The Effect of Time on Volume Flow Rate of the Distillate Output of Single Slope and Double Slope Insulated Solar Stills

Sabi'u Bala Muhammad and Kaisan Muhammad Usman

Abstract- The experiment was conducted using both single slope and double slope insulated solar stills both filled with same sample of water to the capacity of 25l and 50l respectively. The distillate yields of the two different solar stills were measured in ml and the corresponding volume flow rates were calculated and tabulated. The graphical representations of the results were presented in form of bar charts. The highest yields of the solar stills were observed between the hours of 15.00-16.00 as 210.00ml and 490.00ml respectively with volume flow rates of 3500mm^3/s and 8166.67mm^3/s correspondingly. The lowest yields as recorded between the hours of 8.00 and 9.00 were 0.40 ml and 30.00 ml with the corresponding volume flow rates of 6.67mm^3/s and 500.00mm^3/s for both single and double slope solar stills accordingly. There was a remarkable increase in the output of the two different solar stills from 8.00am to 4.00pm on hourly basis and then a sudden decline in the output was observed between 4.00pm and 6.00pm.

Index Terms–Distillate, Solar Still, volume flow rate, yield

1 INTRODUCTION

Solar distillation is a process by which impure water is heated by energy from the sun, the evaporated water vapor is trapped and the condensed distillate collected as fresh water (Garba *et al,* 2005). A solar still is used for solar distillation. It is a device developed to utilize direct sunshine for the production of distilled water. The dimension of the still can be varied to meet one's distilled water requirement. The use of solar energy for water distillation has been in existence long time ago (David and Gerard, 1983). A lot of equipment have been prepared based this technology as early as 2 millenniums ago. The first large capacity basin solar still was built at Las Salinas, Chile, in 1974 (Williams, 2007). It has a surface area of 4,757m^2 and a daily production of 22.5 cm^3 of fresh water per day. It operated for a number of years with life span of 40 years. According to the author, research contributions from the U.S.A, the USSR, Algeria, Australia, Greece and India in recent years, are accountable for the popularisation of this **practice** in localities lacking both clean potable water and power, but rich in sunshine and saline ground water or sea water.

Water purification from the solar stills depends mainly on solar radiation intensity, but humidity has no effect on it. A gentle wind is favourable and the production increases with ambient temperature. Depth of saline water in the still and the angle of inclination of the glass cover affect distilled water production. Smaller angle and smaller depth increase productivity (expressed in litres /m^2/day). For buildings, solar stills may be mounted on roof tops (Hay, 1971). An advantage of this approach is that, the cost of the solar still is particularly offset by the savings in ordinary roof costs since the still replaces the roof (Sabi'u, 2007).

Either glass or plastic can be used as material for covering, although is often preferred for durability and ease of cleaning. PVC and polythene are not very desirable as covers on account of their shorter life. Plastic pipes and fittings would be used to reduce cost and weight (Hay, 1971). With a radiation intensity of 550cal/cm^2/day, the annual average productivity of a solar still can be 3litres/m^2/day, the production being higher in summer and lower in winter.

- *Sabi'u Bala Muhammad is a Lecturer with Department of Physics, Usmanu Danfodio Universtity Sokoto, Nigeria and an M.Sc. Candidate with Same University, PH-+2348030683492 E-mail: sbala02@yahoo.com*
- Engr. Kaisan Muhammad Usman is a Scientific Officer with Energy Commission of Nigeria, Abuja, Nigeria, *PH-+2348036943404. E-mail: engineer.kaisan@gmail.com*

2 METHODOLOGIES

Two types of solar stills were filled with same sample of water. A single slope insulated solar still and a double slope insulated solar still both subjected to same conditions. The volume of water used to fill the single slope insulated solar still was 25litres while the volume of water used fill the double slope insulated solar still was 50litres. The Various yields of distilled water were measured on hourly interval, starting from 8.00 to 18.00. The corresponding volume flow rates were calculated in mm^3/s. The results were tabulated and then compared as shown below.

3 RESULTS AND DISCUSSIONS

The following results were obtained from the experiment conducted using both single slope insulated solar still and double slope insulated solar still as described in the procedure above:

Table 1: Effects of Time on Volume Flow Rate of the Distillate Output of Single & Double Slope solar Stills

Time Interval (hour)	Single Slope Yield (ml)	Double Slope Yield (ml)	Single Slope Flow Rate (mm^3/s)	Double Slope Flow Rate (mm^3/s)
8.00-900	0.40	30.00	6.67	500.00
9.00-10.00	16.70	50.00	278.33	833.33
10.00-11.00	35.00	82.00	583.33	1366.67
11.00-12.00	50.00	205.00	833.33	3416.67
12.00-13.00	120.00	307.00	2000.00	5116.67
13.00-14.00	170.00	410.00	2833.33	6833.33
14.00-15.00	190.00	460.00	3166.67	7666.67
15.00-16.00	210.00	490.00	3500.00	8166.67
16.00-17.00	140.00	310.00	2333.33	5166.67
17.00-18.00	100.00	195.00	1666.67	3250.00

The results depicted in the table above are presented pictorially in figure1 and figure2 below as bar charts.

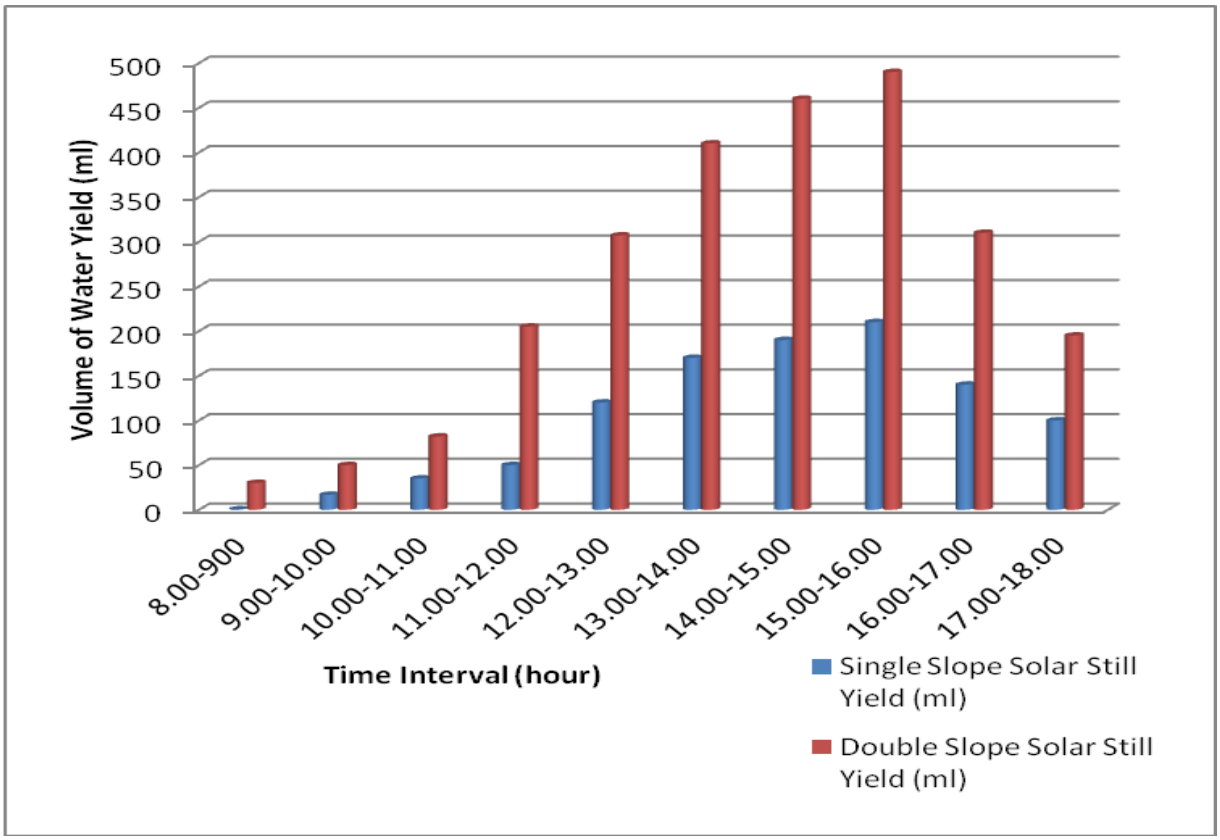

Figure 1: Single & Double Slope Solar Still Yields per Hour

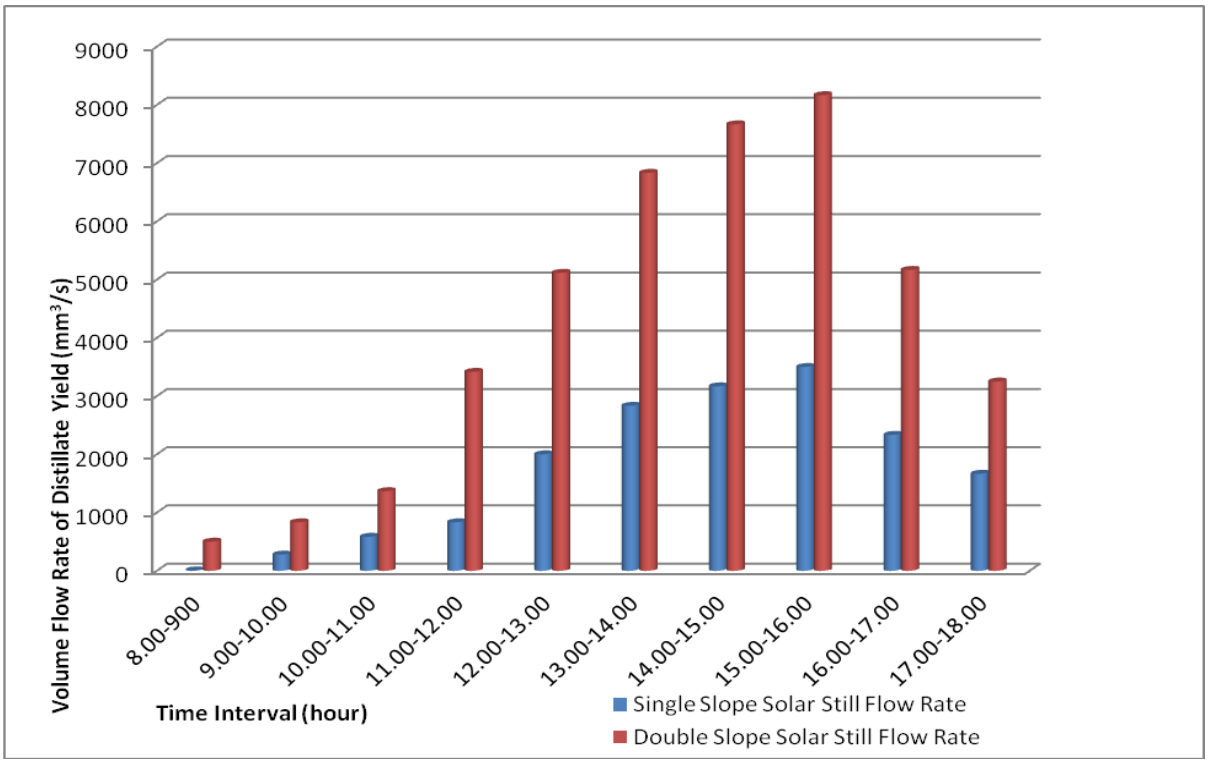

Figure 2: Mass Flow Rate of Single & Double Slope Solar Still Yields per Hour

From the figures 1 and 2 above, graphical representations of the results are presented in form of bar charts. It can be seen categorically clear from figure1, that, the highest yields of the solar stills were presented between the hours of 15.00-16.00 as 210.00 ml and 490.00 ml respectively. Similarly, from figure2, between same times interval of 3.00pm and 4.00pm the highest volume flow rates of 3500mm3/s and 8166.67mm3/s are presented for single slope insulated solar still and double slope insulated solar stills correspondingly. The lowest yields recorded between the hours of 8.00-9.00 were 0.4 ml and 30.00 ml with the corresponding volume flow rates of 6.67mm3/s and 500.00mm3/s for both single and double slope solar stills accordingly. There was a remarkable increase in the output of the two different solar stills from 8.00am to 4.00pm and then a sudden decline in the output was observed between 4.00pm and 6.00pm.

4 CONCLUSIONS

The best distillate yields and volume flow rates of water from both single slope and double slope insulated solar stills in Sokoto State, North Western Nigeria during the month of November were achieved between the hours of 15.00 and 16.00. The least outputs were achieved between the hours of 8.00 and 9.00. There is a considerable difference between the outputs of the two solar stills with double slope still giving more than twice that of the single slope still. Solar stills can be used in Sokoto State and the entire North Western region of Nigeria especially during the afternoon hours to purify water for drinking and other domestic purposes.

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