Available online www.jsaer.com

Journal of Scientific and Engineering Research, 2016, 3(4):126-130

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Effect of Relative humidity on Photovoltaic panels' Output and Solar Illuminance/Intensity

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Abstract Investigation of the effect of relative humidity on photovoltaic panel output has been studied and results from other research have been corroborated. Also, the relationship between relative humidity and solar illuminance/intensity has been deduced. At near similar values of air temperature, air pressure and wind direction: the solar illuminance/intensity and relative humidity have a negative correlation with output current and voltage. More so, a huge data to minimize errors, not considering similarity of solar illuminance/itensity, air temperature, air pressure and wind direction output the same results. Some characteristic models for photovoltaic panels are also presented.

Keywords Effect, Relative humidity, Solar illuminance, Solar intensity, Photovoltaic panel and Output.

Introduction

There is no such thing as a perfect technology. Research reveals the different factors can affect the efficiency of solar panel mounting systems. Some of these factors have been studied to either increase or decrease the power production from the three types of mountings such as sun intensity, cloud cover, relative humidity, and heat build up [1].

The weather has been studied to have some significant effect on electromagnetic waves. Solar radiations are members of the electromagnetic waves. Photovoltaic cells employ solar radiations in their operation; hence these cells are affected by the weather or condition of the atmosphere which they are exposed [2-3]. In a cloudy, the amount of raining radiation surely will be smaller than a sunny day. None the less, attention has been on how to improve on output efficiency of photovoltaic cells through the materials used in its construction but not limitations in weather.

The Earth's atmosphere is composed of gases which are held together by gravity. It protects the Earth and all living things therein from solar radiation. It consists of different layers with pressure, thickness, density, and mass that also varies. Changes in the atmosphere can produce variations in the conditions of the atmosphere which can greatly affect the Earth and its inhabitants. One of the factors which can cause these changes in the air is humidity. Humidity refers to the amount of water vapour in the air or atmosphere. It is characterized not by moist air but by the water content of the mixture of water vapour and other components of the air [4].

Humidity may be absolute or relative. Absolute humidity is the amount of water vapour in a unit volume of air which is expressed in kilograms per cubic meter. It does not change according to the temperature of the air. When there is a high amount of water vapour in the air, absolute humidity will also be high. Relative humidity is the percentage or ratio of the amount of water vapour in a volume of air at a given temperature and the amount that it can hold at that given temperature. An amount of water vapour in warm air will result to a lower relative humidity than in cool air [4].

As per the facts when the light consisting of energy/Photon strikes the water layer which in fact is denser, Refraction appears which results in decreasing of intensity of the light which in fact appears the root cause of decreasing of efficiency. Additional there appears minimum components of Reflection which also appears on the site and in that, there appears light striking is subjected to more losses which after the experiments conducted resulted approximately in 30% loss of the total energy which is not subjected to utilization of Energy for the Solar panel [5].

AS far as the efficiency of the Solar cell is concerned, Efficiency is termed as the amount of the light that can be converted into usable format of electricity. Because of the efficiency depends upon the value of Maximum Power Point of the Solar cell , due to the above effect of humidity ,the maximum power point is deviated and that indirectly results in decreasing of the Solar cell Efficiency [5-6].

This paper intends to conduct an experiment to corroborate the claims from earlier experiments on the effect of relative humidity on photovoltaic outputs and determine the effect of relative humidity on solar illuminance/intensity as it has a direct bearing on the performance of a photovoltaic cell.

Methodology

The four major weather parameters: air temperature, air pressure, relative humidity and wind speed and direction were measured intermittently in the course of daylight and simultaneously with solar illuminace/intensity and output voltage and output current of the photovoltaic panel.

The photovoltaic panel is the mono-crystalline cell type with 1.5 W, 12V rating. The dimension of the photovoltaic plate, excluding the metallic frame of the panel is 45 cm by 14.5 cm. The panel was mounted on a platform of about 105 cm and exposed to direct sunlight. The outputs of the photovoltaic panel (current and voltage i.e. short circuit current and open circuit voltage respectively) were measured with the aid of a multi-meter and the solar illuminance/intensity was measured with a Digital Illuminance Meter (DT-1309 model).

Results and Analysis

Figs. 1 to 5 show the graphical representation of the results extracted from the data in the experiment conducted.

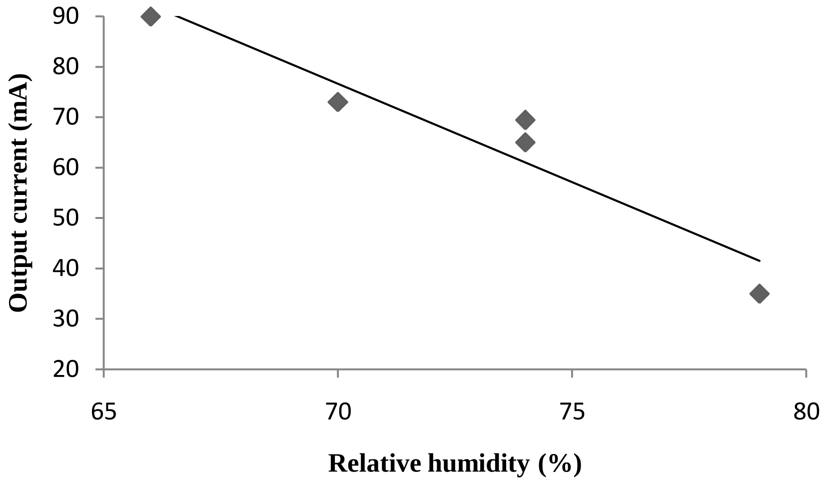

Figure 1: Relative humidity against Output current at near constant air temperature (88 ± 2 ^{0}F), air pressure (29.89 ± 0.02 inHg) and wind direction (WSW)

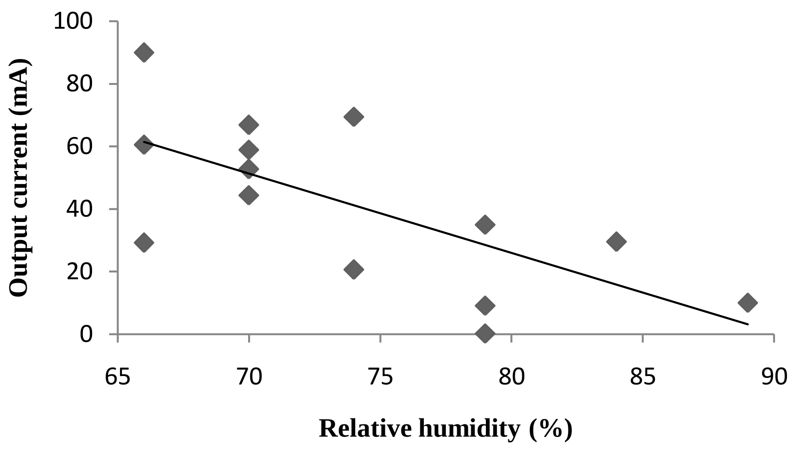

Figure 2: Relative humidity against Output current regardless of air temperature, air pressure and wind speed and direction

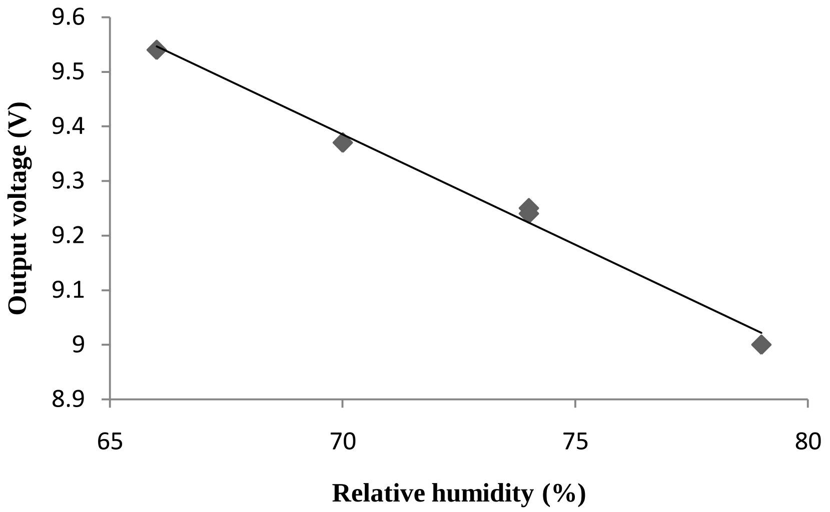

Figure 3: Relative humidity against Output voltage at near constant air temperature (88 ± 2 ^{0}F), air pressure (29.89 ± 0.02 inHg), wind direction (WSW) and Solar illuminance/intensity (20 ± 4 KLux)

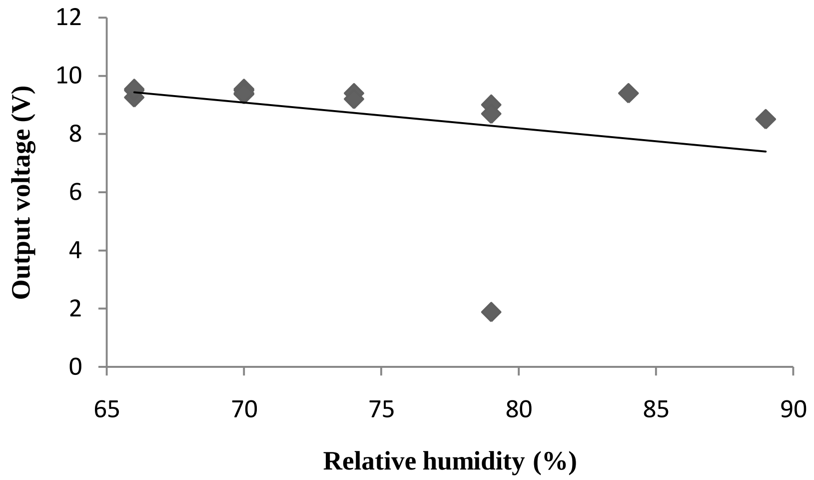

Figure 4: Relative humidity against Output voltage regardless of air temperature, air pressure and wind speed and direction

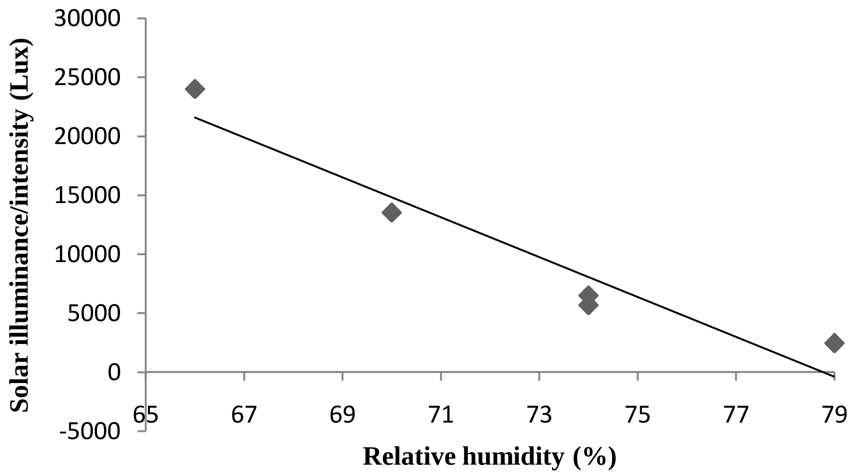

Figure 5: Relative humidity against solar illuminance/intensity at near constant air temperature (88 ± 2 ^{0}F), air pressure (29.89 ± 0.02 inHg) and wind speed (WSW)

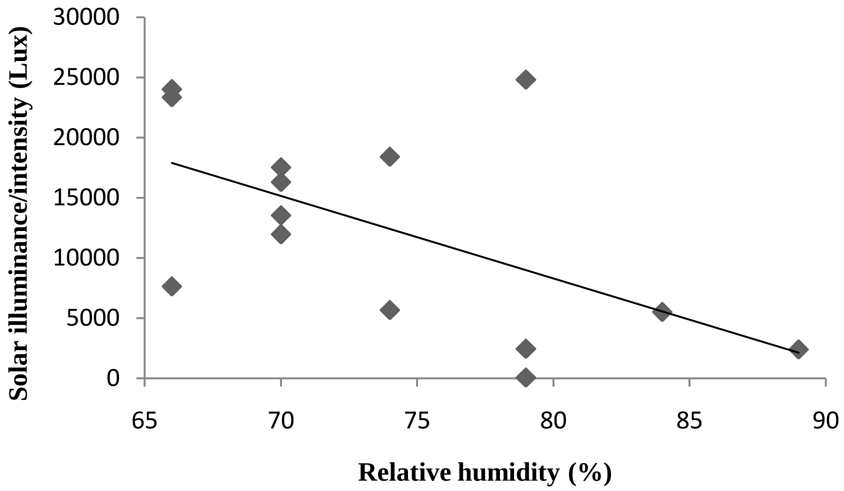

Figure 6: Relative humidity against Solar illuminance/intensity regardless of air temperature, air pressure and wind speed and direction

In fig. 1, at near similar value of solar illuminance/intensity, air temperature, air pressure and wind direction, the output voltage decreases with increase in humidity. Also, a larger data to eliminate errors, but for non-similar values of solar illuminance/intensity, air temperature, air pressure and wind direction also clear the air with a replication of the output in fig. 1.

Also, since output current is directly proportional to output voltage, though nonlinearly, the output voltage as well is impaired by the rise in relative humidity. The graph in fig. 3, shows the representation taking into account similarity of solar illuminance,/intensity, air temperature, air pressure and wind direction. More so, fig. 4 is a reflection of the representation in fig. 3, not bringing into cognisance the similarity of solar illuminance/intensity, air temperature, air pressure and wind direction.

Figs. 5 and 6 are the graphical representations of the result obtained from the comparison between relative humidity and solar illuminance/intensity at constant and non-constant air temperature, air pressure and wind direction. The figures also show that solar illuminance/intensity and relative humidity have a negative correlation: a rise in any of the two quantities result in a fall in the other.

One phenomenon explains the results obtained above. The higher the amount of humidity in the air, the higher the amount of water vapour present in the air. The molecules and in other words, the particles of the water vapour results in absorption, reflection (diffuse and no-difuse), refraction and collision of the solar radiation particles (or photons). This may result in the reduction of the solar radiation raining on the surface of the photovoltaic cell panel and consequently, output current and voltage and solar illuminance/intensity.

Conclusion

At near similar values of air temperature, air pressure and wind direction: the solar illuminance/intensity and relative humidity have a negative correlation with output current and voltage. Also, a huge data to minimize errors, not considering similarity of solar illuminance/itensity, air temperature, air pressure and wind direction outputs the same results. The characteristic models deduced from the graphical representations are:

IL = K/R, where I is output current, R is relative humidity, L is solar illuminance/intensity and K is constant; at uniform air pressure, air temperature, wind speed and direction: provided the output capacity is not exceeded.

VL = K/R, where V is output voltage, R is relative humidity, L is solar illuminance/intensity and K is constant; at uniform air pressure, air temperature, wind speed and direction: provided the output capacity is not exceeded.

Hence IVL = K/R, with all symbols retaining their meaning as above and the conditions above hold sway.

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