Colling System Application In PV Module Toward Output Voltage And Current PV Module

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Abstract. Solar cell is a source of electrical energy derived from solar energy. This energy source utilizes sunlight absorbed by the PV Module and then transformed into electrical energy. The research stage begins with the preparation of the tool; the next stage is constructing a heat discharger made of aluminum plate which is given a cooling fin of aluminum material with a thickness of 0.3mm. After that it is affixed to the back side of the PV module. Data collection method is conducted by taking hourly data for 7 hours with different solar intensities every hour and displayed in tabular form. From the results of research data conducted for 3 days, data obtained on average value of the temperature difference between module 1 that does not use a cooling system and module 2 that uses a cooling system is 1.470C, the difference in voltage is 1.06 volts and the difference in current strength is 0.05 Amp. Thus it can be concluded that by applying a cooling system to the PV module the module temperature will be cooler, and the voltage on the PV module using the cooling system is higher than the PV module which is not used cooling system. To the contrary the current strength in the cooled PV module is slightly lower in value compared to strong currents in modules that do not use a cooling system.

Keywords: Electric energy, Solar cell, cooling system

1 Introduction

Electrical energy source from solar energy is a renewable energy source that is very popular nowadays. This energy source is popular because it can be placed in almost all regions in Indonesia both in the mountains, plains and coastal areas. This solar power plant is also very suitable for the climate in Indonesia, where the summer is longer than the rainy season, namely summer lasts from March to November and the rainy season is from December to February.

Eastern Indonesia is a region considered very suitable for the application of solar power plants in June, with the potential of sunlight reaching 4.5-4.8 kwh / m2 / day. Asyari et al. [1] stated that the high intensity of the sun also affects the power output of a PV module, the main component of the solar power system, because the high intensity of the sun causes the temperature to be quite hot. According to Ferrade et al. [2] the intensity of sunlight on the cell output power of PV that solar cells can operate optimally if the cell temperature remains normal (at 25^0C). When the temperature rise is higher than normal, the temperature in the cell will decrease the voltage value (Voc). Each temperature increase of 10 ^{0}C solar cells (from 25 ^{0}C) will decrease by about 0.4% in the total power produced or it will be weakened twice to increase the temperature of cells per 10 ^{0}C. So, to get the maximum output of a PV Module, the temperature in the module must be maintained at an ideal temperature or close to the ideal temperature of 25 ^{0}C [3].

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Normal operating temperature (NOCT) irradiation - an average of between 600 to 900 Watt / m² is said to be the optimum irradiation value. If the sun position is in the south latitude, then the solar Array (PV Array) must be faced (tilted) facing north and vice versa (north latitude facing south) [4].

The solar module tilt is adjusted to the installation location, the closer to the equator, the smaller the tilt angle will be, and the farther the greater the slope will be between 10 º to 15 º. In Figure 1 we can see the curve of the solar module power graph to irradiation and temperature. Photovoltaic (PV) is a technology and research sector that deals with the application of solar panels for energy by converting sunlight into electricity. Due to increasing demand for clean energy sources, the manufacture of solar panels and photovoltaic assemblages have expanded dramatically in recent years. Generally, during sunny and hot conditions (the equator), photovoltaic temperatures can reach 40-50 ºC and it is not impossible that the temperature can be higher than that. As a result, losses (decrease in power) [5]. In Figure 1 shows us the time graph, current (Ampere) and solar irradiation (Watt / m2).

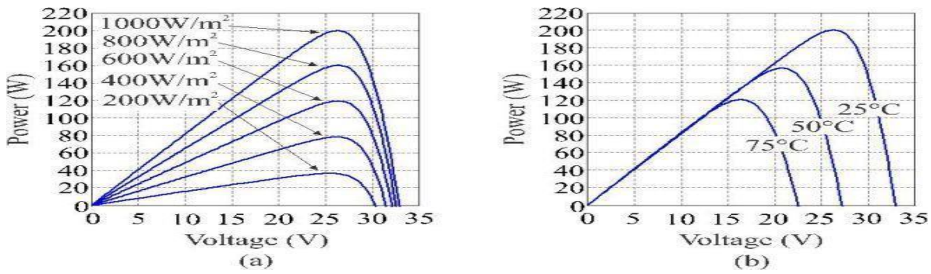

Figure 1. Curve of solar module power against irradiation and temperature

A solar module is a group of solar cells arranged and connected in series or in parallel. The solar module is packaged in a protective laminate against the environment. The power of the solar module in watt peak units combined with the number of solar cells installed on the solar module. The average lifetime of a solar module can be up to 30 years.

The silicon cells themselves do not experience damage or degradation even after decades of use. However, the module output will decrease in time. This degradation is caused by two main factors, namely the damage of the top layer of Ethylene Vinyl Acetate (EVA) cells and the bottom layer (Polyvinyl Fluoride Film). The natural damage of EVA occurs gradually between the glass layer and the cells themselves [6]. A photograph a solar module is shown in Figure 2.

Figure 2. Solar Module

2 Experimental Procedure

This research was conducted on a laboratory scale with the aim to determine the effect of temperature on the output voltage and current strength on the PV Module. Data collection procedure was done by placing two PV modules side by side. Module 1 was not equipped with a cooling system while Module 2 was equipped with a cooling system. The way to collect data was to measure solar irradiation using solar power meters, to measure the temperature of both PV Modules with a laser thermometer. And followed by measuring voltage output (Voc) and strong current output (Isc) from each PV module by using a multi tester and clamp meter. This measurement was performed every hour started at 10 am and ended at 4 pm. The measurement results were displayed in tabular form, as in the following table:

3 Results and Discussion

This research was conducted by comparing the output voltage and current strength on the PV Module output and results are shown in Table 1.

Table 1. Voc and Isc of the examined PV module

Number	Temp (°C)		Irradiation (Watt/m²)	Time	Open circuit voltage (Voc) in volt		Short circuit current (Isc) in ampere	
	Modul1	Modul2			Modul1	Modul2	Module1	Modul2
1.	42.6	41.1	1205.4	10	20.61	21.67	2.47	2.46
2.	43.9	42.3	1251.6	11	20.47	21.58	2.54	2.53
3.	50.6	48.4	1260.9	12	20.56	21.56	2.45	2.43
4.	46.9	46.8	1155.6	13	20.22	21.35	2.21	2.2
5.	44.3	42.1	922.9	14	20.16	21.33	2.18	2.16
6.	44.6	42.9	926.7	15	20.05	21.28	1.85	1.8
7.	34.6	33.6	629.3	16	20.02	21.25	1.8	1.6
Average	43.92	42.45	1050.3		20.29	21.43	2.21	2.16

After making these measurements, the results of these measurements were put in tabular form as above and also presented in graphical form as below.

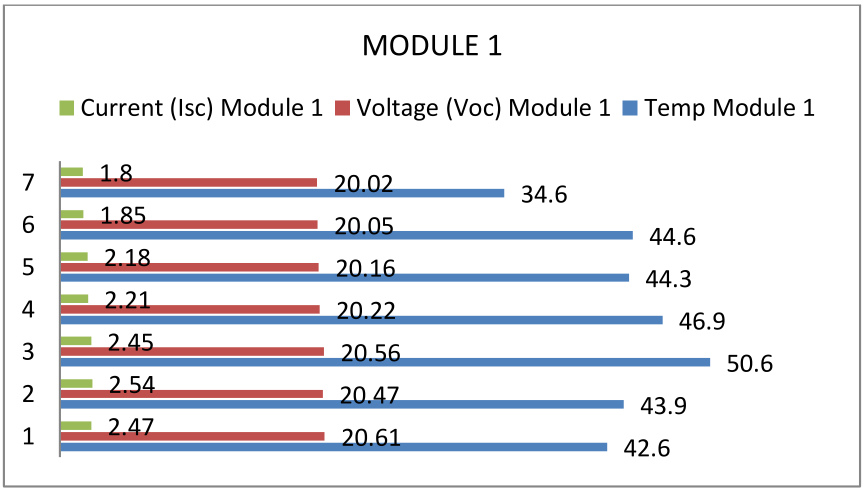

Figure 3. Output Voltage and Current Strength in PV Module1

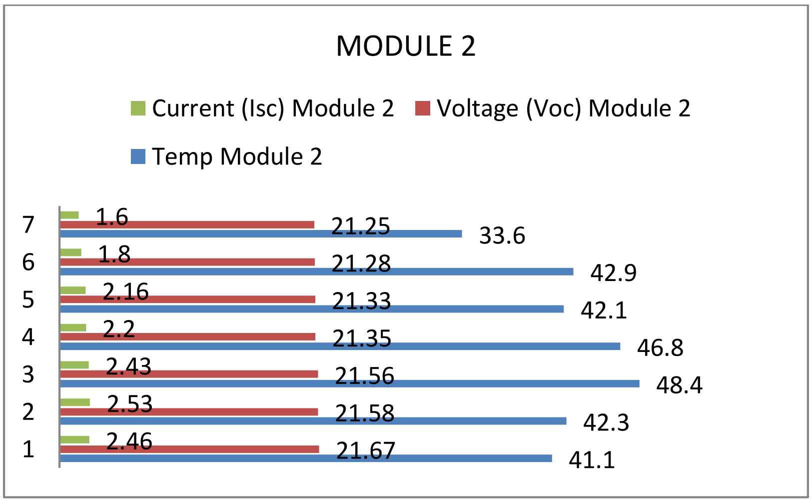

Figure 4. Output Voltage and Current Strength in PV Module2

The data from this study was presented in the form of an experimental table that was testing by measuring the voltage output (VoC) and current strength (Isc) of the PV Module every 1 hour for 7 hours in a day. From the data table above, we can see that the temperature of the PV module using the cooling system is lower than the PV module which does not use a cooling system. If the average temperature is taken within seven measurements, the temperature of the PV module using the cooling system is 42.45^0C, while the PV Module temperature that does not use a cooling system is 43.920C. The average voltage output in PV Modules that use a cooling system of 21.43 volts also looks higher in value compared to PV Modules which do not use a cooling system with output voltage value of 20.29volts. On the average current strength output on PV Modules that use a cooling system the current strength value is 2.16 Amp. This value is to somewhat lower compared to the value of strong current output on PV Modules that do not use a cooling system with a strong current output value of 2.21 Amp, although it is not significant, as well as the output voltage (Voc) of PV modules that use a cooling system is higher than that of PV modules that do not use a cooling system.

From the results of this study it can be said that the use of a cooling system on a PV module is able to reduce the temperature of the PV module. And that the output voltage value of a PV Module that uses a cooling system is higher than the PV module that does not use a cooling system, although the difference in the output voltage value is not too significant. But on the strong current output, the value of the strong current output of the PV Module that does not use a cooling system is slightly higher than the PV module that uses a cooling system.

4 Conclusion

Based on data from the above, research results can be concluded as follows:

1. PV Module 2 which uses a cooling system has the average temperature of lower than (42.45 ^{0}C) compared to PV Module 1 which does not use a cooling system with the temperature of (43.92 ^{0}C).
2. PV Module 2 which uses a cooling system has a higher voltage output value of (21.43 volts) compared to PV Module 1 which does not use a cooling system with the voltage output value of (20.29 volts).
3. PV Module 2 with a cooling system has the current output strength of lower than (2.16 Amp) compared to PV Module 1 which does not use a cooler system with the current output strength of (2.21 Amp)

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