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# Experimental Investigation of Solar Still Performance With Paraffin Wax as PCM.

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**Abstract: - The availability of fresh, safe and clean potable water is the major problem faced by most of the countries all over the world. Many water purification technologies are developed out of which solar distillation or desalination is being most economical and sustainable technology under development. The solar stills provide a great relief to the remote areas where advanced purification technologies such as reverse osmosis, UV, electro dialysis cannot be used due to cost constraints. Numbers of solar still designs were developed over last decade. This article studies stepped solar still design with pyramidal glass cover used at domestic level. The solar stills are not commercialised or standardized due to their limited yields. However with the current research and improvements they can be successfully commercialised for future domestic applications. This paper discusses the performance of stepped solar still using paraffin wax as a phase change material.**

**Keywords- commercialise, distillation, desalination, electro dialysis, osmosis, paraffin wax, phase change material (PCM).**

## 1. INTRODUCTION

The greatest advantage of solar energy over other forms of energy is that it is clean and free from any environmental pollution. Over the last century fossil fuels have provided most of our energy as they are much cheaper and more convenient to use compared to energy from alternative sources of energy and until recently not a enough concern is provided to the environmental pollution. For socio economic development clean water is necessary. Nevertheless, especially in African region, there is limited access to water that meets standard limits of water quality. Through desalination the quality of water can be improved. Solar distillation distils saline/brackish water by solar energy. Stepped type solar still is a very simple solar device for converting available saline or brackish or waste water into potable water. Stepped solar still can be easily fabricated using locally available materials. It does not require any skilled labour and has very low maintenance. In a country like India where millions of people are below poverty line and in remote areas solar still can turn out to be of great advantage. It can definitely be a suitable solution for solving drinking water crisis. However, its low productivity limits its use on domestic and commercial level. Hence, a number of innovative works and modifications have undertaken for improvement in productivity of stepped solar still.

## 2. METHODOLOGY

A large number of research works has been carried out by various researchers throughout the world on the design of solar still.

**Table1**
Materials used for fabrication of solar still

| **Materials** | **Uses** |
|---|---|
| Toughened glass and polythene | Glass cover |
| Wood, Thermocol, G.I sheet | Basin |
| Glass wool, Sealants- M seal, Silicon gun | Insulation |
| Wood | Supporting structure |
| Phase change material Paraffin Wax | Heat storage |

The productivity of solar still is inversely affected by the depth of the water. In a solar still, it is very difficult to maintain the minimum depth. Wicks, plastic water purifier and stepped solar still were used for maintaining the minimum water depth. Experimental analysis has indicated that the reduction in water depth results in higher basin temperature, thus improving the productivity. Overall design of stepped solar still is similar to conventional still except the water basin is made up of number of steps. Each step creates the tray to contain water of minimum depth. As compared to conventional still, stepped solar still has higher glass temperature and basin water temperature. It is attributed to the two reasons: (1) A reduced volume of air as compared to conventional still and hence heating of trapped air is at very high rate. (2) Increased surface area for mass and heat transfer as compared to flat basin still resulting in increased temperature of basin water.

The evaporation and condensation rate is increased due to high water temperature thus leading to rise in glass temperature of stepped solar still. Therefore, stepped solar stills give high performance compared to conventional still. A solar still of basin area 0.75×0.75m is fabricated and a glass cover in the form of pyramid is designed and constructed. The four glass triangles of base 0.91m and height of 0.48m having area of 0.22m$^2$ each are cut for the glass angled at 18.45º taken as a latitude of the place where experiment is being carried out i.e. Pune. So that the setup is exposed to maximum solar rays. The four glass triangles then joined using silicon sealant gel using silicon gun. The 2-3 layers of silicon gel are given to ensure perfect joint without any leakage. The pyramidal glass cover is used to capture the solar energy from all sides for all the time of the day.

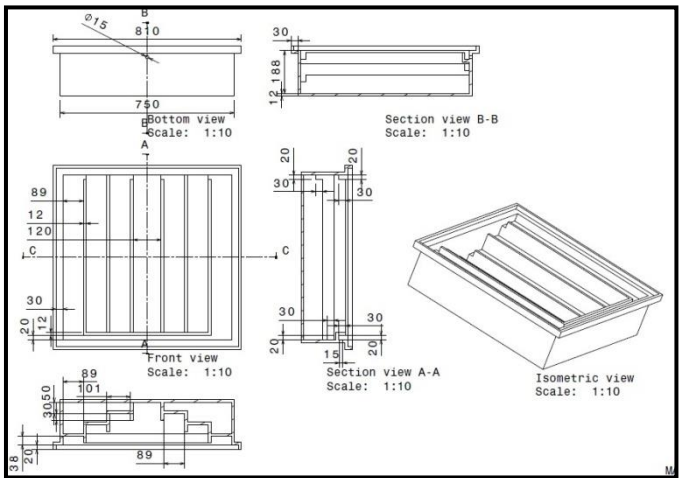



Fig 1- CAD model of experimental setup box.

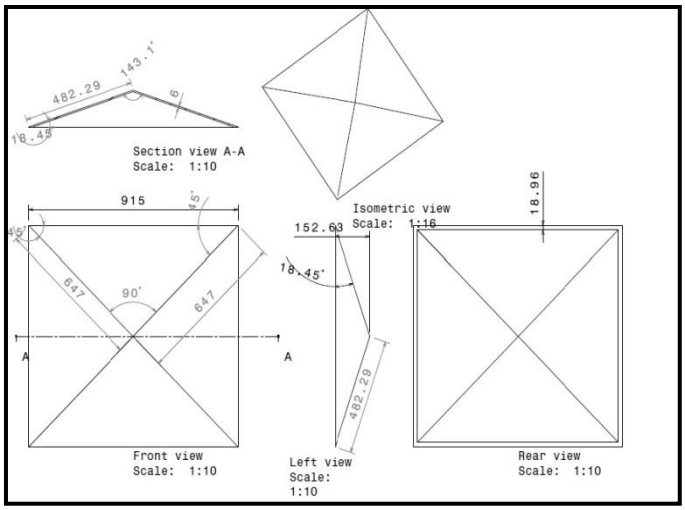



Fig 2- CAD model of experimental setup glass cover.

Firstly a stepped type solar still of wood is fabricated as per the design. The whole box is coloured by black oil paint to convert it into a black body to increase its absorptivity. A thermocol being a bad conductor of heat is used as an extra insulator and is placed in strips on the overall steps. A galvanised iron sheet of 1.125×0.9m is used to cover the inner basin. The end gaps between the box and the sheet due to irregular cutting are sealed by using water resistant epoxy compound i.e. m-seal. To seal

the found leakages the gaps are again sealed using silicon gel sealant until the whole leakage is stopped. Two pipes are introduced through two holes into basin to provide continuous flow of water from a reservoir placed at a higher level. Two outlets are provided to carry out the distilled and condensed water. All the remaining gaps between the glass edges and box are completely sealed to avoid entry of air.

The experiment is carried out using paraffin wax as a PCM. In technology of latent heat storage, when the PCM undergoes phase change process the thermal energy is stored. Paraffin wax is non-corrosive to the container material. It is also chemically inert and stable and does not show phase segregation. It is also available commercially at low cost. The paraffin wax has a melting temperature in the range of 55-60ºc.

The white paraffin wax of 3 kg in a powder form packed in packets is used which are placed in solar still basin.

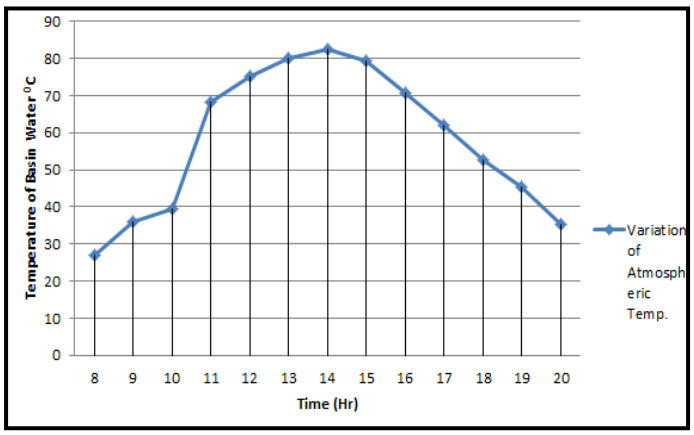
**3. RESULTS**

Fig 3- Actual experimental setup.

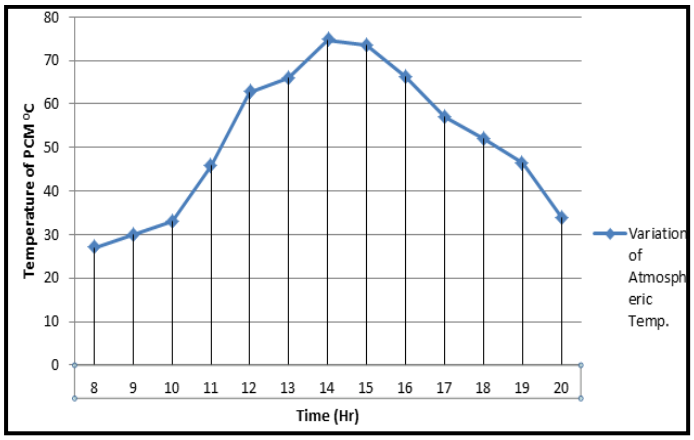
1. Variation of Atmospheric Temperature

| Time of the day(hrs) | Temperature in ºc |
|---|---|
| 8 | 19 |
| 9 | 22 |
| 10 | 23 |
| 11 | 23.5 |
| 12 | 32 |
| 13 | 37 |
| 14 | 36 |
| 15 | 34 |
| 16 | 29.5 |
| 17 | 27 |
| 18 | 25 |

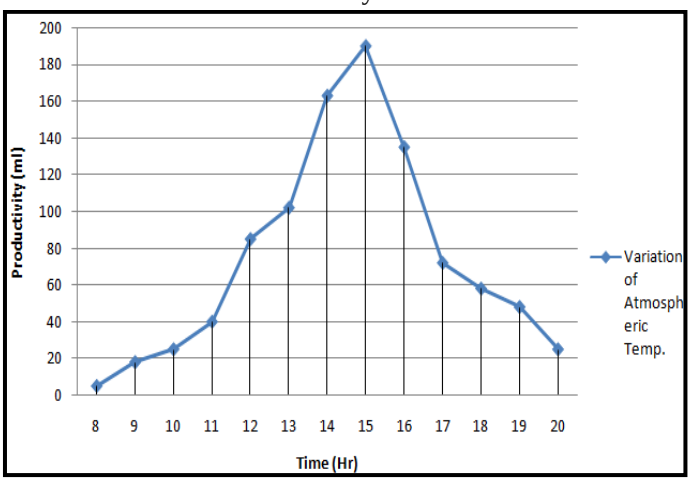
2. Variation of Basin Water Temperature Vs Time




3. Variation of Temperature of PCM (Paraffin Wax) Vs Time




4. Productivity Vs Time




**4. CONCLUSIONS**

1. The maximum basin water temperature is obtained at 2 pm in afternoon around 80ºC.
2. The maximum temperature obtained for PCM paraffin wax is about 75ºC.
3. The performance of solar still gets affected by design parameters like basin area, orientation of still, depth of water, temperature of inlet water, water glass temperature difference.
4. Higher productivity of solar still is obtained by keeping water depth near to 5mm.

**5. REFERENCES**

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