# PERFORMANCE ANALYSIS OF SINGLE SLOPE SOLAR STILL WITH VARIOUS SHAPES OF COLLECTING SURFACES

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## ABSTRACT
India is an emerging and developing country. Till now, there are many villages of rural areas have no access to the potable water. There are many ways available for water desalination. Solar energy is the renewable source of energy that can be obtained directly from the sun. It is widely available all over the world so, it has been selected for our work. Solar desalination is the future scope for water distillation. The aim of this work is to determine the efficient collecting surface for the conventional solar still. The conventional solar still was designed and fabricated successfully. The performance of the solar still is monitored by changing the shape and structure of the collecting surfaces. The finned and corrugated surfaces were selected for this analysis and they were also designed and fabricated as per the requirements.

## 1. INTRODUCTION
The scarcity of water has been increased in the recent years. Water consumption in the world increases every day due to increase in world population. The world population has been estimated to be 7 billion with China and India having the greater number in this estimated value. The world health organization (WHO) and other health organization estimated that one individual person should take at least two litres of water per day. Therefore water consumption for 7 billion people is estimated to be 14 billion litres per day. Most of the people in the world have no access to good drinking water. However, the typical purification system consumes energy as well as money. Everyone wants to find out the solution of above problem with the available sources of energy in order to obtain pure water. Fortunately there is a solution to these problems. It is a technology that is not only capable of removing a very wide variety of contaminants in just one step, but is simple, cost-effective, and environmentally friendly. That is the use of solar energy.

## 2. METHODOLOGY
Water is to be cleaned is poured into the still to fill the basin. The glass cover allows the solar radiation to pass into the still which is mostly absorbed by the blackened base. The interior surface of the still was painted by black color so it can absorb the solar energy efficiently. The water begins to heat up and the moisture content of the air trapped between the water surface and the glass cover. The heated water vapor evaporates from the basin and condenses on the inside of the glass cover. In this process, the salt and microbes that were in the original water are deposited in the base of the still. Condensed water trickles down the inclined glass cover to an interior collection trough and out to a storage bottle. Insulation is to be provided in order to reduce the heat loss to the surroundings. Phase change material (PCM) is used to enhance the productivity of the solar still. Paraffin is used in this work to improve heat transfer in the solar still.

### *2.1 Construction of solar still*
The solar still is made of card board of dimension (915 x 610 x 305 mm). The schematic diagram is shown in the figure 1. Here length L= 915 mm, Breath B= 610 mm, Height H= 305 mm. and at opposite side = 80 mm, Angle $\Theta = 30°$. This still also contains thermocole inside it. The phase change material (PCM) is also poured in a separately in a tray. The channel is fixed in the top of the still nearer to the glass. So, the water which is condensing on the surface of the glass will fall in this channel under the effect of gravity. This completes the construction of the model. The holes for the inlet of water, outlet of brackish water and outlet of pure water is made as per our convenience. We have made the outlet of brackish water at right bottom of the model (from front view of the model), outlet of the pure water at the end of the channel at the right of the still.

| | |
|---|---|
| Length (mm) | 915 |
| Breadth (mm) | 610 |
| Height (mm) | 305 |
| Insulation thickness (mm) | 25 |
| Slope angle ($deg^0$) | 30 |
| Type | Single basin |
| Phase change material | Paraffin |

**Table:1:- Specifications of solar still**

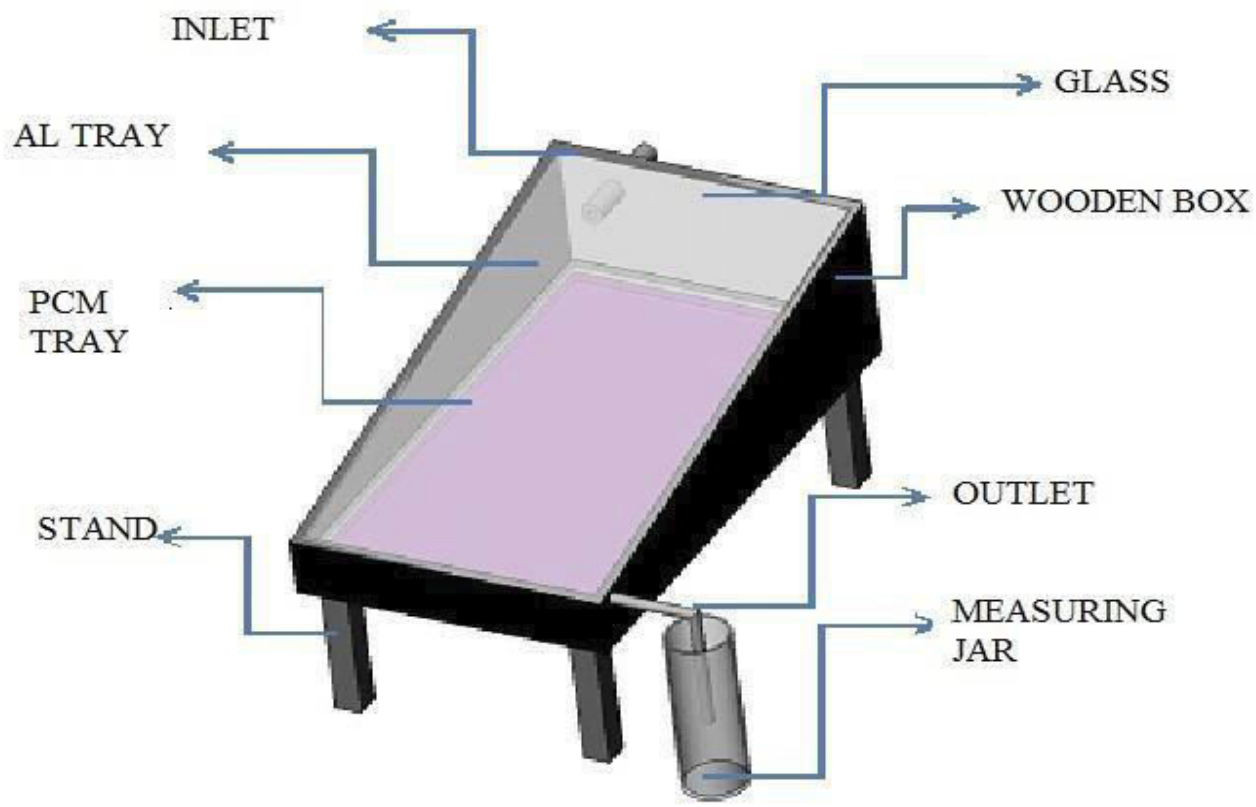



**Figure:1:- Schematic layout of Aluminium basin solar still.**

## 3. OBSERVATIONS

The Aluminium basin solar still was designed, fabricated and kept at kattumannarkoil, at the latitude of $11^0.28'$ N and longitude of $79^0.55'$ E. Usually a normal person can consumes approximately 2-3 litres of water per day. So, the family which consists of four members requires 12 litres of water per day. In order to compensate the losses of water inside the solar still total amount of brackish water required is found to be 20 litres. The provision of additional amount of water is to provide flushing of water. Flushing is nothing but like an allowances provided in the machining operation. It is additional amount of water added to compensate loss of water in the still. The performance of the solar still was analyzed by measuring various parameters such as amount of water obtained as output and time period for the delivery of water. The temperatures required for the analysis is determined by the help of thermocouple. The solar still was partially filled up to depth of 5 cm. The productivity of the still can be measured by using calibrated measuring jar. Usually the productivity of the still can be expressed in terms of ml/day. Overall efficiency of the solar still can be calculated by the ratio of weight of distillate per square meter per day and enthalpy change from cold water to vapour to solar radiation intensity per square meter per day.

### *3.1 Efficiency of Solar Still*

It is determined by:

Efficiency ($\eta$) $= w\Delta h/H$.

Where,

$\eta$ = efficiency of the solar still (%).

w = weight of distillate per square meter per day (ml).

$\Delta h$= enthalpy change from cold water to vapour (KJ/kg).

H= solar radiation intensity per square meter per day (KJ/hr $m^2$).

Here the $\Delta h$ includes latent heat of vaporization, which is being taken as average value 594.5 kcal/kg (2489 kJ/kg).

**Figure:2:- Finished working model.**

## 4. RESULT AND DISCUSSION

The experiment is performed and respective data were recorded for four days in a week continuously. The data were recorded in an interval of one hour. The individual surface had been analyzed for per day. The analysis time period started from 10.00 A.M. and it lasted up to 04.00 P.M. The conventional solar still was analyzed initially and recorded. The phase change material is added to the still on the next day of evaluation. The shape of the collecting surface was changed on the next day into corrugated surface under phase change material. The fourth day analysis was performed by introducing finned surface. The overall efficiency of the solar still can be determined by using the above formula. The actual water collection rate of the still is also noted.

### *4.1. Water collection rate*

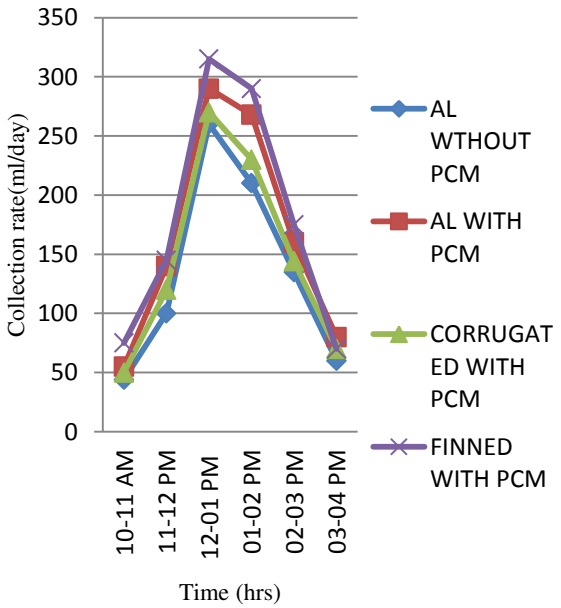
The water collection rate of the various surface are tabulated in the Table 2. From the analysis it was concluded that the collection rate of the finned surface was found to be high comparing to the other surfaces. The efficiency of the various surface solar still was tabulated in the Table 3 which is given below. From the table we may conclude that the efficiency of the finned solar still was found to be high.

| TIME (hrs) | WATER COLLECTION RATE (ml/day) | | | |
|---|---|---|---|---|
| | Al without pcm | Al with pcm | Corrugated with pcm | Finned with pcm |
| 10-11 AM | 44 | 55 | 50 | 75 |
| 11-12 PM | 100 | 140 | 120 | 145 |
| 12-01 PM | 260 | 290 | 270 | 315 |
| 01-02 PM | 210 | 268 | 230 | 290 |
| 02-03 PM | 135 | 160 | 144 | 175 |
| 03-04 PM | 60 | 80 | 70 | 70 |

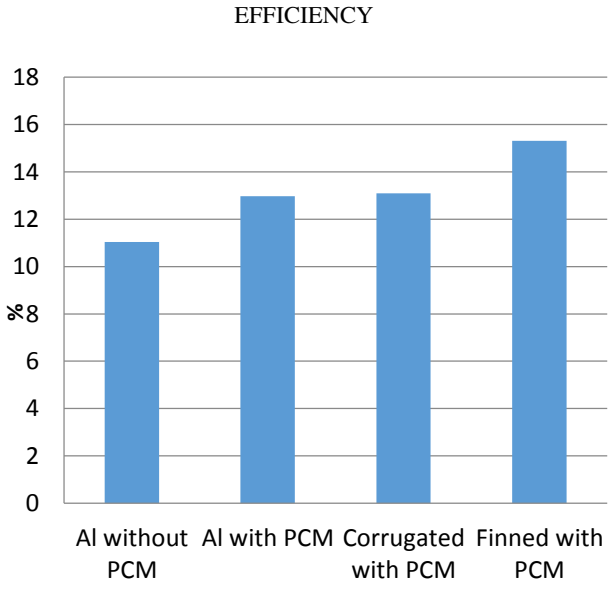
**Table:2:- Water collection rate.**

| SI. NO | TYPE OF COLLECTING SURFACE | OVERALL EFFICIENCY (%) |
|---|---|---|
| 1 | Al Without PCM | 11.04 |
| 2 | Al With PCM | 12.97 |
| 3 | Corrugated With PCM | 13.09 |
| 4 | Finned With PCM | 15.31 |

**Table:3:- Efficiency of surfaces.**




**Graph:1:- Time Vs Collection rate.**




**Graph:2:- Efficiency of stills.**

### *4.2. Efficiency of surfaces*

The Graph 2 shows that the maximum efficiency has been obtained from the finned solar still. The maximum overall efficiency obtained from the finned still was found to be 15.31%. The usage of phase change material improves the efficiency of conventional solar still to some extent that can be understood by the above graph. The solar radiation is the source of energy for working of solar still so, the efficiency depends on it. The major disadvantage about the solar still is its weather dependent characteristics.

## 5. CONCLUSION

The Aluminium basin solar still was fabricated as per the requirements. The efficiency of the conventional solar still was found to be less. So, the efficient collecting surface can be selected from the above alternatives. The utilization of solar energy doesn't require any source of fuel. The efficiency of conventional still can be improved by the addition of phase change material. The corrugated surface still produces nearly same amount of water collection rate comparing to conventional still with phase change material. Similarly the water collection rate from the finned solar still is also high while comparing with other surfaces. The distilled water obtained from the finned solar still was high, while comparing to the other shapes of the collecting surfaces. The brackish water was treated by simple desalination method using solar still. The water collection rate was little higher than other surfaces. The volume of output produced was around 2 litres and the maximum temperature recorded on it was 64°C. The maximum overall efficiency produced by the still was 15.31%.

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