Grenze International Journal of Engineering and Technology, Special Issue

Experimental Investigation on the Influence of Humidity on PV Panel Performance

Abhishek Kumar Tripathi[1], Mangalpady Aruna[2], Ch.S.N. Murthy[3] and Bodapati Prasad[4]
[1, 4]A.K.S. University, Satna, India
Email: abhinitrkl12@gmail.com, drbodapati@yahoo.com
[2, 3]National Institute of Technology Karnataka, Surathkal, India
Email: arunamangalpady@gmail.com, chsn58@gmail.com

***Abstract*— The performance of PV panel is directly influenced by the surrounding environment. Among various environmental parameters, humidity is one of the parameters that affect the performance of PV panel. Therefore, in this paper an attempt is made to study the effect of relative humidity on the performance of PV panel. This study demonstrated that the increase in humidity level has a negative relation with the performance of PV panel. There was a 35.82% reduction in the output power of the PV panel with the increase in humidity level from 65.40% to 98.20%.**

***Index Terms*— Humidity, output power, PV panel and environment.**

I. INTRODUCTION

Energy is the most basic and essential input parameter for any industry. Due to the continuous increase in the cost of fossil fuel and global warming, in all over the world, a green and renewable energy technology getting much more attention in fulfilling the energy demand of world consumers [1], [2]. Solar energy is the best choice as the source of electric power generation among all available renewable energy sources. The solar energy now a day's getting much more attention because of its availability in the remote areas and also it is generally cheap compared to other means of energy sources. Solar energy can be easily converted into electrical energy by the use of solar photovoltaic (PV) panel. The cost of PV panel has dropped substantially over the last few years. The rapid expansion of PV technology all over the world can be attributed to a number of supportive policies in the mining industries. The performance of PV technology depends on internal and external factors. The internal factors that affect the PV panel performance are corrosion, discoloration, breakage and cracking of cells and external factors that affect the performance are dust, wind speed, humidity, moisture ingress, atmospheric temperature, thermal cycling, tilt angle and glass transmittance [3], [4].

With the increase in the use of solar power, it is also very important to know the effect of external environment parameters on PV panel performance. Humidity is an ambient parameter which defined as the amount of water vapour present in the atmospheric air and it is one of the most important parameters that affects the performance of PV panel. Therefore, in this paper an attempt was made to investigate the effect of humidity on PV panel performance.

Grenze ID: 01.GIJET.4.3.3

II. Effect of Humidity on The PV Panel Performance

To analyse the effect of humidity, two scenarios need to be considered. The first scenario is the effect of humidity on the solar radiation and second scenario is humidity ingression into the solar cell enclosure. Whenever the sunlight rays hit the water droplets they undergo the phenomena of refraction, reflection and diffraction. This alters and reduces the solar radiation reaching the panel surface in non-linear manner due to non-uniform distribution and random sizes of water droplets in the atmosphere [5]. Thus, the overall performance of PV panel (output current, voltage and power) reduces with the increase in the humidity level in the environment [6], [7].

In the second scenario, when the PV panels are exposed to humidity for a long time there may be possibility of moisture ingress into the glass of PV panel. When moisture enters into the solar panel, it provides an additional shunt path for the output current of the cell. Thus, the effective shunt resistance of the cells in the panel reduces, which further reduces the output current of the panel. This reduction of output current will be more significant if the series resistance of the cells increases due to the corrosion of the contact pads under the exposure of moisture. Further, sometimes the moisture ingression into the cell of the panel, reduce the life span of the crystalline cell by delamination, embrittlement and corrosive of encapsulant material of the PV cell [8], [9], [10].

III. Methodology - Experimental Investigation

The humidity study was performed on a 20W poly-crystalline PV panel. The relevant specifications of the panel are presented in Table I. This panel was subjected to a humid environment, which is artificially generated by the humidifier, in the laboratory. The electrical parameters of PV panel (such as current, voltage and power output) were measured, for a fixed load of 38Ω, by varying humidity level ranging from 65.40% to 98.20%. Table II indicates the measured and calculated electrical parameters of the panel. The percentage reduction in electrical parameters due to increase in humidity level is depicted in Table III.

TABLE I. TECHNICAL SPECIFICATIONS OF 20W PLOY CRYSTALLINE PV PANEL

Sl. No	Parameter	Ratings
1	Open circuit voltage	21.50 volt
2	Short circuit current	1.28 amp
3	Maximum voltage	17.00 volt
4	Maximum Power	20 watt
5	Maximum current	1.2 amp
6	Fill Factor	0.727
7	Normal operating cell temperature	(47±2) ºC

TABLE II. MEASURED ELECTRICAL PARAMETERS

Relative humidity (%)	Short circuit current, I_{SC} (amp)	Open circuit voltage, V_{OC} (volt)	Output voltage, V (volt)	Output current, I (amp)	Output power, P (watt)
65.40	0.530	19.03	17.52	0.450	7.884
73.50	0.490	18.40	16.90	0.414	6.996
80.40	0.460	17.90	16.52	0.387	6.393
85.60	0.438	17.50	16.10	0.368	5.924
91.70	0.412	17.76	16.27	0.347	5.645
95.10	0.398	17.15	15.80	0.335	5.293
98.20	0.385	16.85	15.57	0.325	5.060

TABLE III. REDUCTION IN ELECTRICAL PARAMETERS

Relative humidity (%)	Reduction in short circuit current (%)	Reduction in open circuit voltage (%)	Reduction in output voltage (%)	Reduction in output current (%)	Reduction in output power (%)
8.10	7.55	3.31	3.54	8.00	11.26
15.00	13.20	5.94	5.71	14.00	18.91
20.20	17.35	8.04	8.11	18.22	24.86
26.30	22.26	6.67	7.13	22.89	28.39
29.70	24.90	9.88	9.82	25.56	32.86
32.80	27.35	11.45	11.13	27.78	35.82

IV. Results and Discussion

Based on the measured electrical parameters graphs were plotted between humidity Vs short circuit current and humidity Vs power, which are shown in Figure 1 and Figure 2. As shown in Figure 1 and Figure 2, the short circuit current and power output are reducing with an increase in humidity level in the atmosphere. This is mainly due to the increase in water droplets in the atmosphere (with increase in humidity level), due to which the effective solar radiation falling on the panel surface reduces. Due to this phenomenon, there was a large variation in short circuit current, whereas the variation in open circuit voltage was meager, as observed in Table 3. These results clearly indicate that the increase in humidity level in the atmosphere degrades the performance of PV panel. The output power of the PV panel was reduced by 35.82% with the increase in humidity level from 65.40% to 98.20% (i.e. with 32.8% increase).

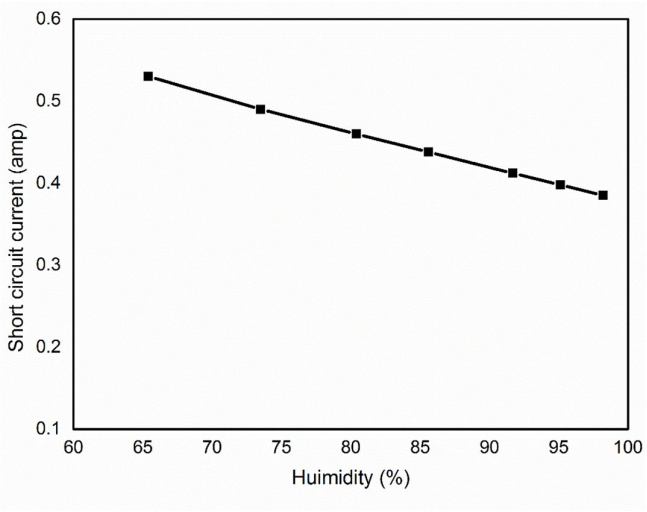

Figure 1. Variation of short circuit current with humidity

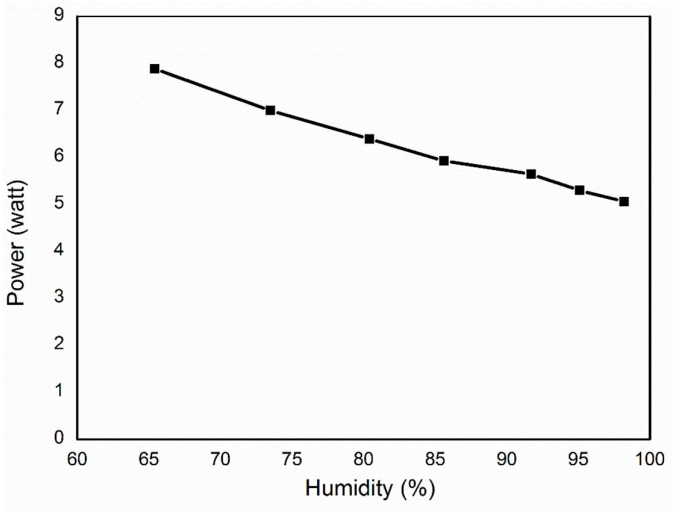

Figure 2. Variation of power output with humidity

The variation in open circuit voltage of the PV panel with increase in humidity level is shown in Figure 3. As indicated in Table 2 and Figure 3, panel experiences a small increment in open circuit voltage i.e. from 17.50V to 17.76V with increase in humidity level from 85.60% to 91.70%. This trend may be due to the

water droplets which are trapped inside the glass of the panel behaving like magnifier lenses that focus the sunlight towards the cell [9].

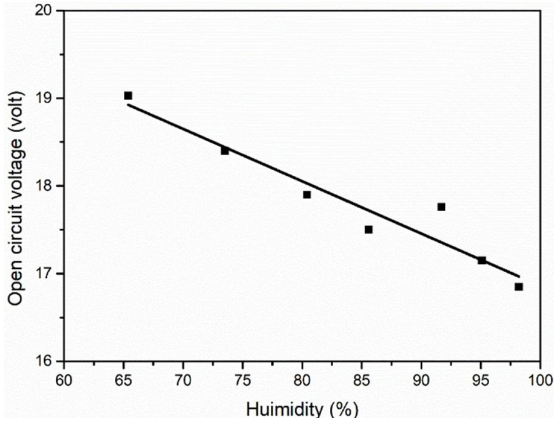

Figure 3. Variation in open circuit voltage with increase in humidity level

V. CONCLUSIONS

Renewable energy, such as solar energy, is becoming more attractive, especially in remote areas where the access to other power sources is difficult. The performance of solar PV panel depends on the surrounding environmental parameters, such as dust, wind speed, temperature and humidity. In this laboratory investigation, the effect of humidity on the performance of PV panel was studied. The results of this study show that the increase in humidity level reduces the short circuit current of PV panel more significantly when compared to open circuit voltage. In the present study the output power of the PV panel was reduced by 35.82% with the increase in humidity level from 65.40% to 98.20%. As solar energy is being an alternative source of energy as mentioned above, the more benefit may derive by minimising the surrounding humidity factor, especially, when the solar power system is proposed in high humid zone.

REFERENCES

[1] M.H. Nehrir, C.Wang, K. Strunz, H. Aki, R. Ramakumar, J. Bing,and Z. Salameh, "A review of hybrid renewable/alternative energy systems for electric power generation: Configurations, control, and applications." IEEE Transactions on Sustainable Energy 2.4, 392-403, 2011.

[2] I. Ozturk, A. Aslan, and H. Kalyoncu, “Energy consumption and economic growth relationship: Evidence from panel data for low and middle income countries,” Energy Policy, vol. 38, no. 8, pp. 4422–4428, 2010.

[3] F. A. Touati, M. A. Al-Hitmi, and H. J. Bouchech, “Study of the effects of dust, relative humidity, and temperature on solar PV performance in Doha: comparison between monocrystalline and amorphous PVS,” Int. J. Green Energy, vol. 10, no. 7, pp. 680–689, 2013.

[4] A. K. Tripathi, M. Aruna, and C. S. Murthy, “Performance of a PV panel under different shading strengths,” Int. J. Ambient Energy, pp. 1–6, 2017.

[5] B. A. L. Gwandu and D. J. Creasey, “Humidity: a factor in the appropriate positioning of a photovoltaic power station,” Renew. Energy, vol. 6, no. 3, pp. 313–316, 1995.

[6] H. A. Kazem et al., “Effect of Humidity on the PV Performance in Oman,” 2012.

[7] M. K. Panjwani and G. B. Narejo, “Effect of Humidity on the Efficiency of Solar Cell (photovoltaic),” Int. J. Eng. Res. Gen. Sci., vol. 2, no. 4, pp. 499–503, 2014.

[8] S. Mekhilef, R. Saidur, and A. Safari, “A review on solar energy use in industries,” Renew. Sustain. Energy Rev., vol. 15, no. 4, pp. 1777–1790, 2011.

[9] C. M. Tan, B. K. E. Chen, and K. P. Toh, “Humidity study of a-Si PV cell,” Microelectron. Reliab., vol. 50, no. 9, pp. 1871–1874, 2010.

[10] S. Mekhilef, R. Saidur, and M. Kamalisarvestani, “Effect of dust, humidity and air velocity on efficiency of photovoltaic cells,” Renew. Sustain. Energy Rev., vol. 16, no. 5, pp. 2920–2925, 2012.