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## Research Article

### PERFORMANCE IMPROVEMENT OF SINGLE SLOPE SOLAR WATER DISTILLATION PLANT BY USING PARAFFIN WAX MATERIAL

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#### ABSTRACT

In India the difficulty of drinking water is becoming increasingly, due to the two factors; firstly that the population of the India has increased fast and secondly the standard of living of human being has increased. Only 1% of earth's water is in a fresh, liquid form, and nearly all of this is polluted by diseases and toxic compounds. For this cause, purification of water is very important for drinking.

Keeping these things in mind, we have manufactured an experimental model which will convert the dirty water into pure clean water using non-conventional sources of energy (i.e. solar energy). In this paper, we have got two comparative experimental data first simple distillation system means without using any phase change material and second same distillation system using phase change material like paraffin wax. This paper presents a practical study of heat transfer enhancement of paraffin wax existing in solar distiller a form of two packets. The Experiment was performed different depth level of water in solar still like 10 liters, 15 liters and 20 liters. The practical tests conducted in Thatipur, Gwalior (M.P.) winter season at November and December 2015. The result show that the experiment performs with and without using paraffin material, with using paraffin material is more effective. It has increased distiller amount as well as distillation time.

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#### INTRODUCTION

In this modern world water is the most important and basic necessary for human, animals and plants along with food, air and this is also necessary for various industrial processes. The requirement of pure/clean water is increase due to two factors; firstly that the population of the world has increased fast and secondly the standard of living of human being has increased. So this cause there is almost no water left on earth that is safe and cleanest form to drink without any purification. Only one percentage of earth water is in a fresh, cleanest form (liquid state) and nearly all of this is polluted by both diseases including cholera, typhoid and toxic chemicals. [1]

**Solar Energy Applications** - Solar energy is the energy produced and radiated by the sun, more specifically, the sun's energy that reaches to the earth. Solar energy is primary source of all kind of energy on the earth. Solar energy has the chief potential of all the sources of non-conventional energy and if only a lesser amount of this form of energy could be used, it will be one of the best important supplies of energy especially when other sources in the country have short. The applications of solar energy are very wide. It is used for heating and cooling of residential building, solar cookers, solar drying of

agricultural and animal products, solar furnaces, solar water heating, salt production by evaporation of sea water of inland brines and solar water distillations etc.[2].

**Water Distillation Process** - The solar radiation is transmitted through the glass or plastic cover and captured by a black surface at the bottom of the still. The inner surface uses a blackened material to increase absorption of the sun rays. In the still working water begins to heat up and the moisture content of the air surrounded between the water surface and the glass cover increases. The heated water vaporizes from the basin and condenses on the inside of the glass cover. In this process, the salts, toxic compounds and microbes that were in original water are left behind. Condensed water drops down the inclined glass cover to an inside collection trough and out to a storage bottle. Figure 1 show the working operation of single slope solar water still [3].

Srivastava & Agrawal [4], have analyzed a high performance solar energy operated distilled water plant is presented. The monthly and annual productivity of the high performance plant are compared with that of a conventional basin type solar still of equal material and size. The cost of the distilled water produced is determined by uniform cost analysis method.

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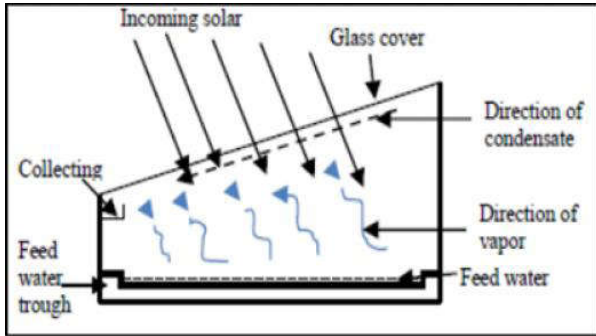


Figure 1 Working operation of single slope solar still [3]

The analysis revealed that the production cost of the distilled water produced per liter by the high performance plant is Rs.5.07, whereas that for the conventional still is Rs.7.90 when the market cost is Rs.20.00. The high performance solar distilled water plant can be very cheap, cost effective, pollution free equipment and also operates by non-technical person. Chaichan & Kazem [5], conducted a practical study of heat transfer enhancement of paraffin wax existing in single slope solar water distiller base and sides. Aluminum powder was added to paraffin wax to improve its thermal conductivity. Three distillers fabricated; one without any change, the second took the advantage of placing PCM inside it and the third one used PCM with aluminum powder to enhance its thermal conductivity. The practical tests conducted in Baghdad, Iraqi weathers at January and February, 2013. The results show that aluminum powder perfected phase change materials exhibit enhanced thermal conductivity in comparison to the base material. Adding aluminum powder to PCM, increased distillation as well as increased time distiller productivity. Medugu and Ndatuwong [6], designed and tested a solar still under actual environmental condition of Mubi, Nigeria. They developed theoretical analysis of heat and mass transfer mechanisms inside the still. They did experimental and theoretical investigation on the distillation performance of the solar still. They found that the instantaneous efficiency increases with the increase of the solar radiation and the feed water temperature. Tenthani *et.al* [7], designed two conventional stills were designed with an equal geometry but the internal surfaces of their walls were painted white. These solar stills were tested outdoors under the same atmospheric conditions at the Malawi Polytechnic. Distillate output was measured during experimentation. It was found that the average daily distillate outputs were 2.55 kgm<sup>2</sup> and 2.38 kgm<sup>2</sup> for the experimental still and CSS respectively. In addition, the efficiency of the experimental solar still was 6.8% more than that of the CSS. It can therefore be concluded that painting the internal surfaces of the walls of the still white improves the distillate output of the still.

### Experimental Setup

The single sloped horizontal basin types solar still were manufactured and used in this study. The Different parts were prepared and collected for the preparation of final proposed model. After collecting all the parts, these were assembled to prepare final model. After assembling all of the parts mentioned above the proposed model look like.



Figure 2 Single Slop Solar Water Distillation System

This proposed modal is called as solar water distillation system. This is the final setup of experiment and all the part of this experiment show in figure 2.2. The dimension of experiment described below thought the geometric diagram. The entire dimensions proceed in SI unit (mm or cm).

**Components of Experimental Setup** – The following parts have been used to prepare the model:

1. Wooden Box	5. Transoarent Glass
2. Thermocol Sheet	6. Paraffin Wax
3. G.I.Tank	7. Thermometer
4. Channel	

After the prepared of final setup, we have used following experiment procedures for these experiments are as:

1. First we have filled different amount of water in galvanized iron tank i.e., 10 liters, 15 liters and 20 liters are in different working days.
2. After the taking of reading without using any phase change material with different depth level of water quantity. Then we have putted phase change material (paraffin wax) in a form of two packets inside the water tank. Then we have tacked reading again using phase change material in different depth level of water quantity at Gwalior climate condition during months of November and December 2015.



Figure 3 Solar Still during performing day

3. This experiment has given two types of comparative data, with and without using PCM at different depth level of water i.e. 10 liters, 15 liters and 20 liters. The complete Procedure has given the idea of comparative experimental study of solar water distiller system and a

practical study of heat transfer enhancement of paraffin wax existing in solar distiller system.



Figure 4 Solar Still with using Paraffin Wax

- Due to performed of this experiment, the maximum temperature of water in the system is 57°C (of 10 liters input water) obtained at Gwalior climate condition at 02:00 pm.

**Parameters of Experiment & Methodology**

**Parameters of Experiments** - The various parameters related to experiment are as:

S.No.	Parameters	Symbols
1.	Inside Water Temperature	$t_i$
2.	Outside Water Temperature	$t_o$
3.	Max. Obtained Inside Water Temp. with using Paraffin Wax	$(T_{max})_i$
4.	Max. Obtained Inside Water Temp. without using Paraffin Wax	$(T^*_{max})_i$

**METHODOLOGY**

The following methodology used for percentage improvement of water are as

$$\% \text{ Improvement} = \frac{\text{Total amount of output water with using PCM} - \text{Total amount of output water without using PCM}}{\text{Total amount of output water without using PCM}} \times 100 \%$$

**RESULTS AND DISCUSSION**

**Result obtained from experiment setup without using paraffin wax material at 10 liters, 15 liters and 20 liters of input water.**

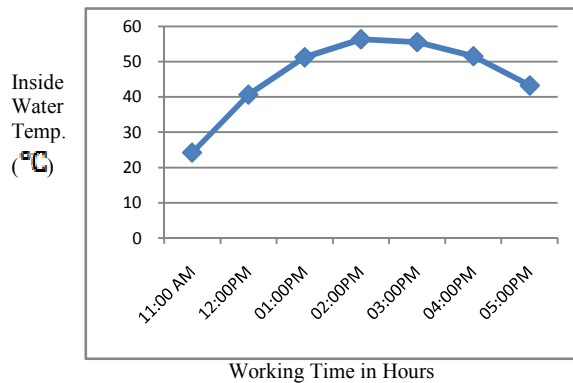


Figure 1 Variation of inside Water Temperature with Working Time

**Variation of inside Water Temperature with Working Time at 10 liters of input water:-**The experiment was performed from 11:00am to 5:00pm. In this condition we have got maximum temperature of water 56.3°C and amount of fresh water 400 ml.

**Variation of inside Water Temperature with Working Time at 15 liters of input water:-**The experiment was performed from 11:00am to 5:00pm. In this condition we have got maximum temperature of water 51°C and amount of fresh water 300 ml.

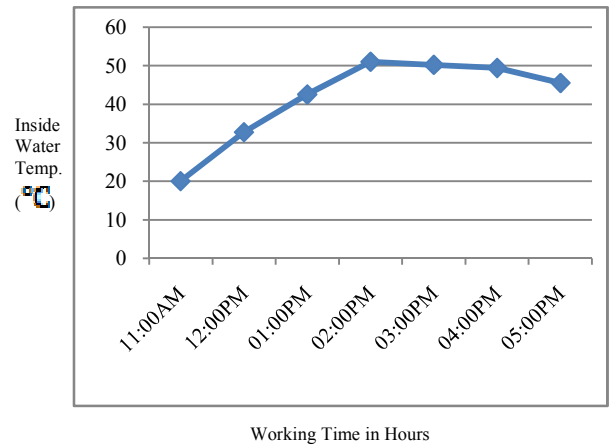


Figure 2 Variation of inside Water Temperature with Working Time

**Variation of inside Water Temperature with Working Time at 20 liters of input water:-**The experiment was performed from 11:00am to 5:00pm. In this condition we have got maximum temperature of water 45.3°C and amount of fresh water 380 ml.

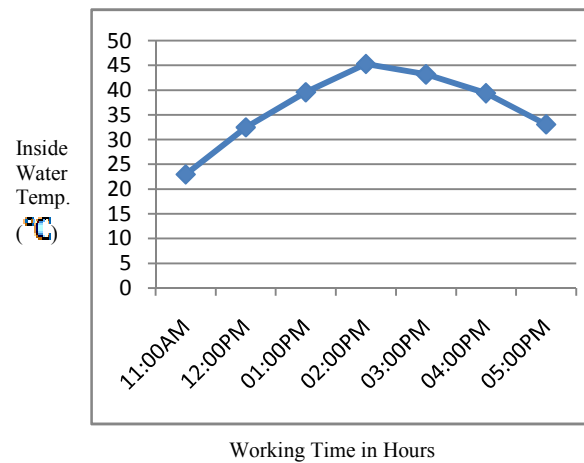


Figure 3 Variation of inside Water Temperature with Working Time

**Result obtained from experiment setup with using paraffin wax material at 10 liters, 15 liters and 20 liters of input water.**

**Variation of inside Water Temperature with Working Time at 10 liters of input water:-**The experiment was performed from 11:00am to 5:00pm. In this condition we have got maximum temperature of water 57.3°C and amount of fresh water 500 ml.

**Variation of inside Water Temperature with Working Time at 15 liters of input water:-**The experiment was performed from 11:00am to 5:00pm. In this condition we have got maximum temperature of water 52.7°C and amount of fresh water 350 ml.

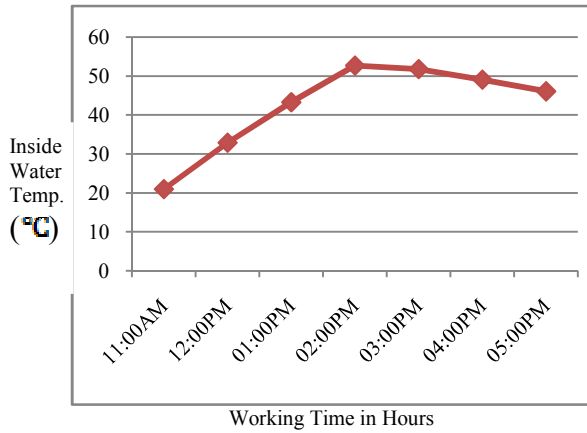


Figure 5 Variation of inside Water Temperature with Working Time

**Variation of inside Water Temperature with Working Time at 20 liters of input water:-**The experiment was performed from 11:00am to 5:00pm. In this condition we have got maximum temperature of water 46.1°C and amount of fresh water 420 ml.

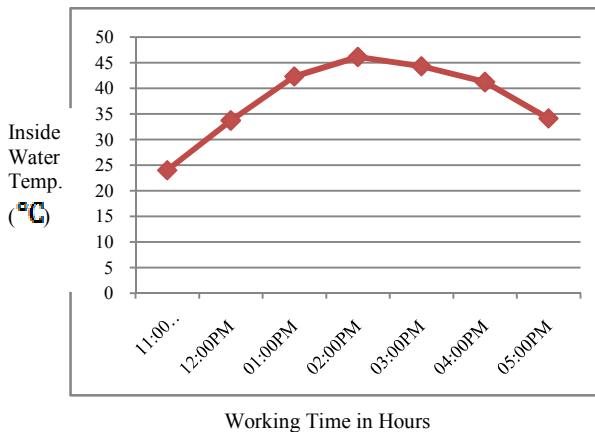


Figure 6 Variation of inside Water Temperature with Working Time

**Comparison of inside water temperature with and without using phase change material at 10 liters of input water.**

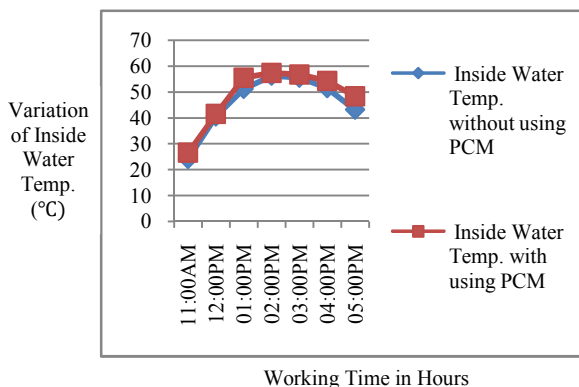


Figure 7 Comparison of inside Water Temperature with and without using PCM

**Comparison of inside water temperature with and without using phase change material at 15 liters of input water.**

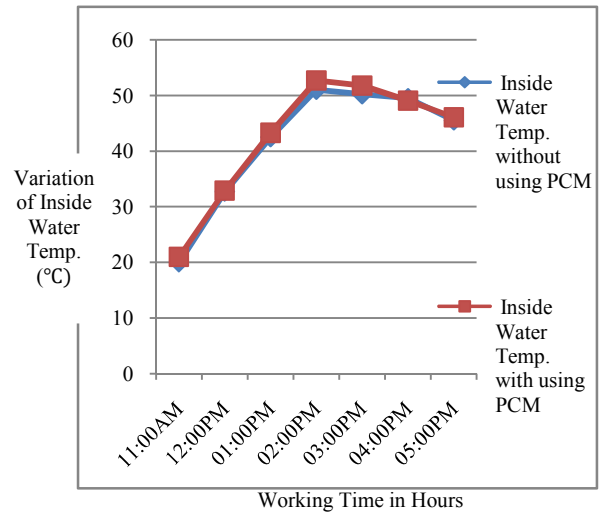


Figure 8 Comparison of inside Water Temperature with and without using PCM

**Comparison of inside water temperature with and without using phase change material at 20 liters of input water.**

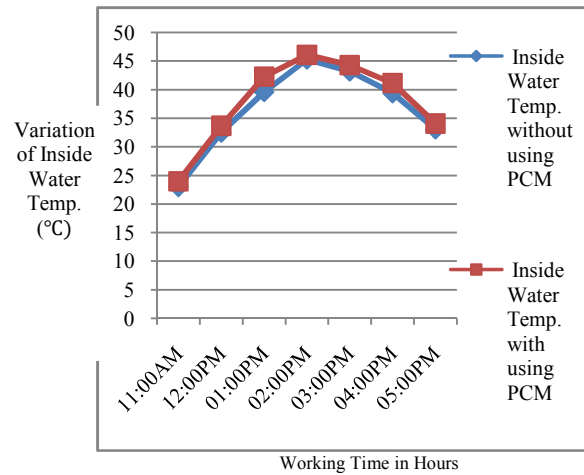


Figure 9 Comparison of inside Water Temperature with and without using PCM

## CONCLUSION

After performing the successful experiment on solar water distillation system by using paraffin wax material, the following major conclusions have been drawn from the result obtained.

1. We can conclude that the increase in temperature and hence the evaporation is maximum in the period of 11:00 AM to 2:00 PM. The maximum temperature achieved at 2:00 PM, and then the temperature decreases.
2. From the above experimentation it can be concluded that the performance of solar distillation system with and without using phase change material, with using phase change material more effective and get more amount of fresh and clean water. Total percentage of the improved

solar still was found to be 25%, 16% and 10% at 10 liters, 15 liters and 20 liters input water serially, higher than that of the without using paraffin wax material.

#### Future Scope

Solar distillation process needs to low grade energy which is freely, easily available and also there is no greenhouse pollutant as in the case with other purification techniques using fossil fuels. In future it can be used in remote places where there is no electricity and fuels

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