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Comparative Analysis of Solar Panel Tilt and Lighting in Design Solar Test Simulator

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ABSTRACT

Designing the Solar Panel Test Simulator by means of setting up the solar panel placement holder so that the designed tool is able to provide a simulation of solar panel measurements based on actual conditions. The performance of the solar panels is shown through a monitor display placed on the design which will contain information about the solar panels as a whole. Limitations in placing the position of the solar panels will not provide a reference regarding the measurement conditions based on the angle of incidence of the sun, so further planning needs to be done regarding the position of the solar panels when the measurements are taken. The development carried out in the design of this tool is in the form of setting the solar panel mount in the form of a tilt of the solar panel mount of 00, 900, 1800, and a halogen lamp distance of 30 cm as the energy source for measurements. Measurement results based on design, temperature 46 0C and light 100%

Keywords : Solar Panels, Solar Test Simulator, sun angle, inclination, design

1. INTRODUCTION

The present invention concerns the Solar Panel Test Simulator Ramp Solar Design. The design of the Solar Test Simulator for Solar Panels is done by adjusting the mount for placing the solar panels, so that the designed tool is able to provide a simulation of solar panel measurements based on actual conditions. Design of the Solar Test Simulator by providing light variation values through setting the voltage and distance of the lights according to the conditions during the measurement. The performance of the solar panel is shown through the monitor display and contains information about the solar panel as a whole.

The application of solar panel testing equipment with several methods using various currently available light sources such as incandescent, LED and halogen lamps is carried out using equipment called a solar test simulator (Reichmuth et al., 2020). Tests are carried out to obtain solar panel performance that meets installation requirements according to power capacity requirements (Frolova et al., 2019). The characteristics of sunlight in Indonesia, which is at the equator, make it possible to carry out a simulation process using halogen lamp light (Tanesab et al., 2019). Test data recording is often carried out through variations in lighting through conditioning the voltage supply to the lamp. The design of solar panel testing equipment based on specified conditions is expected to be able to show the process of variations in the output of solar panels on the market

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2. LITERATURE REVIEW

2.1 Equivalent circuit of a solar cell

The way the solar module itself works is actually identical to a semiconductor diode device. When light comes into contact with the solar module and is absorbed by the semiconductor material, electrons are released which causes the flow of electric charge.To approximate the performance of the solar module, a mathematical model was developed to describe the solar module. The form of the solar cell equation circuit, where the current (I) and voltage (V), the solar module (IL/cell's photocurrent), then the series resistance (Rs) and shunt resistance (Rsh) can be seen in the following picture:

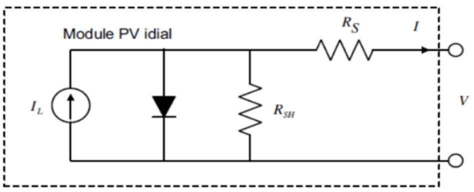

Figure 2. Solar module equivalent circuit

The mathematical equation of the above circuit can be written as follows:

$$I = I_L - I_o\left[exp.\left(\frac{(V+IR_S)}{nKT/q}\right) - 1\right] - \frac{(V+IR_S)}{R_{SH}} \quad (1)$$

Where:
I =solar cell equivalent circuit current (Ampere)
Io =reverse saturation current (Ampere)
n= diode ideal factor

q =factorelectron filling (1,602·10-19 C)
k =Boltzman constant (1.3806.10-23 JK-1)
T =solar cell temperature (oK)

2.2 Influence of Environmental Factors on Solar Module Output

a. Temperature

Temperature affects cell performance and photovoltaic efficiency. If the solar module is in cold conditions, it will produce more power. In general, when the irradiance on the cell is 1kW/m2 the cell temperature is approximately 300C higher than the surrounding air. The characteristics of temperature changes in solar cells are shown in the image below:

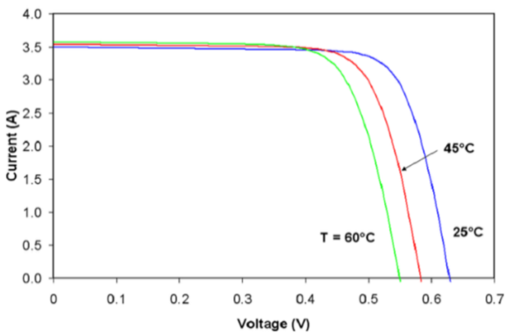

Figure 3. characteristics at different solar module surface temperatures.

b. Light intensity

The effect on the amount of sunlight energy obtained by the solar module (photovoltaic) is reduced or the intensity of the light weakens, so the voltage and electric current produced will also decrease. The decrease in voltage is relatively smaller than the decrease in electric current. The image below shows changes in the current and voltage of a solar module (photovoltaic) based on the varying values of the intensity of sunlight obtained.

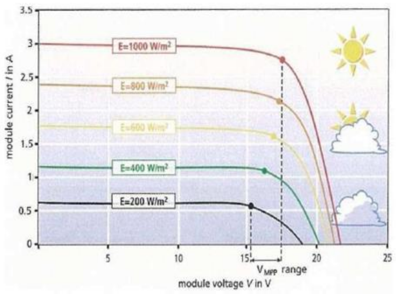

Figure 4. Curve Against Constant Irradiance and Temperature

c. Directional Movement of the Sun

Several ways to get more solar radiation are by adjusting the position of the solar module. The position of the solar module can be adjusted to follow the movement of the sun by determining the position of the tilt angle, declination angle, longitude, zenith angle, angle of incidence of the sun, surface azimuth angle, and the angle of the sundial relative to the movement of the sun. The second way is to use a reflecting mirror. The following illustrates several important angles of solar energy.

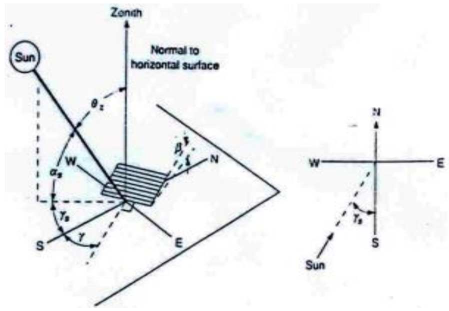

Figure 5. Important angles of solar energy

METHOD

There are 2 solar panels used which are connected in series to show whether the performance results match the capacity of the panels. The 20 WP solar panel used with the specifications is in the following image.

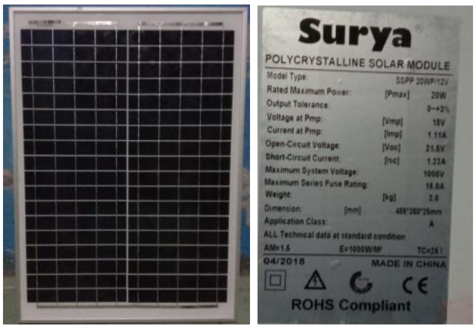

Figure 6. Solar panel specifications

The development carried out in the design of this tool is in the form of setting the solar panel mount in the form of the tilt of the solar panel mount and the distance of the halogen lamp as an energy source which is measured manually using a solar meter, thermometer and multi meter as shown in the following figure.

Figure 7. Solar Test Simulator solar panels

RESULTS AND DISCUSSION

The measurement results show results that are in accordance with the solar panel datasheet. The test used two solar panels connected in series with the following results:

Table 1. Solar Test Simulator solar panels

Slope		angle 0o			90o angle			180o angle		
No.	Reff Light (W/m2)	Light (W/m2)	Temperature (oC)	Voltage (V)	Light (W/m2)	Temperature (oC)	Voltage (V)	Light (W/m2)	Temperature (oC)	Voltage (V)
1.	5	100	46	23.9	100	46	19.85	100	46	19.4
2.	10	100	46	23.9	100	46	19.85	100	46	19.4
3.	20	100	46	23.9	100	46	19.85	100	46	19.4
4.	30	100	46	23.9	100	46	19.85	100	46	19.4
5.	40	100	46	23.9	100	46	19.85	100	46	19.4
6.	50	100	46	23.9	100	46	19.85	100	46	19.4
7.	60	100	46	23.9	100	46	19.85	100	46	19.4
8.	70	100	46	23.9	100	46	19.85	100	46	19.4
9.	80	100	46	23.9	100	46	19.85	100	46	19.4
10.	90	100	46	23.9	100	46	19.85	100	46	19.4
11.	100	100	46	23.9	100	46	19.85	100	46	19.4
12.	110	100	46	23.9	100	46	19.85	100	46	19.4
13.	120	100	46	23.9	100	46	19.85	100	46	19.4

The table above explains the parameters seen through the tilt of the solar panel at 5 W/m2 light at an angle of 0o where the light is at 100 W/m2, temperature 46**ºC**, and Voltage 23.9 V, at corner90owhere the light is at 100 W/m2, the temperature is 46**ºC,**and voltage19.85 V and on180o anglethe light is on100W/m2, temperature46 oC, and Voltage19.4V. We can conclude that the solar panel is tilted at an angle0o, 90o angle, 180o angle, light, temperature and voltage will experience changes.

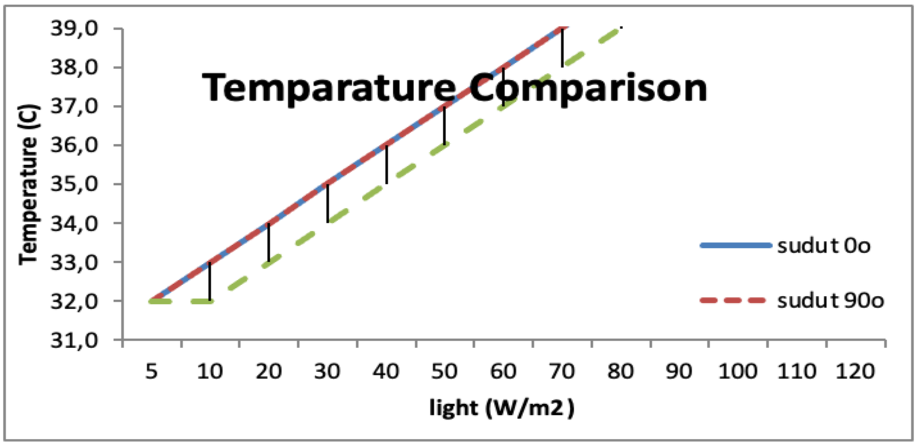

Figure 8. Solar Test Simulator solar panels

From the picture above, the temperature comparison that occurs in the Solar Panel Test Simulator is at an angle0o, 90o angle, 180o angle where light and temperature are at the lowest slope of 0.20, the highest slope is at 2.75 with an average slope of 0.79. It can be seen that the angle of inclination of the light will affect the high and low temperatures produced.

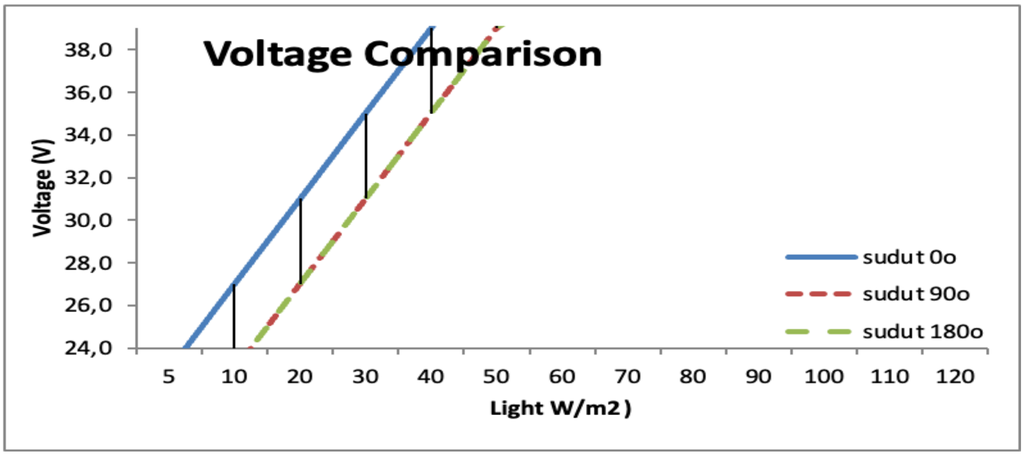

Figure 9. Test Simulator solar panels

From figure 9 Solar Test Simulator solar panels can be concluded that the voltagecorner0o, 90o angle, 180o angle produce the lowest voltage of 19.04, the highest voltage of 23.09 and the average voltage produced by light from different angles is 4.05. If the light we use is greater, the voltage produced will also be higher.

CONCLUSION

The results of the development of data collection were carried out with several considerations that had been designed. Tests using two solar panel plates connected in series show results that are in accordance with the energy capacity generated by the solar panels based on the datasheet. The development carried out in the design of this tool is in the form of setting the solar panel mount in the form of a tilt of the solar panel mount of 00, 900, 1800, and a halogen lamp distance of 30 cm as the energy source for measurements. Measurement results based on design mean temperature difference of 0.79% with voltage of 46%.

Declaration by Authors
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