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Reflector and passive cooler for optimization of solar panel output

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Abstract. The objectives of this study were (1) To determine the effect of using passive reflectors and coolers on the output power produced by solar panels. The research method used was an experimental method with a true experimental design model, namely in this design there were 2 systems, the first system was treated, the second system was not given treatment. The variations in treatment in this study are as follows; (1) Solar panels without using passive cooling reflectors and (2) Solar panels using reflectors and passive cooling. Data were collected for 4 days from (08.00-14.00) with a sample of 50 Wp solar modules. The data collection technique used was literature study, performance and testing documentation. The results showed that the results of the solar panel testing power with 2 variations of treatment, namely, (1) The solar panel without using a reflector and passive cooling produces an average power of 47.68 Watts and (2) Solar panels using a reflector and passive cooler are 59.63 Watts. The results of this study indicate that solar panels using reflectors and coolers increase the power by 25.07% of solar panels without using reflectors and passive cooling.

1. Introduction

One of the most promising is solar power sources of renewable energy today. Solar cells, likewise, it can be used as a photovoltaic (PV) cell [1], [2]. When, randomly, photons in sunlight free electrons are affected by the surface of solar cells, generated, which flows to generate power. Solar cells are also placed on a flat plate, systems which can be built on rooftops or put on other sunny spots, A solar cell is made up of multiple layers of varying fabrics [3]. A glass cover is the top layer of the or other encapsulating substance intended to safeguard a cell under weather conditions [4]. This electron flow is the current, and the current can be drawn off to be drawn off by placing metal contacts on the top and bottom of the solar cell [5], [6]. Externally used. this current determines the electricity (or power) along with the voltage of the cell (which is a function of the strength of its built-in electric field). that can be generated by the solar cell. The output of solar cells varies and is defined by the mate [7], [8]. The main problem of photovoltaic is that the amount of output power generated is relatively not constant because it is influenced by the intensity of the sun and the temperature of the surrounding environment. The power generated from photovoltaic is determined by the amount of solar intensity received by the solar panels [9]. The greater the solar intensity received by the panel, the greater the power that can be generated by the photovoltaic. The alternative to increase the output power of the sun is to increase the intensity of light received by the panel by using a reflector in the form of a flat mirror [10]. The reflected light beam is parallel, this makes it easier to evenly beam sunlight onto, so that the light intensity received by the panel can be increased. However, this causes an increase in photovoltaic temperatures, which results in a decrease in the resulting power output, this decrease is caused by the efficiency of the solar panels which decreases by about 0.5% for every 1°C increase in surface temperature [11]. The factor for the decrease in the value of the output power is voltage, because the semiconductor components are sensitive to temperature changes so that it has a lot of influence on changes in voltage rather than current.

2. Methods

This research is using experimental method [12]. Experimental research is to examine the impact of a treatment on the results of the study, which is controlled by other factors that might influence these results. In principle, this study aims to find the effect of certain treatments on others under controlled conditions.

The research variables used are the independent variable is a variable that may cause, influence, or influence the research results. This variable is also known as the treatment, manipulated, antecedent or predictor variable. The independent variables used are reflectors and passive cooler. The dependent variable is a variable that depends on the independent variable. The dependent variable is the result of the independent variable. Another term for the dependent variable is the criterion, outcome, effect, and response variables. The dependent variable used is the output power of the solar panels. The control variable are variables that have the potential to affect the dependent variable. The control variable used in this study was the research time at 08.00-14.00 WIB.

Analysis of the data in this study using a graph of sunlight intensity (irradiation), temperature and power. The graph is used to compare the test results of solar panels without reflectors and passive cooler with solar panels using reflectors and passive cooler, this is done to see the effect of each variable in increasing solar panel power.

3. Result and Discussion

The effect of using reflectors and passive cooler to optimize the output power of solar panels is done to determine the effect of changing the value of the output power generated by solar panels, with 2 variations of treatment; 1. Solar modules with reflectors and passive cooler, and 2. Solar modules without reflectors and passive cooler.

3.1. Framework modeling

The frame for the solar module is made using 10×10 mm hollow iron with a thickness of 1 mm with a length of 1000 mm and a width of 540 mm, while the reflector supports use 20×20 mm angle iron with a thickness of 1 mm with a length of 670 mm and a width of 540 mm.

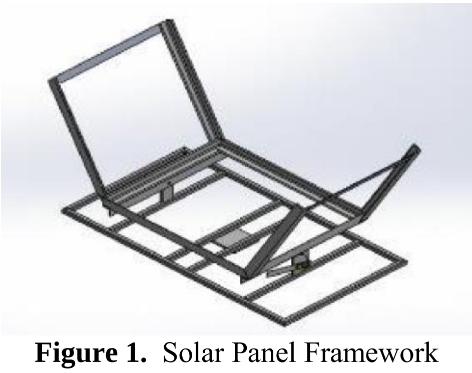

Figure 1. Solar Panel Framework

3.2. Reflector modeling

Reflector modeling is carried out using flat mirrors on both sides of the solar module, flat mirrors are designed with a slope of 70° [13], this is adjusted to the results of previous studies that the highest output power value when testing using a reflector is at an angle of 70° from the outside of the panel, and also in research, which states that the greatest power value is obtained in a solar module with an angle of 70°. This reflector modeling uses a mirror support frame from both sides to avoid changing the position of the mirror.

Figure 2. Solar Panel Framework and Reflectors

3.3. Passive cooler modeling

Please ensure that affiliations are as full and complete as possible and include the country. The Passive cooler modeling is carried out by utilizing liquid in the form of water filled in an aluminium box and utilizing air media through a heat sink, to help heat transfer.

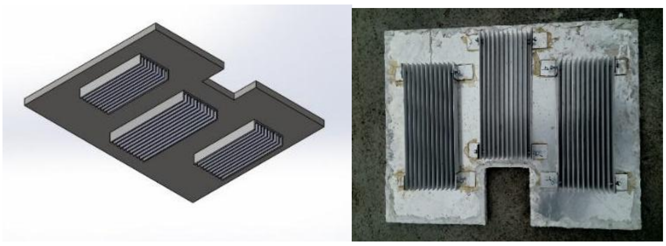

Figure 3. Passive Cooler Box and Heat Sink

Figure 4. Position of Cooler Box and Heat Sink

Determination of the azimuth angle, latitude, longitude, and tilt angle of the solar module is carried out in order to obtain the maximum output power value from the solar module with the appropriate placement of the solar module, in this case the researcher uses the global solar atlas software to determine the direction of the solar module, the optimal angle of inclination. solar modules that adjust to the location of the test, namely the latitude and longitude. In the picture below, it shows the coordinates of the solar module test location at −6°07'49″ south latitude and 106°09'53″ east longitude, so that the optimal value of the solar module's slope is 9° to the north.

To see the increase in the power produced, several measurements were made:

a. Sunlight intensity (irradiation)

To find out the comparison value of light intensity received when testing solar panels using reflectors and passive cooler with solar panels without reflectors and passive cooler [14].

b. Temperature
The value of the temperature on the surface of the solar panel has an impact on the power output generated by the solar panel. An increase in temperature can result in a decrease in power, which is caused by the efficiency of the solar panel decreasing by about 0.5% for every 1 ° C increase in surface temperature [11].

c. Power Output
Power measurements are carried out to determine the ratio of the power produced by solar panels using reflectors and passive cooler with solar panels without reflectors and passive cooler [15].

Comparison of the light intensity of solar panels without reflectors and passive cooler with solar panels using reflectors and passive cooler. In testing solar panels without reflectors and passive cooler with solar panels using reflectors and passive cooler, measurements of sunlight intensity were carried out to determine the large value of changes in the intensity of solar light using a reflector.

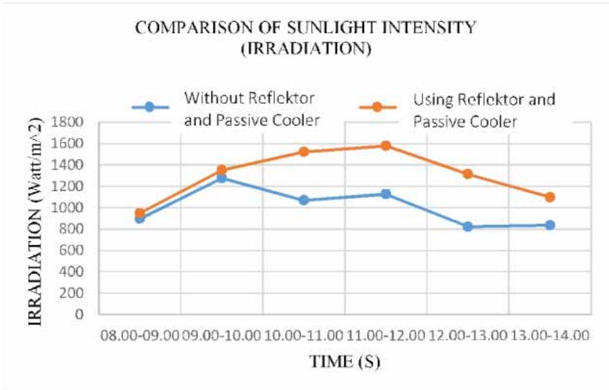

Figure 5. Comparison of the light intensity of solar panels without using reflectors and passive cooler with solar panels using reflectors and passive cooler

Based on the graph above, the value of sunlight intensity increases every hour but the increase in sunlight intensity is very low at 08.00-09.00 on a solar panel that uses a reflector. This is because the angle of incidence of the sun in the morning is not reflected maximally by the reflector, which is only on one side of the reflector, thereby reducing the amount of reflected intensity. The average intensity results of solar panels using reflectors and passive cooler with solar panels without reflectors and passive cooler are as follows.

Table 1. Comparison of the light intensity of solar panels without using reflectors and passive cooler with solar panels using reflectors and passive cooler

The average light intensity on a solar panel uses a reflector and passive cooler	Average light intensity on solar panels without reflectors and passive cooler	Percentage
1302,18 watt/m^2	1004,35 watt/m^2	29,65%

Comparison of the light intensity of solar panels using reflectors and passive cooler with solar panels without reflectors and passive cooler can be seen that the increase in light intensity on solar panels using a reflector is 29.65% compared to solar panels without reflectors. Comparison of temperature of solar panels without reflectors and passive cooler with solar panels using reflectors and passive cooler. In testing solar panels using reflectors and passive cooler, it is expected that an increase in the intensity of sunlight is expected, but there is no decrease in the value of the voltage generated on the solar panel, as for the comparison chart of the temperature of solar panels using reflectors and passive cooler systems with solar panels without reflectors and passive cooler is as following.

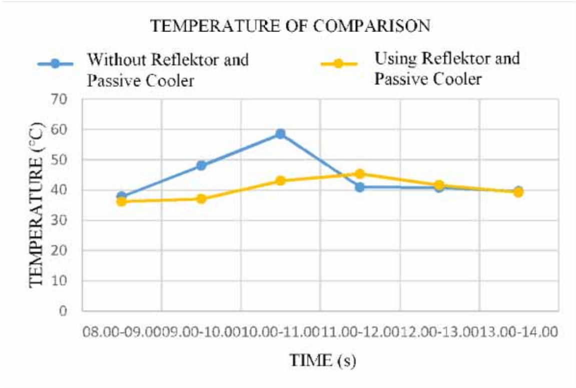

Figure 6. Comparison of temperature solar panels without using reflectors and passive cooler with solar panels using reflectors and passive cooler

Based on the graph above, it can be seen that the temperature increase in solar panels without using reflectors and coolers is higher than solar panels using reflectors and coolers, which is shown at the highest temperature value in the graph occurring at 10.00-11.00 WIB, reaching 58.5°C while the temperature The highest solar panel with a reflector and passive cooler system at the same hour is 45.3°C, this test is conducted to determine the percentage of temperature increase in the solar panel with the difference between the difference in temperature value on the surface of the solar panel with the ambient temperature when testing solar panels using a reflector and cooling with solar panels without reflectors and passive cooler. The comparison of the value difference between the temperature difference between the solar panel and the environment is as follows.

Table 2. Comparison of temperature solar panels without using reflectors and passive cooler with solar panels using reflectors and passive cooler

The difference in the average temperature value between solar panels that use reflectors and passive cooler with the ambient temperature	The difference between the average temperature value between solar panels without reflectors and passive cooler with the ambient temperature	Percentage of temperature drop
9,82°C	12,62 °C	22,19%

The comparison result of the average value difference between the temperature difference of the solar panels in the table above shows the average value of temperature increase in solar panels using reflectors and passive cooler is only 9.82°C while solar panels without reflectors and coolers have an average temperature increase. amounting to 12.62°C, so the percentage of temperature reduction in solar panels using a reflector and passive cooler is 22.19%, this data shows that the addition of a cooler in a solar panel equipped with a reflector is quite effective in reducing the surface temperature of the solar panel.

Comparison of the power of solar panels without reflectors and passive cooler systems with solar panels using reflectors and passive cooler systems. The test results of solar panels using reflectors and passive cooler show an increase in the power generated by solar panels, this happens because solar panels that use reflectors and passive cooler experience an increase in light intensity and a decrease in temperature on the solar panel.

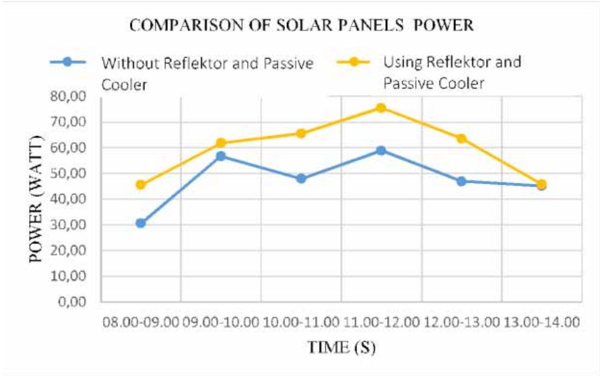

Figure 7. Comparison of solar panels power without using reflectors and passive cooler with solar panels using reflectors and passive cooler

Based on the graph above, it can be concluded that the power generated by solar panels using reflectors and passive cooler increases at 10.00-13.00 WIB, this is due to an increase in the intensity of sunlight from the reflection of mirrors on both sides of the solar panel and the passive cooler system affects the increase in the voltage generated by the panel. Sun. Testing of solar panels using reflectors and passive cooler shows the highest power gain at 11.00-12.00 at 75.54 Watts. The comparison of the resulting average power values is in the table below.

Table 3. Comparison of solar panels power without using reflectors and passive cooler with solar panels using reflectors and passive cooler

The average solar panel power uses a reflector and passive cooler	Average power of solar panels without reflectors and passive cooler	Percentage
59,63	47,68	25,7%

The comparison of the power in the table above shows the average value of solar panels using reflectors and passive cooler is higher, which is 59.63 Watts compared to solar panels without reflectors and passive cooler, only 47.68 Watts, the percentage increase in solar panel power using a reflector is equal to 25.07%.

4. Conclusion

Optimization of the output power of solar panels using reflectors and passive cooling influences the temperature which has decreased by 22.19%, able to increase the power by 25.07% with the highest power of 75.54 watts. Based on these results, to optimize the output power of solar panels, a combination of reflectors and coolers can be used when compared to using only reflectors or only using coolers.

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