www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 4 Issue 3 March 2015, Page No. 10620-10624

Effect of Temperature on Maximum Power Point of Photovoltaic Module

Mrs AbubakarAbisetu[1], DrDominicS.Nyitamen[2]Dr Nnorom Achara[3]
[1] Department of Electrical/Electronic Engineering, Kogi state Polytechnic Lokoja, Nigeria
[2] Dept. of Electrical/Electronic Engineering, Nigerian Defence Academy, Kaduna, Nigeria
[3]Dept. of Mechanical Engineering, Nigerian Defence Academy, Kaduna Nigeria
[2]dsnyitamen@nda.edu.ng,
Keywords: Photovoltaic cell, Cooling chamber, irradiance, PV module, surfacetemperature

Abstract: *The voltage output and the maximum power point are found to drop with high irradiance and the associated high solar cell surface temperature. The rise in temperature produces thermal agitation which not only increases the dark current but also enhances the losses of free carriers in a PV cell. A number of PV cells have been assembled locally into PV module and experimentally investigated. To control the temperature of the PV module, a cooling chamber (refrigerator) was used. Experiments were performed with and without the cooling chamber. The maximum power point was found to drop with increasing surface temperature. The experiments were carried out and data collected with and without the cooling chamber. In comparison, the surface temperature of the PV module without cooling was found to be higher. However, operation with the cooled chamber recorded a drop in the PV module temperature and in the maximum power point. The study has led to the inference that maximum power point and the output power decrease with an increasing PV cell temperature.*

I. Introduction

The adoption of renewable energy as means for electricity generation globally has been exceptionally rapid, especially in remote areas such as developing country where conventional electricity is not available or unreliable [1,2]. Among the renewable energies, solar energy (the energy sourced from PV module)is one of the most promising sources. PV system is clean and noiseless, requires little maintenance, as well as easy installation and integration. However, temperature affects the output of PV cell [3,4].

Effect of temperature on PV module has been investigated by researchers but they have mostly based their experimentation on a controlled environmental chamber (artificial environment) with sun emulator as sunlight, under this condition irradiance and wind speed are kept constant.This artificial environment does not reflect the real environment where PV module will be sited and itcannot be simulated under a natural sunlight where a number of micro-climatic parameters along with thetemperaturesimultaneously drive the module.Fesharaki et al. investigated theinfluence of temperature on PV cells up to 80°C but they based their investigation on the conversion efficiency of PV cells [5]. This paper aimed at investigating the effect of temperature on maximum power pointof photovoltaic module under the influence of natural sunlight.

II. Experimental set up

The Schematic circuit diagram of the experimental set up of the PV module is shown in fig.1 (without cooling system) and fig. 2 (with cooling system). The two circuit diagrams were used simultaneously to test the I-V, P-V characteristics and to investigate the effect of temperature on maximum power point. Two PV modules were built in-house and used for the experiment, one of the PV modules was cooled and the other left atambient temperature. In order to find various current – voltage points of the PV module, a variable resistor is used as load.The experiments were conducted from 9.00 a.m. to 2.00 p.m. for the period of two weeks. In the experiment, PV module d.cvoltage, current, temperature and ambient temperature were collected simultaneously during the operation of the set up. The PV module voltage was measured by connecting a digital voltmeter across it. The load current, which is the current generated by the PV modulewas measured with digital ammeter. The value of P_{max} was calculated by multiplying voltage and load current of the PVmodule.

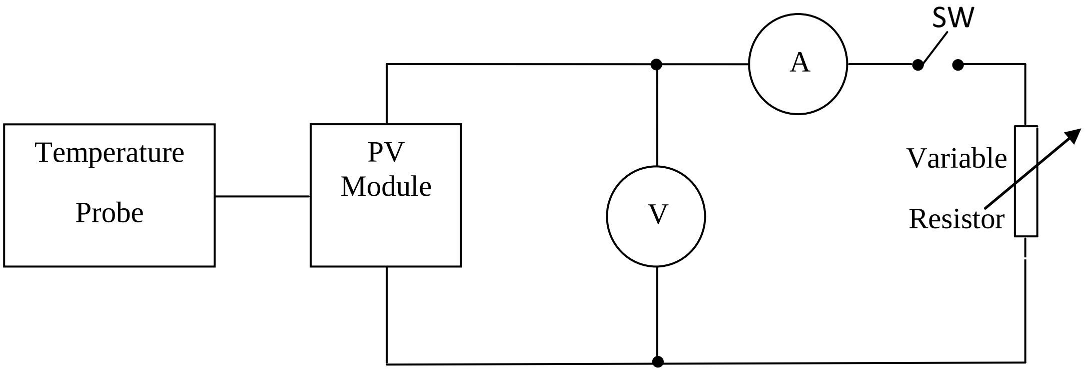

Figure 1; Schematic Circuit Diagram Without Cooling System

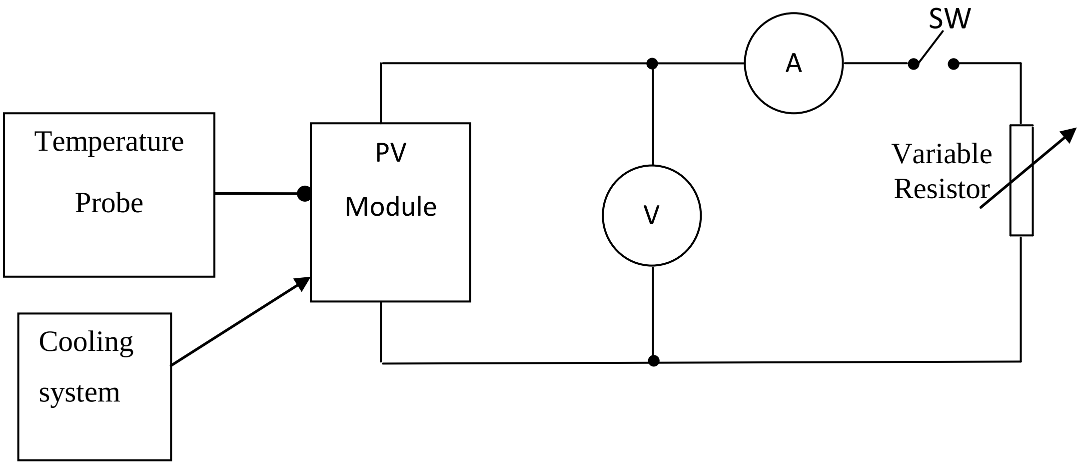

Figure 2;Schematic Circuit Diagram With Cooling System

Fig. 3;TheIn-house Built PV Module

The PV module used is made up of mono-crystalline silicon cell. The output of the in-house built module varies from 3 to 4.5 volts for different values of load. The PV moduleused is shown in Fig.3.

III. Results and Discussion

The data recorded during one of the sets of the experiments is tabulated in table 1. The data collection was carried out simultaneously for both the cooled and uncooled PV modules. The uncooled module was boxed as for the cooled chamber. The maximum power point of the PV module is presented in figure 4. It can be observed that the maximum power point of the PV module is almost a linear function of ambient temperature. The maximum power point of the PV module decreases as PV module surface temperature. The impact of cooling is also shown in figure 4. Under the same meteorological condition, the maximum power point of non-cooled case (P.A) is lower than the cooled PV module (P.B) and this is also reflected in the maximum power point of the module. The corresponding characteristic graphs drawn are shown in figure 5 and 6.

The performance of the PV module depends highly on the environmental conditions which vary throughout the day. It is observed from fig.5 and fig.6 that, as the temperature increases the I-V and P-V characteristic curves of the PV module shifts down and so does the maximum power point.

Table 1: Data collected (voltage,Current).

PV Module without cooling system (Panel A)				PV Module with cooling system (Panel B)		
Current (A)	Voltage (V)	Power (W)		Current (A)	Voltage (V)	Power (W)
0.191	0.000	0.000		0.190	0.000	0.000
0.174	2.282	0.397		0.182	2.209	0.398
0.157	2.780	0.436		0.161	2.800	0.451
0.131	3.370	0.441		0.148	3.420	0.506
0.100	3.540	0.354		0.125	3.647	0.443
0.056	3.790	0.212		0.092	3.851	0.354
0.000	4.120	0.000		0.000	4.223	0.000

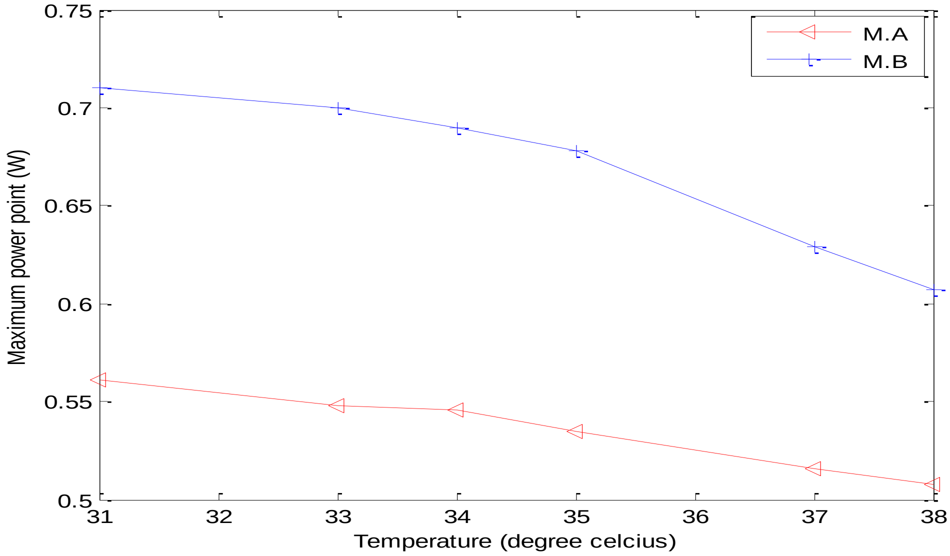

Fig. 4. PV maximum power as a function of temperature

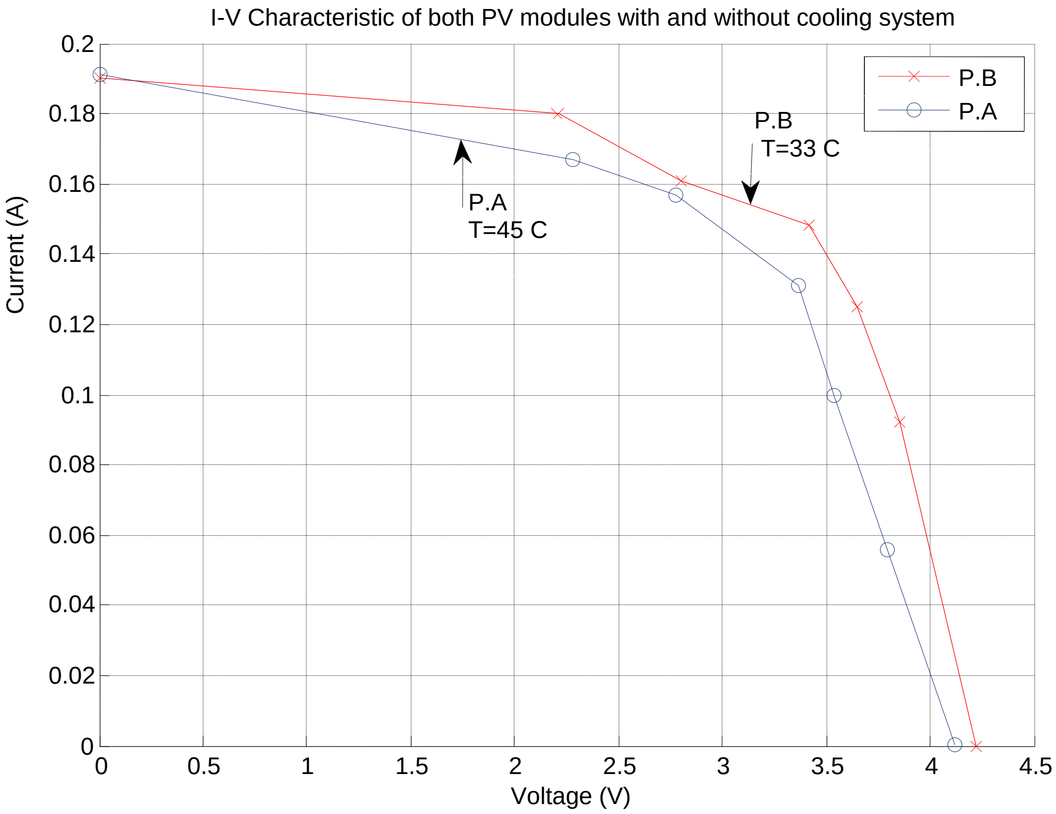

Fig.5. I-V characteristics of solar PV module

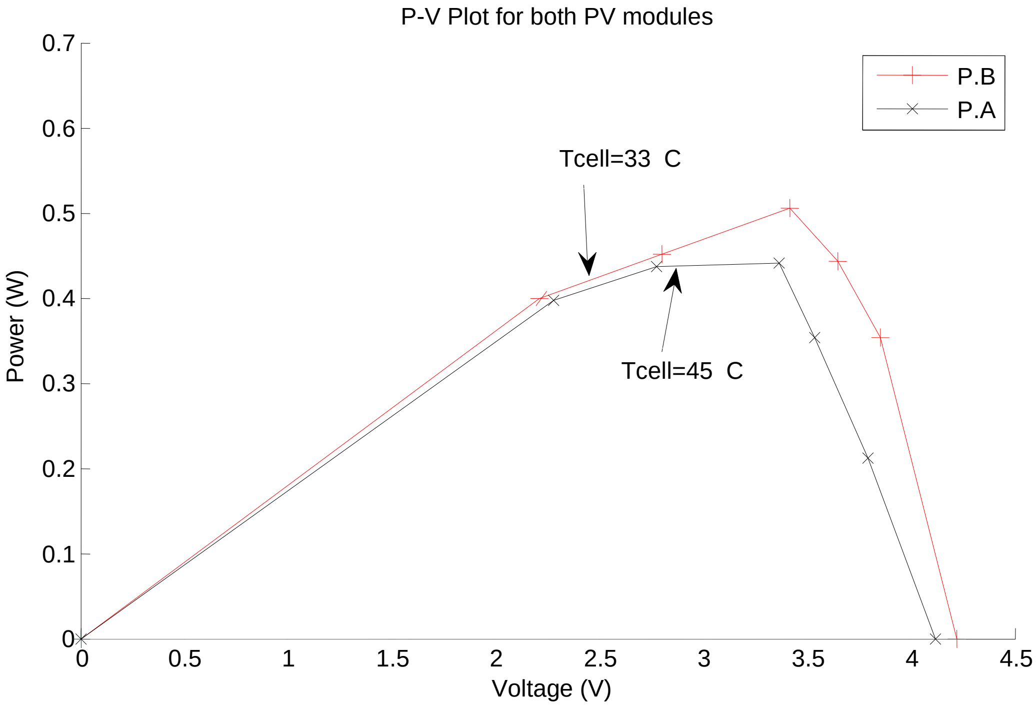

Fig.6. P-V characteristics of solar PV module

IV.Conclusion

The results obtained show that the maximum power of a PV module is reduced as temperature is increased and also the open circuit voltage (V_{OC}) of PV module decreases as the module temperature increases.The statistical test results estimated with a 95 percent confidence interval shows that the mean current and voltage for the PV module with the cooling system exceeds the mean for the PV module without the cooling system. The increase in current of the cooled PV module over the PV module without cooling system is 10.22%higher and the voltage generated by the cooled PV module over the voltage generated by the PV system without cooling system is about 20.74% also higher. This percentage increase in voltage over the percentage increase in current can be explained by the fact that temperature change has more effect on voltage generation of PV module than the current generation. This is in agreement with the theoretical prediction in voltage and current generation of PV cell.

References

1. Muneer T., M. Asif and Munawars. 2005. “Sustainable Production of Solar Electricity with Reference to the India Economy”. Renewable Sustainable Energy Review. 9:444-473.
2. Dincar I (2003): The role of Energy in Energy Policy Making. Energy Policy Vol. 30 137-149.
3. Hirata, Y. and Tani, T. (1995), Output Variation of Photovoltaic Modules with Environmental Factors-I, The Effect of Spectral Solar Radiation on Photovoltaic Module Output. Solar Energy, vol. 55, no. 6, pp. 463-468.
4. D. E. Carison, Photovoltaic technologies for commercial power generation. Annu. Rev. Energy, 15:85 98, 1990.
5. V. JafariFesharaki, I. Arbaban, J JafariFesharaki and M. Jomardi ‘The efeect of environment on PV module efficiency.’ Advanced Material Research. Vols. 535-537 (2012) pp 1283-1286.