

2019 PV Panel Cooler to Enhance Output Performance Using Perforated Aluminium Plate by Irwin Bizzy 2019

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⁵ PV Panel Cooler to Enhance Output Performance Using Perforated Aluminium Plate

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Abstract. The Indonesian state is situated around the equator which has renewable energy potential that is sourced from sunlight. The radiation generated by the sun can be used as a source of electrical energy. The progression of today's photovoltaic (PV) technology has opened up the possibility of the sun to assist as an infinite source of vigour that can substitute fossil-derived energy sources. PV panel research has been performed to ameliorate the operation of its output by designing a cooling system constructed from aluminium with holes. This cooling system is located along the spine of the PV panel. The outcome of the research indicates that the accession of the electric current is 120% compared to without using a cooling scheme. ³ average rise of PV panel surface temperature is 50.23°C, the surface temperature of the back of P ⁸ panel with cooling is 58.72°C, the surface temperature of aluminium is 42.49°C, and the surface temperature of the end of the PV panel without cooling is 47.57°C.

Keywords: Cooling system, current, PV panel, temperature, radiation

1. Introduction

Geographically, the territory of Indonesia holds a tropical mood with high heat and humidity. The Indonesian region lies close to the equator. For that, continuous sunlight shines on the Indonesian region except when it is muddy and rainy. This enormous sunlight potential is possible to utilise photovoltaic cell (PV) technology in Indonesia. This PV can convert the solar radiation coming to the cell surface into direct current electricity. The utilisation of this PV also supports energy conservation programs. Energy conversion consists of improving energy efficiency, reducing the role of fossil fuels, and adding energy supplies that are sourced from an environmentally friendly push. PV technology is an alternative energy source technology that becomes an option for tropical regions because solar energy sources have an abundant reserve of renewable and environmentally friendly energy.

The growth of the PV industry that provides solar cells is very speedy. Use of technology to convert solar radiation directly into electricity by using a silicon p-n connection. This technology is utilising the radiant energy from sunlight to be used without first being converted into heat will result in high theoretical efficiency [1]. Some of the factors that cause PV efficiency are changes in cell temperature, maximum power point tracking, and energy conservation efficiency. There has also been simulated [2] that the PV panel output power decreases with increasing panel temperature followed by reduced ability. Meanwhile, based on the expenditure is known to reduce the output power due to weather



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conditions and ambient temperatures. The results also show the presence of solar radiation that comes to the surface of solar panels against ambient temperatures and solar panel temperature.

Although PV technology is experiencing hardships in its development, PV material technology has overgrown today. The donor-acceptor-based organic solar cells have been created [3] with a power conversion efficiency of more than 3.5%. With nanotechnology, the resulting material can achieve 10% efficiency. This type of solar cell is very flexible compared to other types, so it is a native user application. Currently, the exciting thing is the growth of the PV market is increasing every year [4]. One of the vast extensions of this PV market is due to the decreasing cost to produce PV itself, and the efficiency of PV is also growing from year to year. According to [5] that it has initiated the development of Metal-Wrap-Through (MWT) solar cell technology on n-type mono crystalline silicon wafers with an efficiency increase. Researchers [6] have investigated the factors that may affect the efficiency of solar cells. One of the most important is the effect of temperature, where, when low temperatures will produce a high voltage or vice versa. Maximum Power Point Tracking (MPPT) method is also studied. Furthermore, the study of bifacial n-type solar cells with a 20.6% efficiency is produced by improving the process and their electrical properties[7].

The focus of this research is on PV panel technology, primarily related to overcoming the effect of PV panel surface temperature on the output of electric current rise. The PV panel is modified by installing a cooling material on the back of the panel in the form of a hollow aluminium plate. The perforated plate technology itself has been quite well known as one of the techniques used for space heating of the building's air. The use of perforated plates and solar energy has been used to reduce the HVAC system coolant load. The two main advantages of using perforated plates are air sucked directly through the holes so that the surface of the plate is relatively lower temperature and heat loss becomes small and simple in manufacture due to not wearing transparent glass [8] and[9]. Also, the perforated plate is also used in the drying process of agricultural products [10]. At certain times the intensity of solar radiation coming to the surface is quite large, above 600 Watt / m² and can be used to reduce the water content of gaharu leaves for two days on average by 10% depending on the intensity of solar radiation.

2. Material and Method

The study was conducted on a small-scale PV panel of the laboratory. The research methodology is an experiment with creating a PV panel system that can drain current and DC voltage. The specifications of PV panels and cooling media used are each described in table 1 and table 2.

Table 1. Specification of Panel PV

Electric Rating	Specification
Cell Type (2 units)	Polycrystalline (185 x 380 mm)
Peak Power	8 Wp
Max. Power Voltage	5.5 V
Max. Power current	1.45 A
Maximum System Voltage	600 Volt DC

Table 2. Dimensions of Aluminium Cooling

Name of parts	Specification
Dimension	50.30 x 21 x 0,2 mm
Hole diameter	0.25 mm
Distance between holes	20 mm
Number of holes	190 units
Arrangement of holes	inline

2.1. Panel PV System

PV panel system consists of 2 units, and both are placed parallel with a slope of 15 degrees. One of the PV panels mounted cooling medium on the back. The cooling material is a perforated aluminium plate. Scheme of test equipment is shown in figure 1. The measuring equipment used consists of k type thermocouple wire to measure temperature, pyranometer to measure the intensity of solar radiation received by PV panel surface, clamp meter to measure current and DC voltage, and the anemometer to measure wind speed.

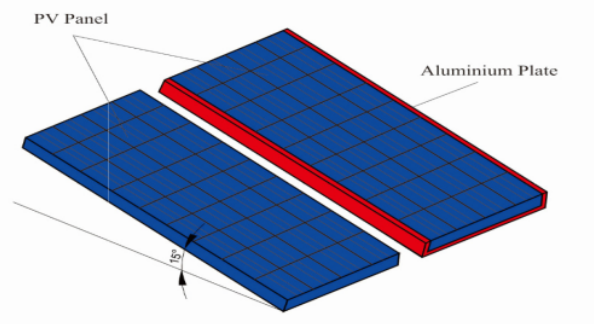


Figure 1. Schematic testing of PV Panel System

2.2. PV Panel Cooling System

The PV panel of a cooling system has been designed at the back side using perforated aluminium plates. This cooling system design scheme is shown in Figure 2. The cooling system specification can be seen in table 2.

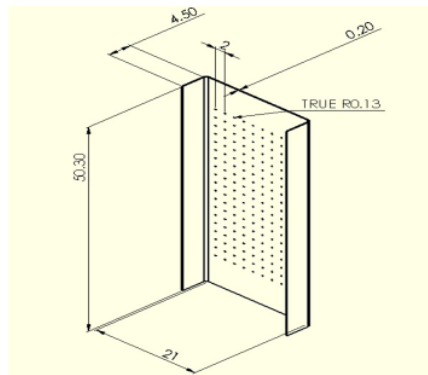
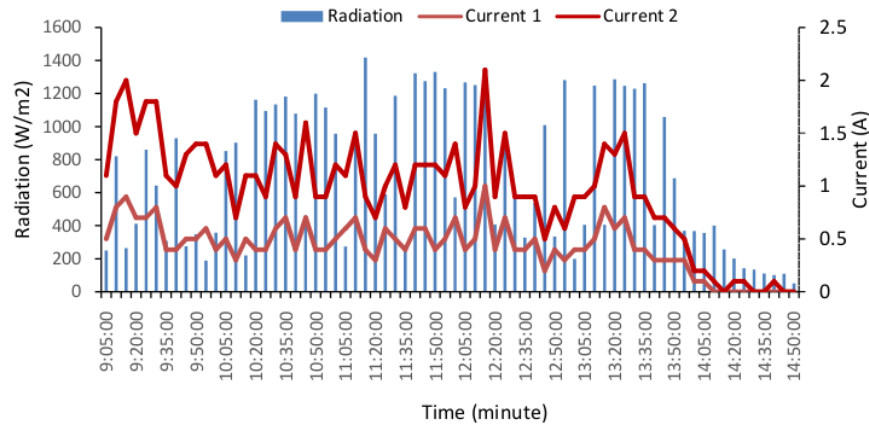


Figure 2. Cooling system PV panel with perforated aluminium plate

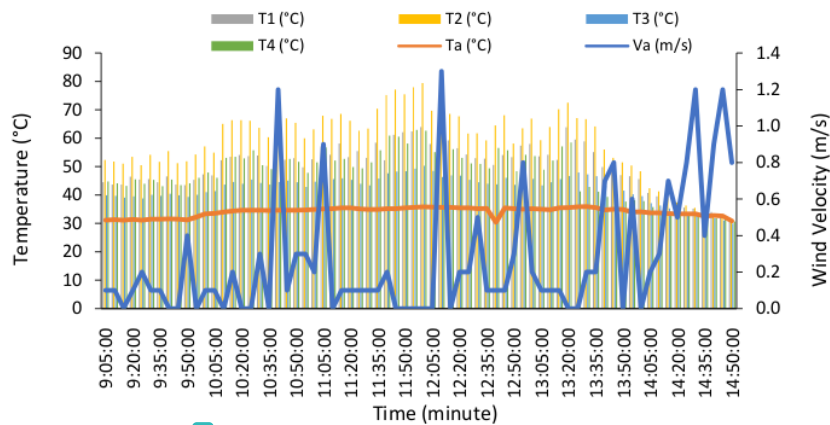
3. Results and Discussion

The characteristics of the test results data in Figure 3 show the solar radiation of Watt per square meter coming to the surface of the PV panel is quite high. The average solar radiation at the time of collection April 26, 2018, is 711 W/m^2 . Average wind speed (V_a) is 0.27 m/s . Average atmospheric air temperature (T_a) is $34.07 \text{ }^\circ\text{C}$. The refrigerated-installed PV panel has an average current rating (A) higher than with no coolant. The average electric current with refrigeration (current 2) is 0.52 A , and the current electric current without cooling (current 1) is 0.43 A . There is an average electric current rise of 120% when using cooling.

Similarly, the average surface temperature of panel PV (T_1) is $50.23 \text{ }^\circ\text{C}$, the surface temperature of the rear of the average PV panel (T_2) using a coolant is $58.72 \text{ }^\circ\text{C}$, the average aluminum surface temperature (T_3) is $42.49 \text{ }^\circ\text{C}$, and the average surface temperature of the rear PV panel (T_4) without cooling was $47.57 \text{ }^\circ\text{C}$ (Figure 5).



⁴ **Figure 3.** The solar irradiance intensity through the experimental day.



⁴ **Figure 4.** The effect of solar irradiance on ambient and PV panel temperature

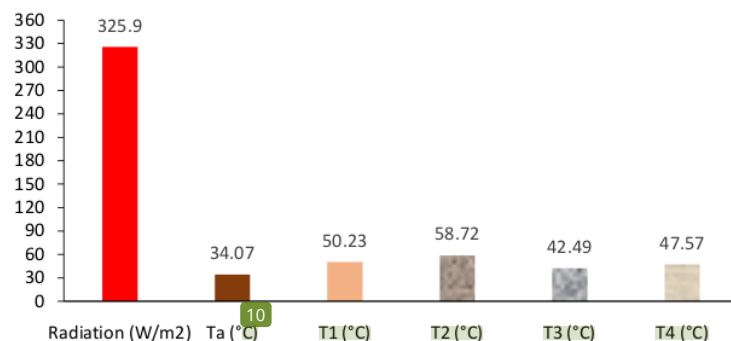


Figure 5. The effect of the average value of solar radiation on the average value of ambient temperature and PV panel

4. Conclusions

This experimental research has resulted in an increase of electric current by 120% by adding a cooling system made of aluminium which is given holes. The effect of radiation received by the collector surface will increase the surface temperature of PV panels and aluminium plates. Through this preliminary study, it is possible to be able to cope with the decreased efficiency of PV panels when solar radiation reaches the highest value. Also, more accurate measuring tools are required to produce better data.

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