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# Comparative Analyses of the Internal Variables for Single Slope and Double Slope Solar Stills with Time

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**Abstract-** The effects of internal variables like water temperature, glass temperature and surrounding temperatures with time were studied and compared for both single slope solar still and double slope solar still water distillers. The single slope solar still was filled with water 25L of water while the double slope solar distiller was filled with 50L of water. The two distillers were kept in an open space to receive direct solar radiation. The respective internal variables: water temperature, glass temperature and the surrounding temperatures were measured and the average glass temperatures of the double slope still were computed and the results were tabulated. The graphs of the respective temperatures were plotted against time intervals of 1 hour each ranging from 8.00 am to 18.00 pm, for all the internal variables. It was observed that, the internal variation of internal variables with time has little or no effect on the type of solar still, whether single slope or double slope.

Index Terms— Internal Variables, Solar Still, Water Temperature, Glass temperature, Surrounding Temperature

## 1 INTRODUCTION

A solar still is used for solar distillation. It is a device developed to use direct sunshine for the production of distilled water. The size of the still can be varied to meet one's distilled water requirement. The use of solar distillation method in water purification is a very important method of solving day to day need of isolated villages for clean and healthy water (Kaisan and Sabi'u, 2012).

The use of energy for solar distillation has been in existence long time ago (David and Gerard, 1983).

### 1.1 FUNDAMENTALS OF PERFORMANCE PREDICTION

The performance of solar still is commonly expressed as the measure of water produced by each unit of the basin area in a day, such as cubic meters or litres per square meter of the basin area per day. The amount of distillate depends on the design of the still, intensity of solar radiation and the atmospheric condition in the surrounding.

Usually, the transparent glass cover, water and basin liner absorbs the incoming radiation with a small fraction of it being reflected back to space by the glass and water surfaces. The absorbed energy in the basin available to

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produce vapour, and hence distillate, depends on the temperature change of the basin water and on the heat losses from the water basin. Consequently, the heat and mass transfer to the transparent glass cover on the outside coupled with the rate of heat dissipation from the cover on the outside will greatly affect the amount of vapour condensed, and hence the quality of distillate produced.

## 1.2 SOLAR STILL EFFICIENCY

If $Q_1(J.m^2.day)$ denotes the solar insolation incident on the still and $Q_2(J.m^2.day)$ the amount utilized in vaporizing the water, the daily output of the distilled water, M (kg/m$^2$) is given by (ELPASO, 1995)

$$M = \frac{Q_2}{L} \text{ - - - - - (1)}$$

Where: L (J/kg), is the latent heat of vaporisation of water.

The efficiency (η) is the amount of energy utilised in vaporising the water in the still over the amount of incident solar energy on the still. These can be expressed as:

$$\eta = \frac{Q_2}{Q_1} X\, 100 \text{ - - - - (2)} \qquad \text{(Garba et al, 2005)}$$

## 2 METHODOLOGIES

The two types of solar still used for the purpose of this work have the following dimensions:

i. Single slope insulated

Height of the still = 28cm

Length of the still = 95cm

Base of the still = 65cm

Area of the still = 7865cm2

ii. Double Slope insulated

Height of the still = 40cm

Length of the still = 144cm

Base of the still = 80.4cm

Area of the still = 12381cm2

During the experimental process, the single slope solar still was filled with 25L of water while the double slope solar still was filled with 50Lof water sample. Between 8.00 a. m to 18.00 p. m time intervals of 1 hour each, the respective temperatures were measured for water samples, glasses and surroundings of each of the two solar stills using thermometer. The results were tabulated in the tables below and the various temperatures were plotted graphically for comparison.

## 3 RESULTS AND DISCUSSIONS

Tables 1 & 2 below show the experimental data obtained from the single slope solar still and double slope solar still respectively

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Table 1 Effects of Internal Variables on Single Slope Solar Still

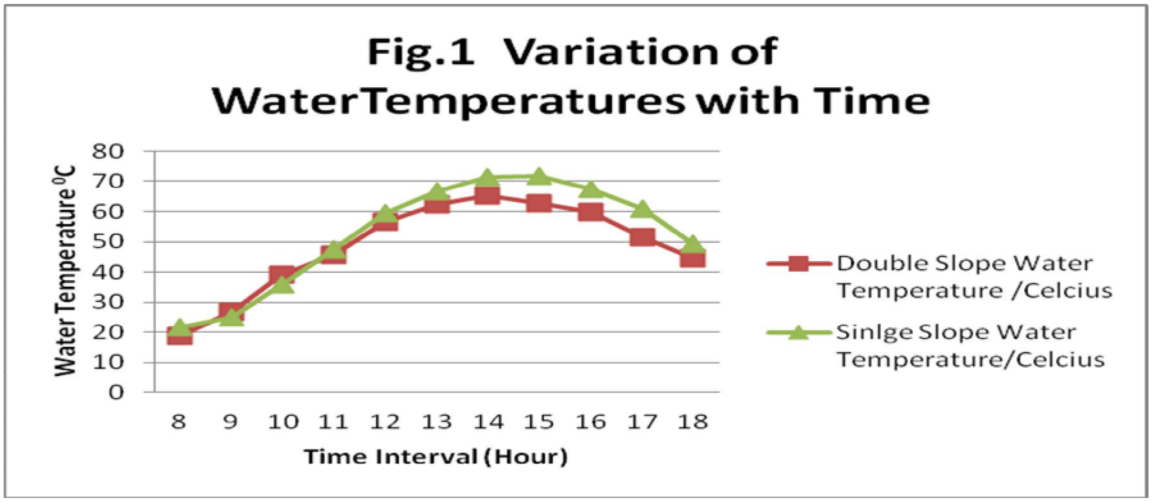
| Time Interval (hour) | Water Temperature Tw / 0C | Glass Temperature Tg / 0C | Surrounding Temperature Ts / 0C |
|---|---|---|---|
| 8.00 | 21.50 | 18.30 | 20.60 |
| 9.00 | 25.00 | 24.50 | 31.80 |
| 10.00 | 36.00 | 36.90 | 38.50 |
| 11.00 | 47.50 | 45.80 | 47.50 |
| 12.00 | 59.40 | 54.70 | 58.20 |
| 13.00 | 66.70 | 61.30 | 45.20 |
| 14.00 | 71.50 | 65.50 | 66.80 |
| 15.00 | 71.80 | 65.90 | 71.30 |
| 16.00 | 67.60 | 60.00 | 54.90 |
| 17.00 | 61.00 | 51.00 | 57.90 |
| 18.00 | 49.40 | 43.70 | 48.50 |

Table 2 Effects of Internal Variables on Double Slope Solar Still

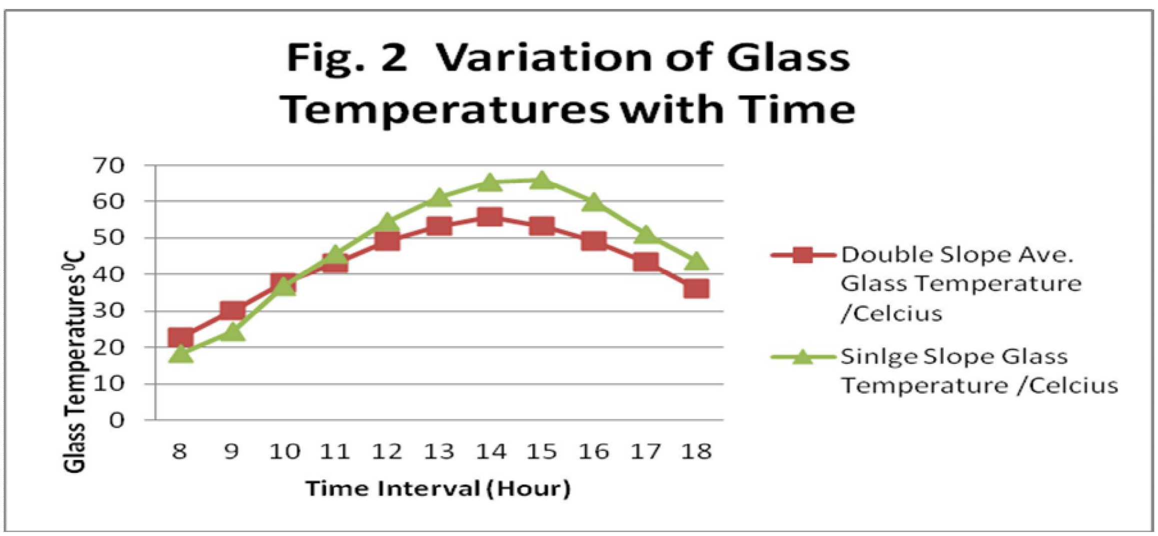
| Time Interval (hour) | Water Temperature Tw / 0C | Glass 1 Temperature Tg1 / 0C | Glass 2 Temperature Tg2 / 0C | Ave. Glass Temperature Tg / 0C | Surrounding Temperature Ts / 0C |
|---|---|---|---|---|---|
| 8.00 | 18.70 | 20.30 | 25.00 | 22.65 | 25.20 |
| 9.00 | 26.80 | 30.10 | 30.20 | 30.15 | 31.80 |
| 10.00 | 39.10 | 36.30 | 39.00 | 37.65 | 38.30 |
| 11.00 | 45.80 | 42.80 | 43.40 | 43.10 | 49.60 |
| 12.00 | 56.40 | 49.00 | 49.40 | 49.20 | 48.10 |
| 13.00 | 62.20 | 53.30 | 53.10 | 53.20 | 64.80 |
| 14.00 | 65.10 | 56.00 | 55.40 | 55.70 | 45.40 |
| 15.00 | 62.90 | 54.20 | 52.70 | 53.45 | 70.50 |

| | | | | | |
|---|---|---|---|---|---|
| 16.00 | 59.90 | 50.10 | 48.40 | 49.25 | 40.60 |
| 17.00 | 51.40 | 44.30 | 42.50 | 43.40 | 37.10 |
| 18.00 | 44.40 | 36.30 | 36.10 | 36.20 | 31.40 |

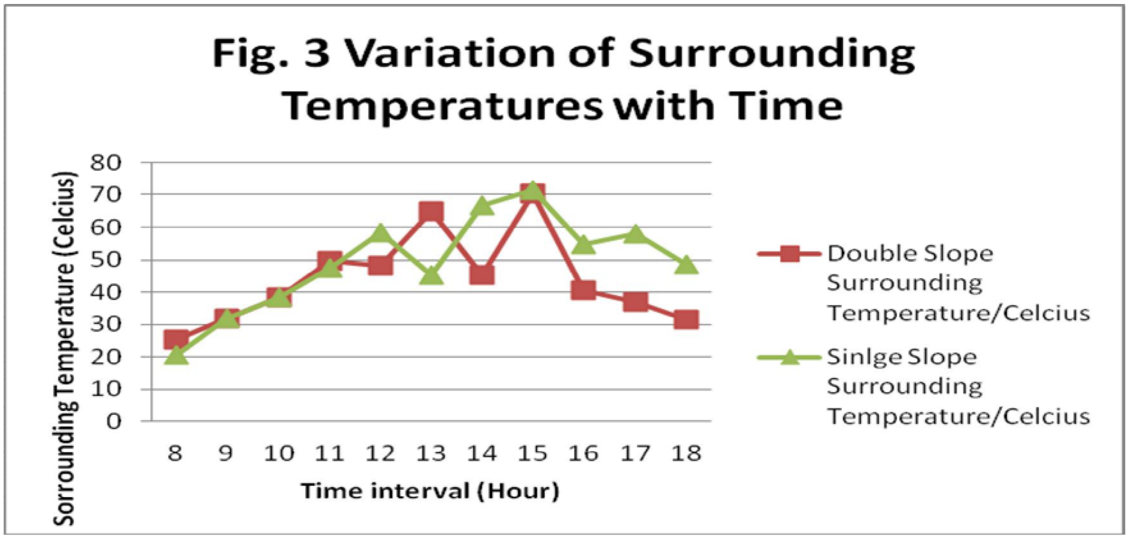
The comparative analyses of the internal variables are presented in figures 1, 2 & 3 below. Figure 1 shows the variation of water temperatures with time for both single slope and double slope solar stills. Figure 2 illustrates the variation in the glass temperatures for both single slope and double slope solar stills. Only that in the case of the double slope solar still, the average of the double glasses temperatures was taken and then plotted on same temperature axis as the single slope still.




From the figure 1 above, it is categorically clear that, both the two curves have same orientation. This shows that the variation of water temperatures with time has no any physical effect on the performance of solar stills. In other words, the number of slopes in solar stills has no any effect on the variation of water temperature with time.



Similarly, from the figure 2 above, it is categorically clear that, both the two curves have same orientation. This shows that the variation of glass temperatures with time has no any physical effect on the performance of solar stills. In other words, the number of slopes in solar stills has no any effect on the variation of glass temperature with time.




Finally, from figure 3 above, the surrounding temperatures vary with time. From 8.00 a. m to 11.00 am, the curves have same orientation, meaning that, the surrounding temperatures have same characteristics. Between 11.00 am and 12.00 noons, the surrounding temperature of double slope begins to decline while that of single slope continues to increase. The duo temperatures change direction between 12.00 noon and 13.00 pm, and re-change their orientations again between 13.00 pm and 14.00 pm. Both the two temperatures reach peak at 15.00 pm and then begin to decline with the single slope curve experiencing a small increase at 17.00 pm.

## 4 CONCLUSIONS

The internal variables have little or negligible effects on the performance of different solar stills with time (Single slope and double slope). Both the water and glass temperatures have the same pattern. While the surrounding temperatures show slight variation with time for the two different solar stills.

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