

# A Study of Performance of Solar Still with Stearic Acid as PCM

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## Abstract

This paper investigates the performance of stepped solar still for stearic acid used as a phase change material. The conventional techniques used for desalination consume large amount of input energy. This energy mostly comes from fossil fuels that causes environmental degradation. So there is need to replace conventional sources by sustainable energy sources like solar energy being the important member. Over the years desalination technique has got worldwide acceptance as a prime method for production of fresh and clean water. The process of desalination is used to remove high salt contents, organisms, minerals from water source. The input energy is consumed for separation of salt and water in desalination process. Use of phase change material is an important technique for improving the performance of solar still. Stepped solar still with pyramidal glass cover and a method of improving yield using phase change material as stearic acid is discussed here.

**Keywords: Stearic Acid, Phase Change Material, Desalination, Degradation, Sustainable, Minerals, Stepped, Pyramidal**

## I. INTRODUCTION

The solar still is very simple device for purification of water using solar energy. Its main advantages are it is cheap and with low maintenance. The low production rates of solar still constraints its use on large scale. The output of the still mainly depends on the basin water evaporation rate and vapour condensation rate at lower surface of glass cover. Many efforts are being made by researchers for improving water evaporation rate by employing different techniques. The locations where the conventional energy sources are costly, the solar still is used to meet demand of fresh water.

Fresh and clean water is required in domestic, industries and agriculture sector. The population explosion and industrial growth is increasing the water consumption at very high rate. The most of the available water is in impure form of brackish or salty which is unsuitable for use and requires treatment. Solar energy is inexhaustible, clean and easily available all over the world. However the use of solar energy is more economical than fossil fuels in low population areas and low rainfall. The water requirement for cooking and family drinking are easily fulfilled by solar still. The water for small, isolated communities is also made available using solar still.

An important factor affecting the productivity is the water level on absorber plate. It is experimentally investigated that, the performance improvement can be achieved by thinner water films. The thinner water films can be obtained by inclined and stepped basin surfaces. Solar stills with inclined absorber surfaces and continuous flow of water are having higher rate of productivity.

The basic requirement of all living organisms is a drinking water. Currently the availability of clean water resources is the major issue for humans. Only 1% potable water complying the standards is available out of 71% water covering earth's surface. Reverse osmosis, Ozone, UV, electro dialysis, activated carbon filtration and vapour compression are used to provide clean portable water. However, the costly technologies are affordable for people living in the remote areas. The remote areas can get supply of water at very low cost by using solar still as the alternate renewable energy technology. The maintenance of solar still is very low and easy to fabricate on small scale.

## A. Classification of Solar Still

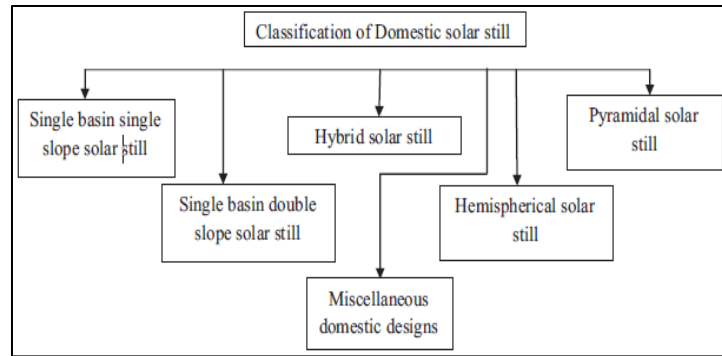


Fig. 1: Classification of domestic solar still

## B. Factors Affecting the Productivity

The numerous factors which influence the productivity of solar still are solar radiation intensity, velocity of wind, temperature of surrounding, temperature difference between glass and water, water depth, angle of glass cover, absorbing basin area etc. The other parameters are considered for modification in design of solar still and consequently to improve its productivity.

### 1) Temperature difference between basin water and glass

The increased temperature difference between glass cover and water in basin increases the natural air circulation inside the solar still. This leads to increased convective and evaporative heat transfer between basin water and glass. For the condensation process this temperature difference acts as a driving force.

### 2) Free surface area and depth of water

The rate of water evaporation in basin is directly proportional to surface area of water exposed to solar radiation. So increasing the basin surface area improves the solar still performance. The stepped solar still increases the surface area of basin for absorbing the heat in radiation. The deepness of water in basin also influences the output of solar still. For the least water deepness, the productivity reaches the maximum.

### 3) Inlet water temperature

The inlet temperature of raw water affects the evaporation rate. Rate of evaporation increases with the overall temperature of basin water.

## II. EXPERIMENTATION

Material used for fabrication of solar still is mainly wood as a supporting structure. Thermocol and GI sheet are used to cover the water basin and to avoid leakage to wooden structure. A toughened transparent glass is used for glass cover. A silver paper, sealants as M-seal and silicon sealant are used for insulation to avoid the leakage of vapour.

The conventional solar still is commonly used for converting brackish and saline water into potable water. It has a low productivity which limits its wide use. Various designs of solar still are used for water distillation are single basin single slope solar still, single basin double slope solar still, hybrid solar still miscellaneous solar still.



Fig. 2: Actual Experimental Setup

### III. RESULTS

#### A. Variation of Atmospheric Temperature

Table – 1  
Variation of Atmospheric Temperature

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

#### B. Variation of Basin Water Temperature Vs Time

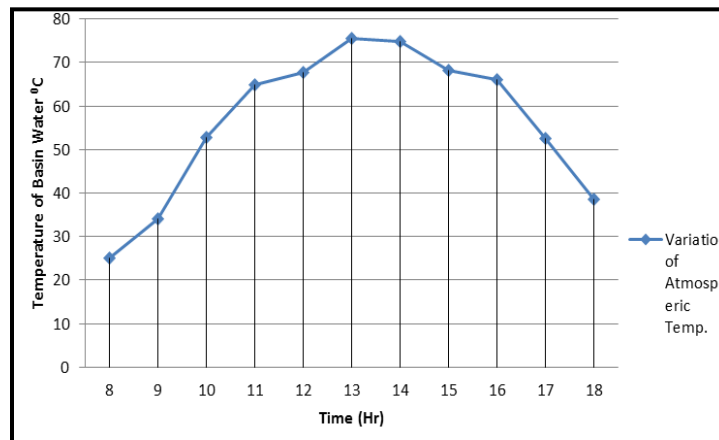


Fig. 3: Variation of Basin Water Temperature Vs Time

#### C. Variation of Temperature of PCM (Stearic acid) Vs Time

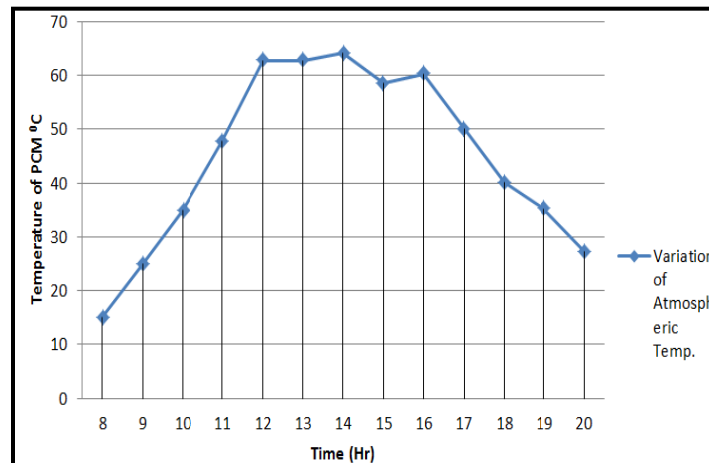


Fig. 4: Variation of Temperature of PCM (Stearic acid) Vs Time

#### D. Productivity vs Time

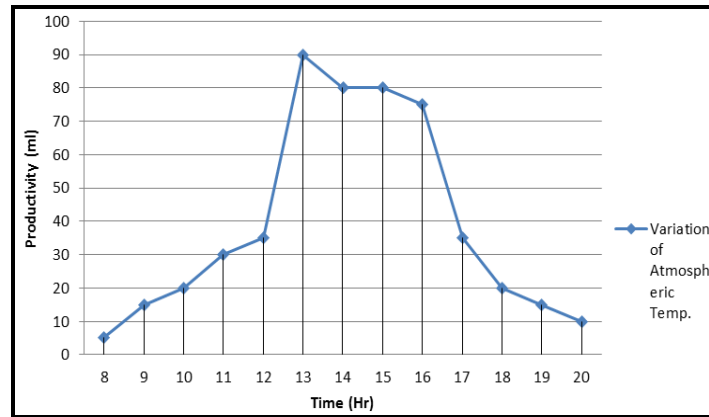


Fig. 5: Productivity vs Time

#### IV. DISCUSSIONS AND FUTURE SCOPE

The outcomes of experiment can be summed up as,

- 1) Maximum Basin water temperature is obtained at 1pm is around 75°C.
- 2) Maximum temperature is obtained for PCM stearic acid is 65°C.
- 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.

This paper analyses the design of stepped pyramidal solar still at domestic level. Many further improvements are needed in current solar still designs. The glass cover temperature inside basin should be kept as low as possible compared to basin water temperature in order to increase the condensation on the glass cover surface. In order to optimize the performance and to improve the productivity, a systematic approach of design is necessary. The productivity can be increased by using phase change materials having higher heat storage capacity. An extensive research in the field of PCM and their properties will lead into improved performance of solar stills.

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