

Effect of Different Environmental Factors on Performance of Solar Panel



Manas Ranjan Das

Abstract: Solar power is future of our planet due to the depletion of non-renewable sources of energy. The renewable sources of energy are responsible for 80% of world's power and we all are directly dependent on non-renewable source which will only last for 1 or 2 decades. Due to increase in power demands new development in renewable sources of energy are going on due to which on commercial level solar cell achieved an efficiency of 15-20% and improving day by day. Some factors affects the performance of solar panel and decreases its output while some factors improves the efficiency of solar cell and improves its performance. These factors includes temperature of solar panel, humidity, and wind velocity, light intensity, altitude and air pressure along with many other factors. In this paper these factors are discussed along with their impact on solar cell performance.

Keywords: Solar cell, efficiency, temperature, humidity, wind velocity, light intensity, altitude, air pressure.

I. INTRODUCTION

The world is at the verge of depletion of non-renewable energy sources, 80% power is supplied by oil, coal and gases while only 20% is supplied by renewable sources of energy which includes solar power, wind power, hydro power, and many more. The non-renewable sources are biggest contributor of environmental pollution. In all renewable sources of energy solar power is fastest growing source of energy. With the development of new methods and technologies efficiency of solar cell is improved in past years and cost of manufacturing is also improved. Despite all the development many environmental factors affects the performance of solar cell, these includes temperature, humidity, wind velocity, light intensity, altitude and air pressure[1]. Some of these improves the performance of solar cell and some factors deteriorates the performance of solar cell.

II. EFFECT OF TEMPERATURE

The solar cell module is used for this experiment is monocrystalline in structure and using phosphorous as doping material. To obtain effect of temperature on performance of solar panel the model is illuminated by a lamp with intensity equal to 1000W/m². The measurement of current and voltage is performed at 10°C, 25°C and 50°C with highly accurate equipment's.4.

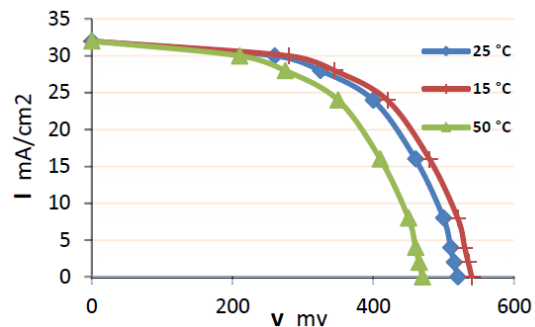


Fig. 1. Effect of temperature on I-V characteristics of solar cell module

According to fig. 1 shows the effect of temperature on the output of solar panel at different temperatures. According to fig 1 temperature is inversely proportional to performance of solar cell i.e. when temperature increases the performance of solar cell decreases[2].

III. EFFECT OF HUMIDITY

The humidity is the amount of water vapour measure in air. The humidity effects the performance of solar cell module in two ways, first due to the deposition of water droplets on surface of solar cell module it reflects the sun light and affects the total output of solar cell and second due to the humidity the metal used in solar panel module for construction start rusting and decreases the life of solar panel[3].

TABLE 1: Show data collected during experiment

Temperature (K)	Humidity (%)	Voltage (DC)	Current Amps (DC)	Powers (Watts)
305	25	17.1	2.78	47.538
305	30	16.72	2.63	43.973
305	35	16.53	2.42	40.002
305	40	16.45	2.3	37.605
305	45	16.41	2.14	35.117
305	50	16.33	2.04	33.313
305	55	16.32	1.88	30.681

From data collected during the experiment Table 1 shows the humidity is directly related with voltage, current and power. The relation between humidity with voltage, current and power is inversely proportional i.e. when humidity increases the value of voltage, current and power decreases. These relations are shown by the help of figure below;

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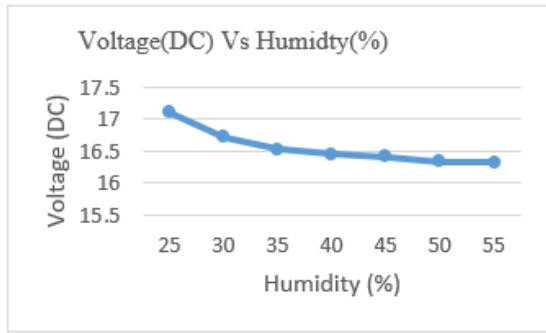


Fig. 2. Humidity vs Voltage

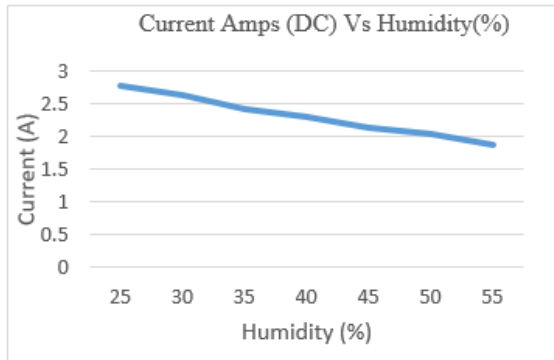


Fig. 3. Humidity vs Current

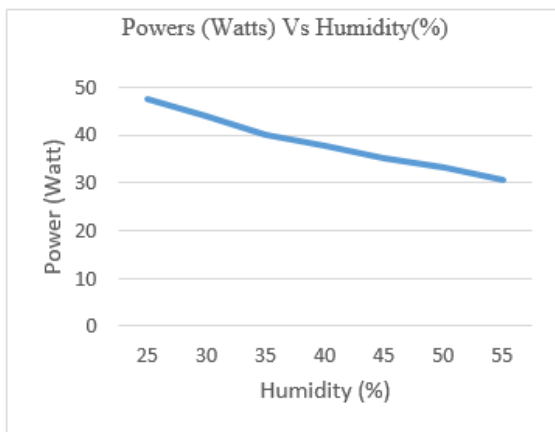


Fig. 4. Humidity vs Power

IV.EFFECT OF WIND VELOCITY

The wind velocity affect the performance of solar cell in positive aspect, it improves the efficiency of solar cell. This helps to reduce the impact of temperature on cell by flowing on the surface of solar cell module, it reduces the temperature of solar panel which effect the performance of solar panel. In other words the wind is directly proportional to performance of solar panel as shown in figure 5 below. In figure5 the data is plotted is temperature and wind velocity, as shown temperature is inversely proportion to wind velocity i.e. when wind velocity increases the temperature of solar cell module decreases[4].

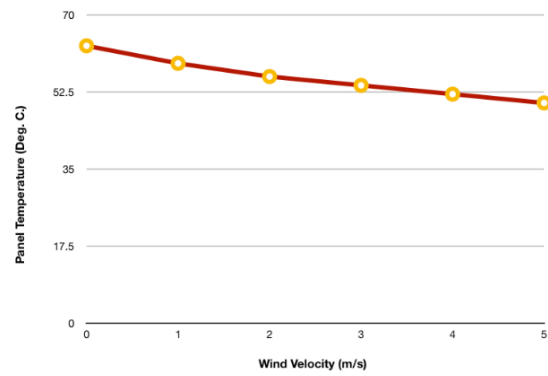


Fig. 5. Temperature vs Wind Velocity

V.EFFECT OF LIGHT INTENSITY

The light intensity is controlled by using lamp, the intensity of light is selected are 100, 800 and 500W/m². By the help of V-I characteristics of solar cell are shown with respect to light intensity in below figure 6 form data collected form the experimental setup.

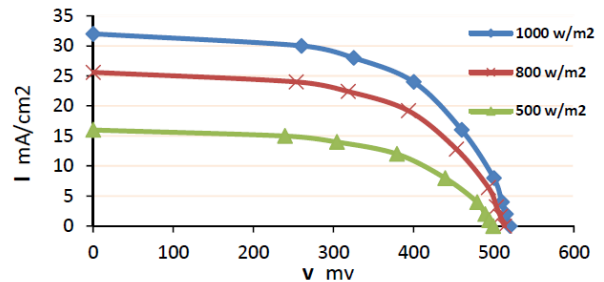


Fig. 6. V-I characteristics of solar cell w.r.t. light intensity

The relation between light intensity and performance of solar cell module is shown in figure 6. According to figure the voltage and current decrease as light intensity decreases i.e. light intensity is directly proportion to efficiency of solar cell. Without proper light intensity output of solar cell drastically decreases and it is a key ingredient for working of solar cell properly[5].

VLEFFECT OF ALTITUDE

The altitude plays a prominent role in efficiency of solar cell. As per experiment is conducted on a sunny day with humidity as 30 percentage, with 4 solar panels and these panels are placed on the ground. At the same time 4 solar panel are placed at a height about 30 meters above surface of earth, and humidity is 26 percentage, with difference in temperature is about 1°C and the readings of both the setup is taken at same time. From these two setups a difference in power generation is seen which represents that more close you go towards the light source, more intensity will be observed and performance of solar cell improves[6]. The readings are shown in below mentioned two tables;

TABLE 2: Reading taken at ground level

Temperature (K)	Humidity (%)	Voltage (DC)	Current Amps (DC)	Power (Watts)
307	30	16.32	2.41	39.331
307	30	17.3	2.34	40.482
307	30	16.45	2.51	42.789

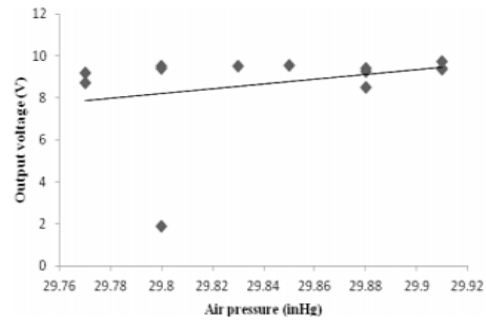


Fig. 8. Voltage (V) vs Air pressure (inHg)

The figure 7 and 8 shows the relation between Air pressure and current, air pressure and voltage respectively. According to figure 7 increase in air pressure results in increase in output current i.e. current is directly proportional to air pressure and According to figure 8 increase in air pressure results in increases in output voltage i.e. air pressure is directly proportional to output voltage of solar cell.

TABLE 3: Reading taken at 30 meters above surface level

Temperature (K)	Humidity (%)	Voltage (DC)	Current Amps (DC)	Power (Watts)
308	26	16.76	2.63	44.078
308	26	17.64	2.53	44.629
308	26	17.08	2.69	45.945

VIII.CONCLUSION

In this paper many environmental factors are discussed which affects the performance of solar cell in any way i.e. it may be positive change or negative change. The temperature decreases the performance of solar cell which results in less power output. The humidity which affect both life and power output of solar cell, is responsible for less power output and due to humidity the rusting starts in solar cell module which directly impacts the life of solar panel. The wind, it improves the performance of solar panel by reducing the temperature of surface temperature of solar panel module. Light intensity is directly related to efficiency of solar panel i.e. higher the light intensity means higher the number of photons falling on surface of solar panel which increases the output of solar cell and directly leads to an improved efficiency of solar panel module. Due to increase in altitude the more sunlight reaches to surface of solar panel which improve the performance and efficiency of solar panel. And the last factor is Air pressure due to the air pressure photons travel with a higher speed and fall on surface of solar panel and increases its output by a significant percentage. These all factors decides the efficiency of solar cell along with some other factors like clouds, visibility and some other.

TABLE 4: Reading comparison of ground level setup with 30 meter above surface level setup

Solar Panel	Power Ground (Watt)	Power Altitude (Watt)	Percentage accession
1	39.3331	44.078	12.06
2	40.482	44.629	10.24
3	42.789	45.945	7.37

In table 4 power output from ground setup and altitude setup are compared and percentage of accession is taken into account. According to results the altitude and performance are directly proportional to each other i.e. when altitude increases the performance of solar cell improves.

VII.EFFECT OF ATMOSPHERIC PRESSURE

The pressure exerted by weight of air present in atmosphere of earth is called air pressure. Air pressure increases with decrease in altitude from the earth surface and the weight of the air is the force acting downward and which increases towards the surface of earth. Form this phenomenon it implies that the force acting downward falling of photons of solar radiation increases with increase in air pressure. When more photons falls on solar cell, which result in high extraction of electrons and consequently higher short circuit current with increase of air pressure i.e. air pressure is directly proportional to intensity of light and intensity of light is directly proportional to power output of solar panel. With increase in light intensity the performance of solar cell improves.

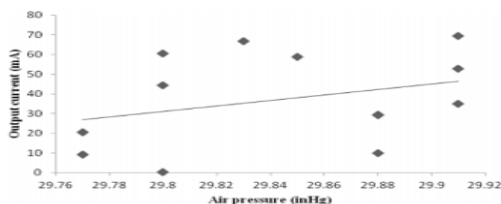


Fig. 7. Current (mA) vs Air pressure (inHg)

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