consists of 90 stills each having evaporating surface of 20.74 m² equally distributed in 15

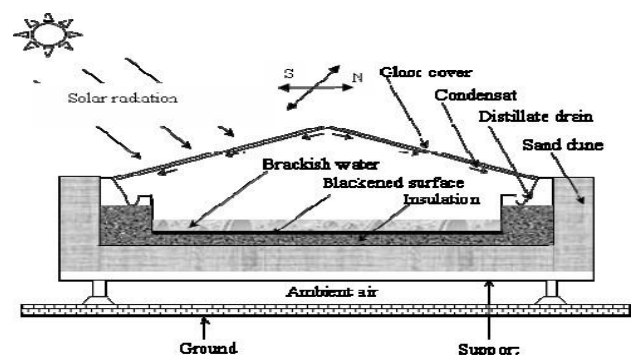


Fig -1: Single basin Double Slope Solar still

Solar working principle is based on regular evaporation and condensation, a constant level of water is maintained and radiation is trapped in an insulated box, these radiation has form of heat energy. The heat energy is responsible for evaporation phenomenon. The rate of evaporation can be accelerated by increasing the absorption of solar heat. Solar absorption can be by employing more absorptive capacities

material as in this study black coated aluminium sheet, Coal powder, joot cloth and concrete material are used.

Still has different absorptive materials to check absorption of solar radiation, including this a constant head, level of brackish water is maintained so that effective convection can be obtained for this separate arrangement has also is incorporated to supply water inside the still, Each slope is inclined at 20° in this case and it is most suitable for capturing incident radiation. A schematics of basic principle is shown in above Fig. this will illustrate various aspects of solar still at a glimpse.

3. EXPERIMENTAL

In the present study design and construction has done, a pictorial view of still dimension are shown as in figure. Wood as a material is used to construct main body of system, at the bottom water proof material is incorporated in order to prevent its leakage.

The top of the wooden box is open at a slope to collect condensed water at the inner surface of Glass top, at the lower side a pipe is fitted to collect the distil water. Aluminium is placed at the bottom of the still, Glass of 5 mm thickness is used for roof top of wooden box, thermacol is used as insulator material as well aluminium foil are taken in use as reflector inside the still. The double slope are at an angle of 20° in this case and it is most suitable for capturing incident radiation.



Fig -1: Single basin Double Slope Solar still

Pipes are used for collecting the distil water and supplying brackish water, most important thermocouples to measure temperature at top of glass and bottom of still and temperature of water inside the still, apart from this volume measuring units.

In the double slope still, the inner surface temperature of the north side is slightly higher than the south side. The water in the basin temperatures and the absorber temperature encounter through entire day cycle.

For using solar radiation Heliometer is used, this device measures the solar intensity of radiation in kW/m² the working range from 0 to 1.2 kW/m². This device ensures the intensity of radiation is workable or not as per the geographical location and climate of that zone.

4. OPERATION

The double slope still was installed on the top floor of building and tested at Agra Uttar Pradesh (27.1767° N latitude and 78.0081° E longitude) India with long axis of the still facing south-north direction with the aim to obtain maximum solar radiation. The setup has been under observation since morning at 6.00 a.m. to 5.00 a.m. within 24 hours with respect to local time during the month of May - June. The experimental procedure started with cleaning the glass sheet of the still. An arrangement has been done for proving brackish local water and a constant head 1.8 cm is maintained for whole day 1.8 by keeping supply of raw water continuously.

Under the operation various parameters like solar intensities, water temperature inside the still, temperature of still bottom and temperature of glass have been examined regularly at the interval of one hour throughout the duration of operation. The observations have been done in two phases, in phase one top of glass is kept dry and one by one material as black coated aluminium, coal, joot cloth and concrete were placed for each set of reading. In the second phase of observation, same material was used but glass top is covered with thin film of water flower over it, again a set of reading has been noted.

TABLE- 1

Material	Properties Thermal conductivity	Density
Aluminium Sheet	0.2 to 1 W/mK	1.1 to 2.3 g/cm ³
Coal	0.8 W/mK	2.4-2.8 kg/m ³
Joot	0.427 W/mK	1.46 g/cm ³
Concrete	0.6 W/mK.	1,400 kg/m ³

The absorptive materials were used, tabulated as above with their properties, and reading have been noted per hour basis as well 24 hours outcomes of distil water volume were recorded. This reading of data and yield of water have been recorded with and without water film over glass top.

First experiment has been done on 24th May 2018, under operating condition black coated aluminium sheet was used, with the help of thermocouples three temperature of Bottom, Glass and Water were recorded.

Observation [1]

At the end of cycle of experiment of 24 hours , outcome of generated still water was measured ,**390 ml** still water was collected out of **8 litre** brackish water supply in the 24 hours.

Second experiment has been done on 25th May 2018, under operating condition black coated aluminium sheet was used with a water is flowing to maintain film over the top of the glass to enhance condensation, with the help of thermocouples three temperature of Bottom, Glass and Water were recorded.

Observation [2]

At the end of cycle of experiment of 24 hours , outcome of generated still water was measured ,**580 ml** still water was collected out of **8 litre** brackish water supply in the 24 hours.

Third experiment has been done on 27th May 2018, under operating condition Coal inside the still was used, with the help of thermocouples three temperature of Bottom, Glass and Water were recorded.

Observation [3]

At the end of cycle of experiment of 24 hours , outcome of generated still water was measured ,**440 ml** still water was collected out of **8 litre** brackish water supply in the 24 hours.

Fourth experiment has been done on 29th May 2018, under operating condition Coal inside the still was used, with a water is flowing to maintain film over the top of the glass to enhance condensation, with the help of thermocouples three temperature of Bottom, Glass and Water were recorded.

Observation [4]

At the end of cycle of experiment of 24 hours , outcome of generated still water was measured ,**760 ml** still water was collected out of **8 litre** brackish water supply in the 24 hours .

Fifth experiment has been done on 31st May 2018, under operating condition Joot cloth inside the still was used, with the help of thermocouples three temperature of Bottom, Glass and Water were recorded.

Observation [5]

At the end of cycle of experiment of 24 hours , outcome of generated still water was measured ,**490 ml** still water was

collected out of **8 litre** brackish water supply in the 24 hours.

Sixth experiment has been done on 2nd June 2018, under operating condition joot inside the still was used, with a water is flowing to maintain film over the top of the glass to enhance condensation, with the help of thermocouples three temperature of Bottom, Glass and Water were recorded.

Observation [6]

At the end of cycle of experiment of 24 hours , outcome of generated still water was measured ,**710 ml** still water was collected out of **8 litre** brackish water supply in the 24 hours.

Seventh experiment has been done on 5nd June 2018, under operating condition Concrete inside the still was used, with the help of thermocouples three temperature of Bottom, Glass and Water were recorded.

Observation [7]

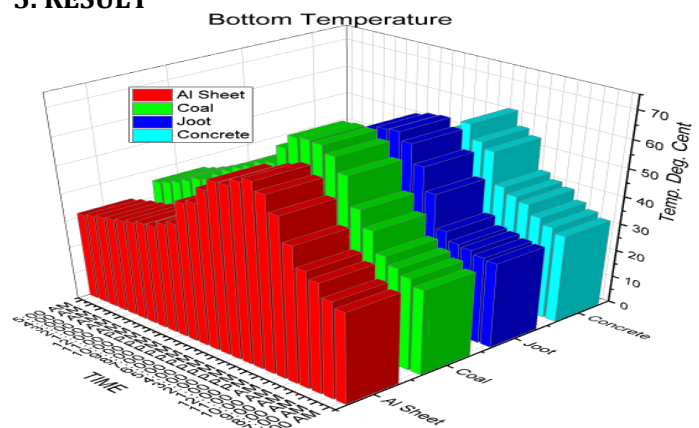
At the end of cycle of experiment of 24 hours , outcome of generated still water was measured ,**350 ml** still water was collected out of **8 litre** brackish water supply in the 24 hours.

Eighth experiment has been done on 7th June 2018, under operating condition Concrete inside the still was used, with a water is flowing to maintain film over the top of the glass to enhance condensation, with the help of thermocouples three temperature of Bottom, Glass and Water were recorded.

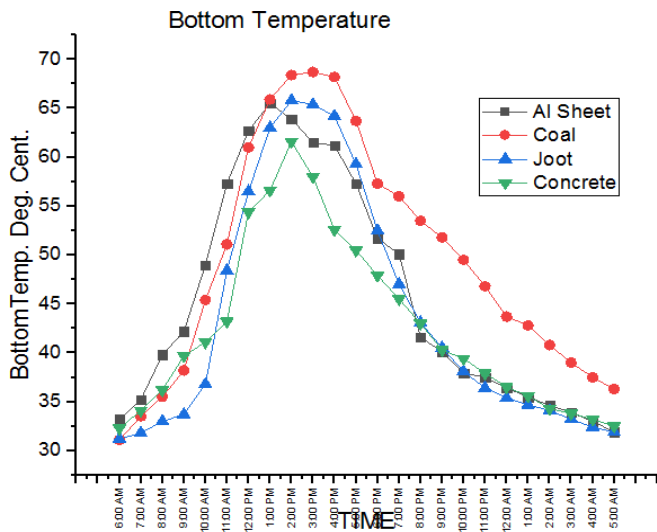
Observation [8]

At the end of cycle of experiment of 24 hours , outcome of generated still water was measured ,**595 ml** still water was collected out of **8 litre** brackish water supply in the 24 hours.

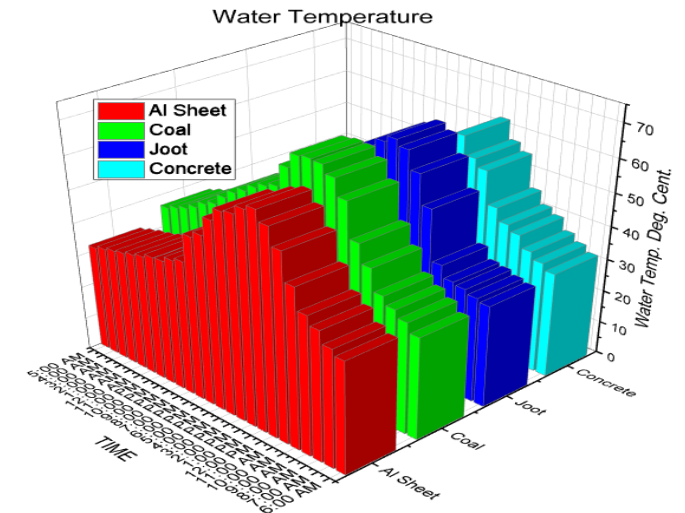
5. RESULT



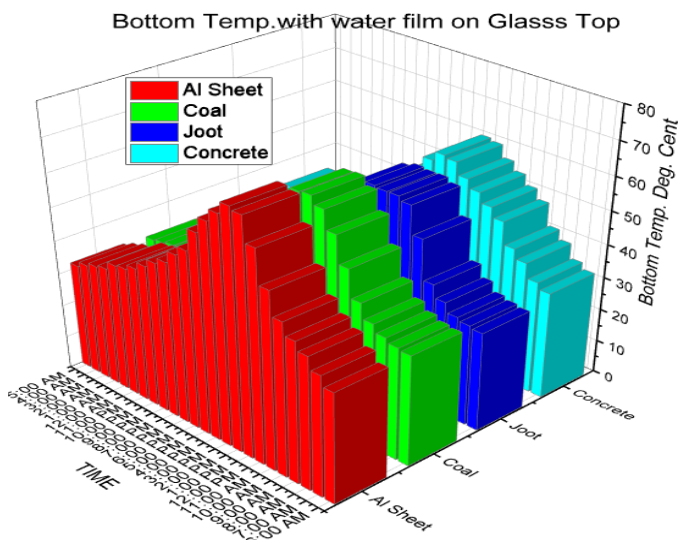
Bottom Temperature variation versus time hour for different materials



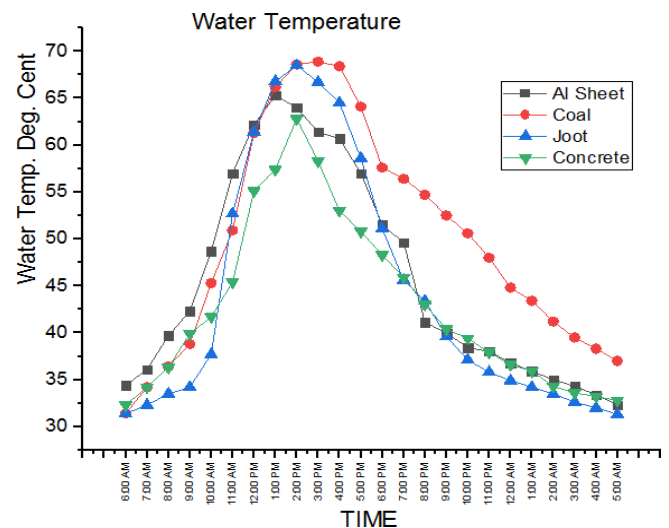
Bottom Temperature variation versus time hour for different materials



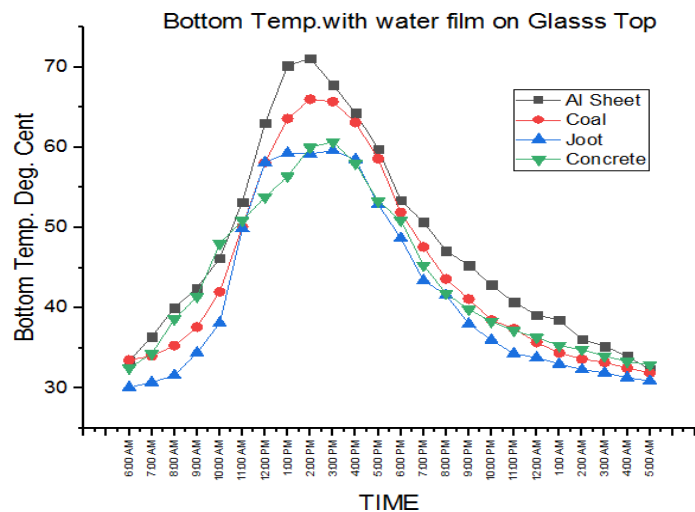
Water Temperature variation versus time hour for different materials



Bottom Temperature variation versus time hour for different materials with water film on Glass Top



Water Temperature variation versus time hour for different materials



Water Temperature variations versus time hour for different materials with water film on Glass Top

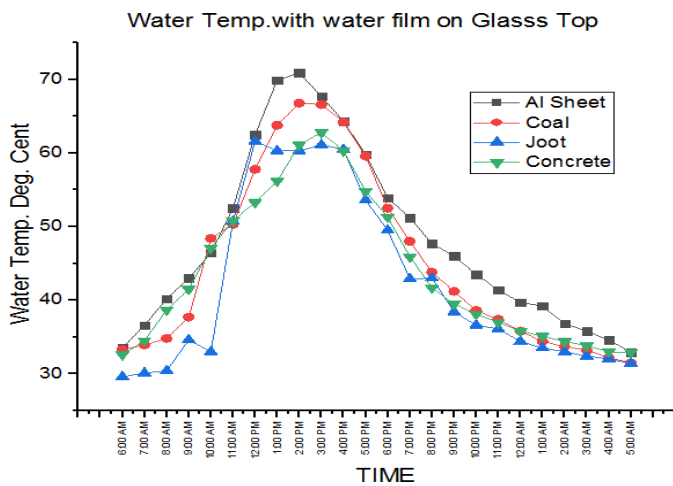
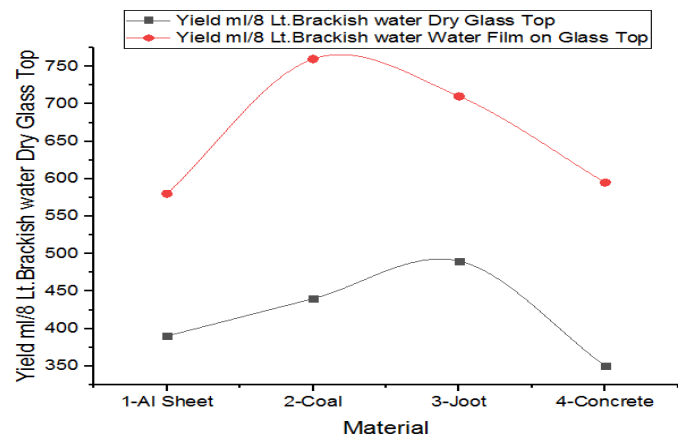
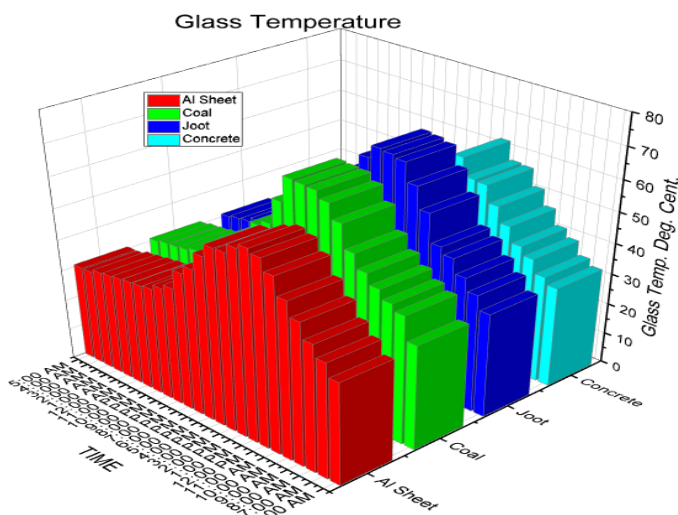


TABLE-2
Still Water Yielding

Material	Yield ml/8 Lt of brackish water(Dry Glass Top)	Yield ml/8 Lt of brackish.(Water Film on Glass Top)
1-Al Sheet	390	580
2-Coal	440	760
3-Joot	490	710
4-Concrete	350	595

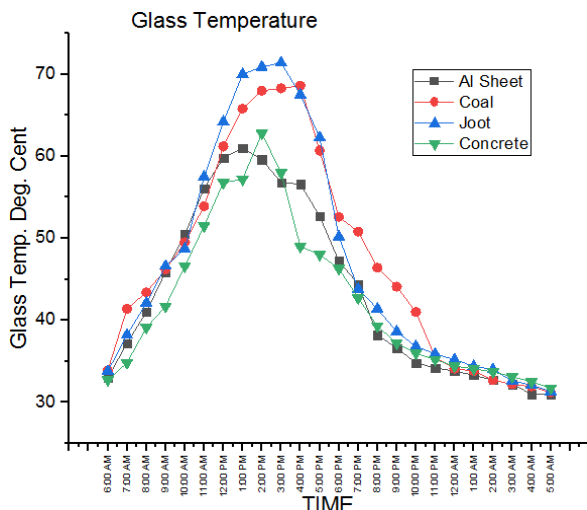
Water Temperature variations versus time hour for different materials with water film on Glass Top



Still water Yield with respect to different materials

Glass Temperature variation versus time hour for different materials

Glass Temperature variation versus time hour for different materials



The salient observation have been drawn to conclude the fact from experimental study as

- (1) The black coated aluminium sheet used as absorptive material The highest temperature is attained by water inside the still at the noon time when radiation has extreme high radiation were incident , water temperature is highest 65°C as compare to bottom temperature and glass temperature (61°C) . When glass top is subjected with water flow, temperatue range is hike with 64.9°C for water and bottom surface of still was 71.1°C and glass temperature attain the value of 64.9°C, at the noon time 2p.m. hence this difference is the main cause of water evaporation.
- (2) When coal as a absorptive material was used ,maximum temperature attained by water, bottom of basin and glass was 68°C and then they shows the difference in temperature such as when still was operated with coal at bottom. When still was operated with water film on the glass top temperature alignment was seen, maximum temperature attained by water, bottom of basin and

glass was 66.8°C, 66°C and 64°C respectively. Initially glass temperature was along with bottom and water temperature up to 12 noon, then it separated by significant amount with bottom and water temperature this help to evaporation and condensation.

- (3) Joot cloth had taken as absorptive material, The glass temperature reached the value of 70°C at 1 pm and bottom temperature attain 63°C and water was at 66.8°C, When working of set up with water film shown some facts about temperature statics glass attain 49°C correspond to water temperature 61.1°C and bottom 59.6°C. Minimum temperature attain by glass 30°C correspond to bottom and glass temperature 31°C.
- (4) Concrete has taken as a absorptive material, the highest temperatures attain 62.8°C by glass and water but for bottom it was 61.6°C. Lowest temperature attain by glass is 31°C and water and bottom temperature attained as 32°C. When was operated with water film on top of glass plate, glass temperature variation reflect its lesser values of temperature than water and bottom temperature, glass temperature maintain a difference in values from 2°C at 8am to largest difference at 10°C at 3pm after that 2- 4°C difference was maintain regularly. the highest temperature attain by water 62.8°C and by bottom temperature it was 60.7°C and glass value was 52.2°C at 3pm.
- (5) For the generation of distil water, joot gives 490 ml per 8 litre of brackish water a day then coal gives 440 ml per 8 litre of brackish water a day in dry state of operation. As we changed mode of operation amount of yielding was improved 760 ml per 8 litre of brackish water of still water was generated by coal and 710 ml per 8 litre of brackish water a day by joot.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to Assistant Prof. Devendra Singh, Department, Mechanical engineering, Sachdeva institute of technology, Farah, Mathura and Assistant Prof. Ajay Sharma, Institute of Technology, Lucknow, U.P. – India, for his valuable guidance and wholehearted cooperation and continuous encouragement throughout the work.

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