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Effects of Some Meteorological Variables on the Performance of Single Slope Solar Stills in Sokoto, North Western Nigeria

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Abstract: *Water is a basic necessity for living. Humans and animals need clean water for healthy life. In this research, water sample was collected from Kwalkwalawa river, in Kwalkwalawa village, Sokoto State, North Western Nigeria. 50L of the water sample was used to fill a double slope solar still, and the whole set up exposed to the solar energy. The distillate yields of the sample were recorded at one hour intervals between the hours of 8.00am and 18.00pm. The corresponding values were measured for some meteorological variables like: solar radiation, ambient temperature, relative humidity and wind speed during each interval. The results were tabulated and picturesque using bar charts. It was observed that the maximum yield recorded was obtained by 15.00pm. which also corresponds to the highest value of wind speed which accounts for condensation of the evaporated distillate. The relative humidity varied inversely with the yield. It has been observed that solar radiation varies parabolically with time, with its maximum value at 13.00pm. Solar radiation also varies linearly with yield only that, radiation reached its peak at around 13.00pm while the yield reached its maximum value around 15.00pm. Finally, the yield of the distilled water increased as the ambient temperature increased, with the maximum yield recorded at the maximum value of the ambient temperature i.e. at 15.00pm. When the ambient temperature started to decline, the yield also started to decline equally. This shows that the ambient temperature is directly proportional to the distillate yield.*

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I. INTRODUCTION

Solar distillation is a process by which impure water is heatedwith solar energy, the evaporated water vapor is trapped and the condensed distillate collected as pure water. Solar distillation is an affordable and reliable source for potable water that is often ignored or underutilized. Solar distillation has the advantage of cost saving over other types of distillation (Sethi *et al*., 2013). It is estimated that over two billion people are not connected to a power grid and will not be in the near future for a reason related to seclusion, low population density, poverty and inaccessibility. For these reasons, and to these people, autonomous solar systems can play a very important role in lighting, pumping, heating, drying etc. (Kaisan *et al*, 2012). 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. Distilled water is used for different purposes in institutions for laboratory experiments, health care centers, motor vehicle batteries, industrial and in commercial organizations. Furthermore, the sun supplies more than enough energy to the entire system, its energy is replenishable, or in another term renewable. About 1.7 X 1017 watts per second of solar radiation is incident upon the earth. This is 30, 000 times the global energy use by human beings (Kaisan *et al*, 2012). The solar distillation process is depended on different meteorologicalparameters, such as weather parameters like ambient air temperature, relative humidity, solar radiation and wind speed.

Increasing of clean and healthy water demand of the people can be solved partially by using solar distillation technologies (Yamali and Solmus, 2008). According to Kaisan and Muhammad (2012) major parameters which influence the solar still performance such as: dry spots and scale formation, air-tight conditions, glass cover inclination were investigated by different researchers; and good results were published (Boukar et al, 2004, Anil etal, 2005, El-Sebaii etal, 2005 and Aybar etal, 2005). The major handicaps that negatively influence the solar still productivity were taken in consideration, and some improvements on the design and operational conditions were made. In this research work however, the variation of some meteorological variables such as ambient temperature, relative humidity, wind speed and solar radiation on the solar still were investigated.

II. METHODOLOGY

A double slope insulated solar still was filled with 50L of water sample from Kwalkwalawa River, Sokoto State, North Western Nigeria. The Kwalkwalawa river is the main source of water for drinking, cooking and other domestic and agricultural functions in the Kwalkwalawa village. However, during the previous research by same authors, it was observed that the water from such source has some contaminations and as such not healthy, and hence, the need for application of solar still distillation. The distillate output of the water sample was observed on hourly basis, between the hours of 8.00am. and 18.00pm. Furthermore, at each hour interval, the solar radiation was measured using Pyranometer. The ambient temperature was measured using Digital Thermometer; the Wind speeds were measured using Anemometer and the relative humidities were measured using Hygrometer correspondingly. The results were tabulated in table 1, and analyses were carried out on the results.

III. RESULTS AND DISCUSSIONS

The experimental results of the effects of some meteorological variables: Solar radiation, ambient temperature, relative humidity and wind speed with distillate yields on hourly basis were tabulated in table 1.

TABLE 1 EXPERIMENTAL RESULTS

Time Interval (hour)	Solar Radiation (W/m2)	Ambient Temperature (0C)	Relative Humidity (%)	Wind Speed (m/s)	Yields in (ml)
8.00	260	26.7	86	1.0	0.0
9.00	455	29.8	81.3	1.6	17.9
10.00	650	30.5	73.3	1.8	31.9
11.00	780	32.4	70	3.2	83.6
12.00	858	34.4	62	1.5	117.1
13.00	871	37.0	54.3	1.6	178.6
14.00	793	37.0	50.7	1.2	240.0
15.00	624	36.2	52	1.3	431.4
16.00	338	35.4	55.3	0.8	532.1
17.00	143	34.4	67.3	0.6	589.3
18.00	13	33.0	73.3	0.9	707.1

3.1 Solar Radiation

It has been observed in figure 1 that solar radiation varies parabolically with time, with its maximum value at 13.00pm. Solar radiation also varies linearly with yield only that, radiation reached its peak at around 13.00pm while the yield reached its maximum value around 18.00pm. Between the hours of 13.00 and 18.00, although the solar radiation had started declining, the yield was still increasing for the two-hour interval. This was because, the solar still has trapped enough energy from the solar radiation, so that the water temperature increased significantly to achieve maximum evaporation and condensation, and of cause the yield

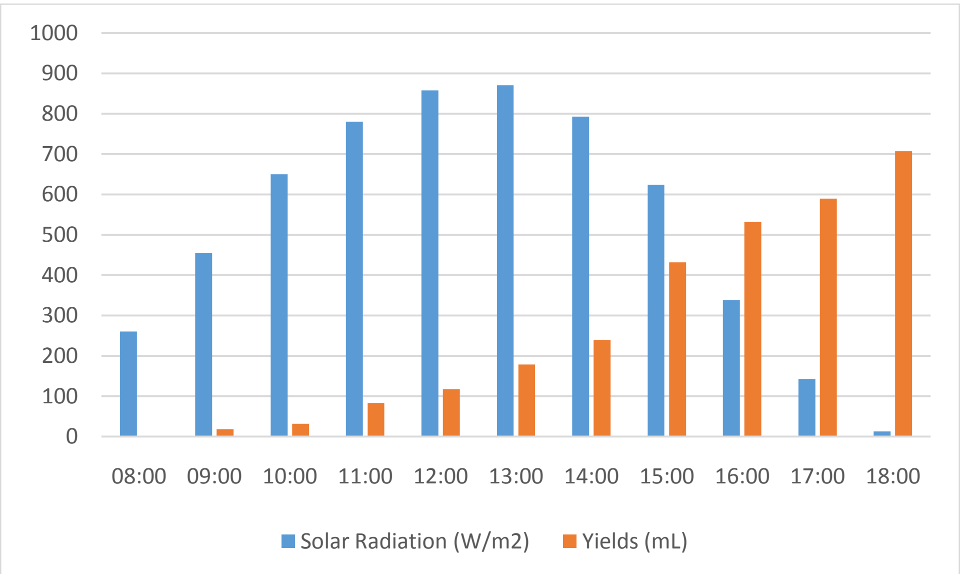

Figure 1 Variation of Solar Radiation with Distillate Yields

3.2 Ambient Temperature

Looking at the results in figure 2, the yield of the distilled water increased as the ambient temperature increased, although the maximum yield recorded at 18:00 and the maximum value of the ambient temperature between 12:00 -16:00. When the ambient temperature started to decline, the yield still increased. This was because, at higher values of the ambient temperature, heat lost by the water content of the solar still due to conduction and convention was thereby reduced. At minimum values of the ambient temperature , more heat was lost from the double slope solar still to the surrounding, this is because, conduction rate is always proportional to the temperature gradient.

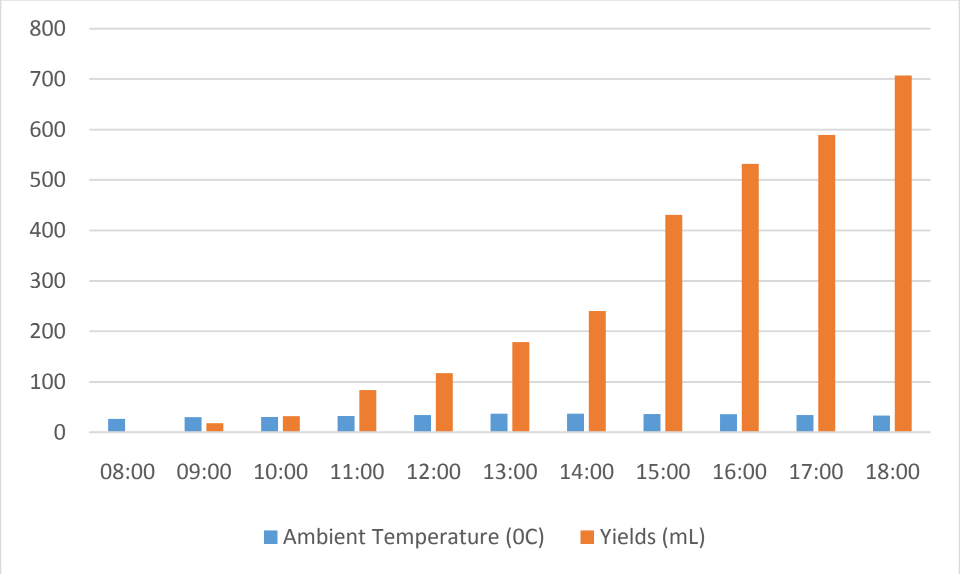

Figure 2 Variation of Ambient Temperature with Distillate Yields

3.3 Relative Humidity

The results of the variation of relative humidity with distillate yields as depicted in figure 3, shows that the relative humidity had negative effect on the yield performance of single slope solar still. It was categorically clear that, minimum yield was recorded at maximum values of the relative humidity (During the hours of 8.00am and 18.00pm). More so, maximum yield was recorded at the minimum values of relative humidity (During the hours of 13.00pm and 15.00pm).

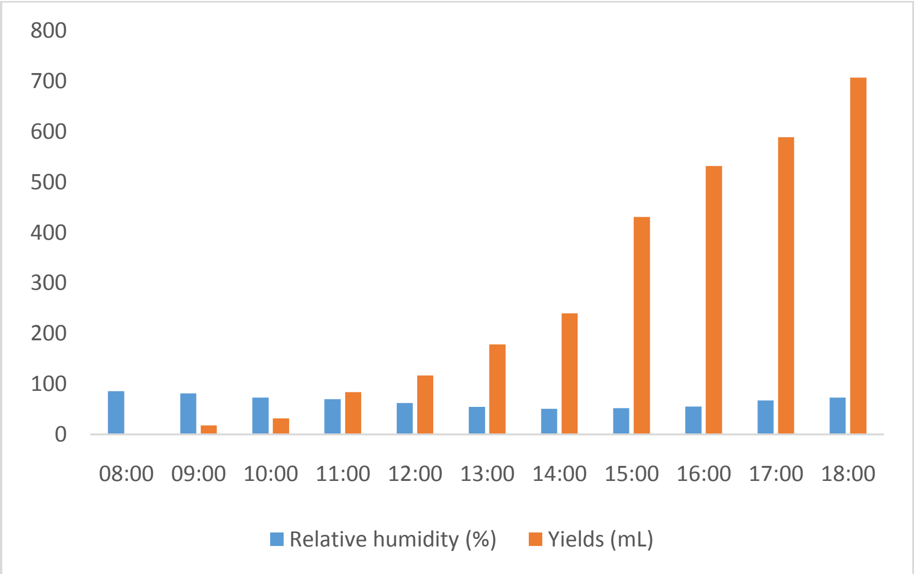

Figure 3 Variation of Relative Humidity with Distillate Yields

3.4 WindSpeed

From the experimental result and the figure 4 below, wind speed fluctuated at each hour reaching its peak at 15.00pm. corresponding to the maximum yield, after which it began to decline. This shows that, more water vapour in the solar still was forced to condense for maximum yield to be achieved at higher values of wind speed. At lower speeds however, even though enough water vapourwas formed less condensation and (of cause) yield was recorded. This is because wind speed may be the only agent of cooling.

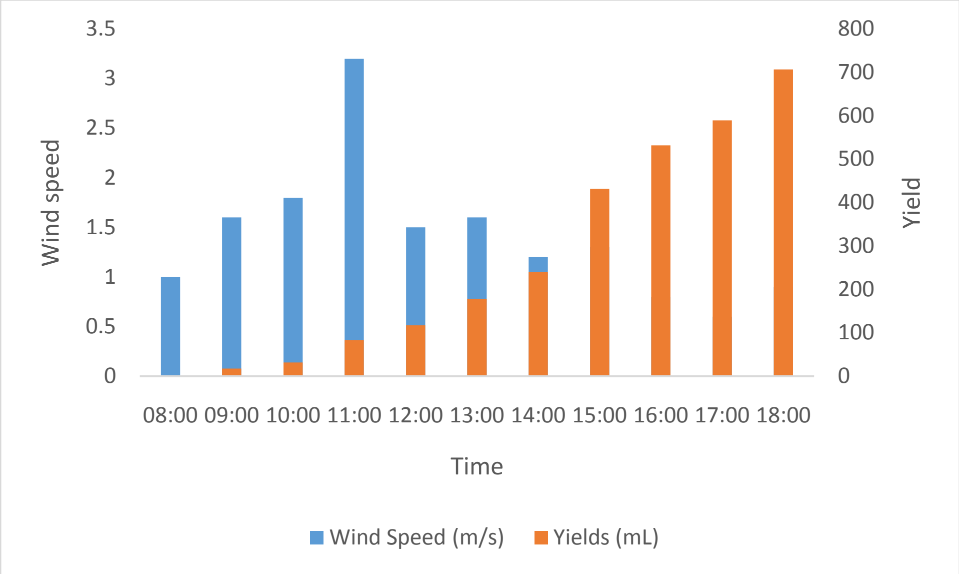

Figure 4 Variation of Wind Speed with Distillate Yields

IV. CONCLUSIONS

Conclusively, going by the experimental findings presented, the solar radiation, the ambienttemperature and the wind speed increase with a corresponding increase in distillate yield. While the relative humidity decreases with a corresponding increase in distillate yield. Hence, all the meteorological variables herein observed, have effects on the yield performance of a double slope solar still withtime.

REFERENCES

[1]. Anil K. and Tiwari G. N (2005). Effect of the condensing cover's slope on internal heat and mass transfer in distillation: an indoor simulation, *Desalination*.180:73-88

[2]. Aybar H. S., Egelioglu F. and Atikol U (2005). An experimental study on an inclined solar distillation system, *Desalination*.180, PP 285-289.

[3]. Boukar M. and Harmim A. (2004). Parametric Study of a vertical solar still under desert climatic conditions, *Desalination*,168:21-28

[4]. El-Sebaii A. A (2005). Thermal performance of a triple-solar still, *Desalination*, 174,23-37.

[5]. Kaisan, M. U. and Muhammad, S. B. (2012). Comparative Analysis of the internal variables for single slope and double slope solar stills with time. *International Journal of scientific & engineering Research*.**3**(12), 2229-5518.

[6]. Sethi, A. K. and Deviedi, V. K. (2013). Design, Fabrication and performance evaluation of Active Solar Still under forced circulation mode. *Research Journal of Engineering Sciences*. **2**(6), 6-12.

[7]. Yamale C. and Solmus I (2008). A solar desalination system using humidification–dehumidification process: experimental study and comparison with the theoretical results. Presented at the Conference on Desalination and the Environment. Sponsored by the European Desalination Society and Center for Research and Technology Hellas (CERTH), Sani Resort, Halkidik:538-551

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