Performance Evaluation of Perforated Aluminum Plate on Polycrystalline 100 Wp PV Module with Computer Recorder

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Abstract: Computer Recorder uses Arduino Board technology to measure temperature, humidity, voltage, and current which are the four parameters of PV output power as performance evaluated with and without cooling media in the form of Perforated Aluminum Plate. Since the voltage provided by the PV module is too high to be used as a receiver for the Arduino, a voltage divider was used to determine the voltage. The DHT22 was used to measure humidity. Finally, the ACS712 module was used to calculate the current, which can detect the current generated by the PV module. Manual measurement is considered inefficient. Therefore we need a real-time data recording device called Datalogger based on Arduino. The Datalogger has a voltage tolerance percentage of 0.025%, a temperature tolerance percentage of 0.08%, and a humidity tolerance percentage of 0.025%. Datalogger is capable of recording a maximum of 5 PV modules simultaneously. Dataloggers are capable of measuring current, voltage, temperature, and humidity. The use of a perforated aluminum plate as a cooling medium can increase the output power of PV modules. It can be seen from the research data, at 11:45 am the average PV output power of P1, P2, P3, P4 are 46.84 W, 52.96 W, 59.29 W, 65.20 W. P4 showed the highest increase the output power of 39.19%.

Keywords: Datalogger, Efficiency, Polycrystalline

1. Introduction

Solar cells or photovoltaic cells (PV) are devices that convert solar energy into DC electrical energy through the photovoltaic effect, the electrical energy produced is influenced by the temperature and intensity of sunlight (Abdulla et al., 2016). The increase in temperature due to excessive intensity exceeding the maximum limit will cause PV performance (Hasan et al., 2015), PV output power, and efficiency to decrease, which is a serious problem.

The cooling technique (Hussien et al., 2015)(Dwivedi et al., 2020) is needed to anticipate the temperature rise that is too high one way is by using a perforated aluminum plate (A. Sofijan et al., 2020) which is a passive cooling technique. Lin J Simpson et al in this research have discussed the effect of passive cooling on the efficiency of PV modules. Illustration demonstrating the use of a dryer to absorb water from air with higher humidity at night when the PV module is cold, and passive evaporation during the day when relative lower humidity (RH) and higher PV module temperature. Initial experiments with this new passive cooling have shown that the operating temperature of PV modules may be reduced by almost 30°C by evaporative cooling (Grubišić-Čabo et al., 2016).

In previous studies, there were still shortcomings such as the use of a multimeter in measuring voltage and current. This makes the data taken can not to be recorded periodically. The multimeter has a weakness in measuring the output of this PV module is the inability of real-time data. The data that can be taken is only in the form of voltage and current data. Muhammad Anser Bashir et al. researched Comparison of Performance Measurements of Photovoltaic Modules during Winter Months in Taxila, Pakistan. They use 3 PV modules and use a multimeter to measure parameters. Automatically there must be 3 multimeters used and 3 people measuring simultaneously. This is considered ineffective and efficient, and a human error may occur (Al-Amin & Murphy, 2017).

Researchers want to analyze the effect of perforated aluminum plates on PV module, measuring instrument in the form of a datalogger or real-time data logger based on Arduino in Energy Measurement of Solar Through Cloud Source Using Arduino which utilizes current, voltage, and humidity sensors to determine its effect on output PV module.

2.Circuit Simulation

The diagram is divided into blocks. as well as the entire series of simulations for this project, created with Proteus 8 Professional. The parameter is the monitor on the LCD panel. This simulation circuit includes the following components. The PV modules generate about 18 volts of electricity. The circuit contains the ACS712 current sensor which detects current, voltage sensor to detect voltage, DS18B20 temperature sensor then detects temperature changes. DHT22 humidity sensor to detect humidity. The Arduino Uno is used as the main controller in this project and requires electricity. This controller requires a 5V power supply.

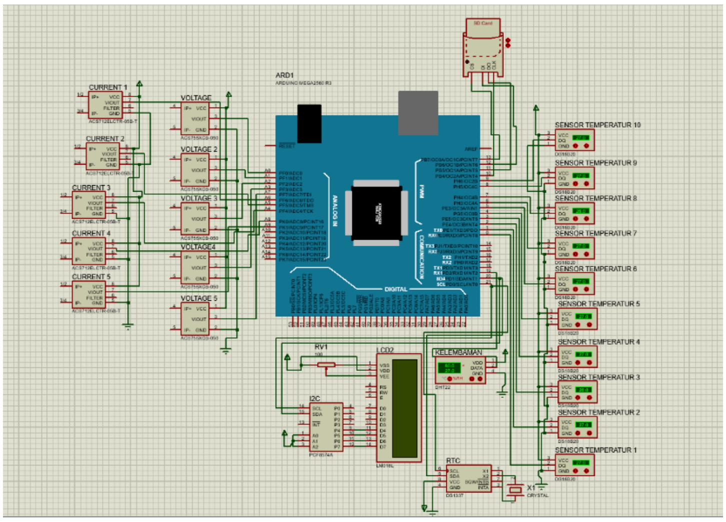

Fig. 1. Circuit Simulation

3. Block Diagram

Solar radiation is absorbed by PV modules, then it will be directly recorded by an Arduino called Datalogger. The strategy is to use Arduino to build a solar energy optimization. Current, voltage, and temperature are all determined using Sensors. Dataloggers are very efficient and effective because they do not require direct human supervision. Datalogger can be used for more than one panel. The number of sensors will follow the number of panels used.

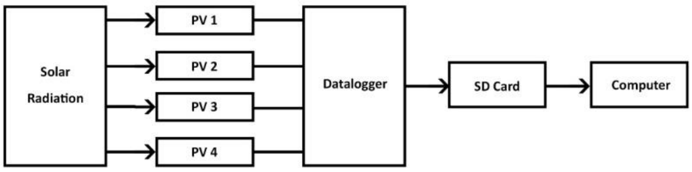

Fig. 2. Block Diagram

Figure 2. Block diagram describes experimental research procedures on the effect of a perforated aluminum plate on 4 PV modules using a computer recorder. There are 4 PV modules used with classification, PV1 as a PV module without a perforated aluminum plate, PV2, PV3, P4 using a perforated aluminum plate with a hole diameter of 10 mm, 12.5 mm, and 15 mm. Furthermore, PV output parameters will be recorded by the datalogger. The data will be stored on the SD Card, which finally the data can be viewed on the computer.

4.Analysis and Result

Analysis after the research procedures, datalogger testing, measurement result data, and calculations have been carried out correctly, the desired data variables will be obtained, namely the characteristic value of open-circuit voltage (V_{OC}), short circuit current (I_{SC}), PV module surface temperature (°C), humidity (%), and solar radiation(W/m^2).

4.1. Datalogger Testing

The datalogger is made with an Arduino microcontroller base to get the PV output power and temperature values of the PV modules. The sensors used by the Datalogger are voltage sensors, current sensors, and temperature sensors. voltage sensor and current sensor are done using a power supply.

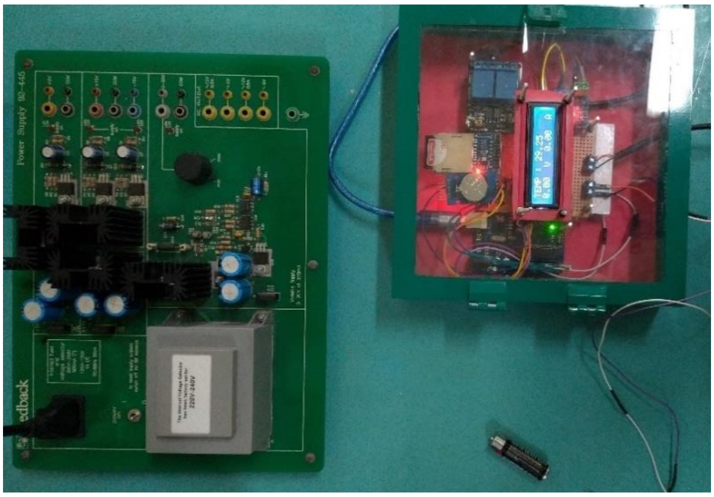

Fig. 3. Sensor Test on Datalogger

Tolerance generated on the sensor used:

a. Voltage sensor : 0,025%
b. Temperature sensor : 0,0081%
c. Humidity sensor : 0,025%

4.2. Result of Solar Radiation versus PV output power

It can be seen from the graph in Fig. 4 when the highest solar radiation is 1030 W/m^2, the resulting PV output power on P1. P2, P3, P4 are 47.52, 52.97, 58.89, 65.52 Watt, P4 shows the largest power output. An increase in output power is shown from the results of measurements of V_{OC} and I_{SC} by a datalogger.

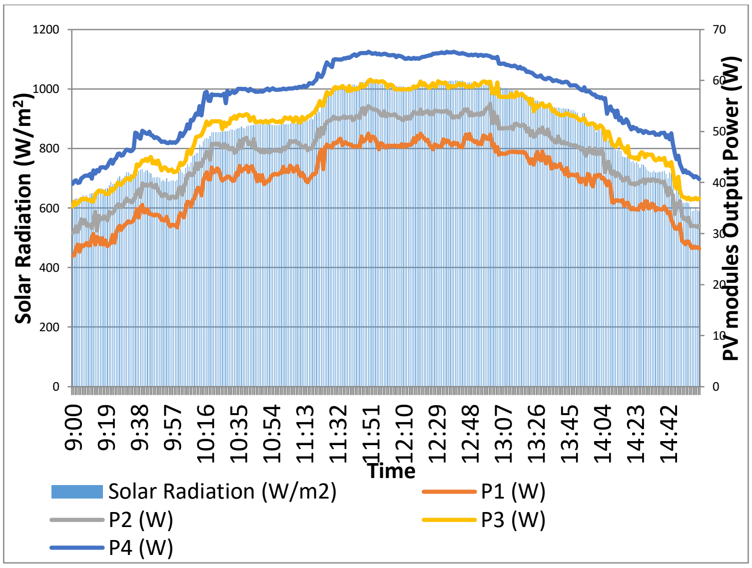

Fig. 4. Result of Solar Radiation Versus PV modules output power

4.3. Result of solar radiation Versus Temperature

It can be seen from the graph in Fig.5, when the highest solar radiation is 1030 W/m^2, the resulting temperature on PV1 without perforated aluminum plate (T1) is 59 ℃, on PV2 using a perforated aluminum plate with a hole diameter of 10 mm (T2) is 54.1 ℃, on PV3 using a perforated aluminum plate with a hole diameter of 12.5 mm (T3) is 49 ℃, on PV4 using a perforated aluminum plate with a hole diameter of 15 mm (T4) is 43 ℃.

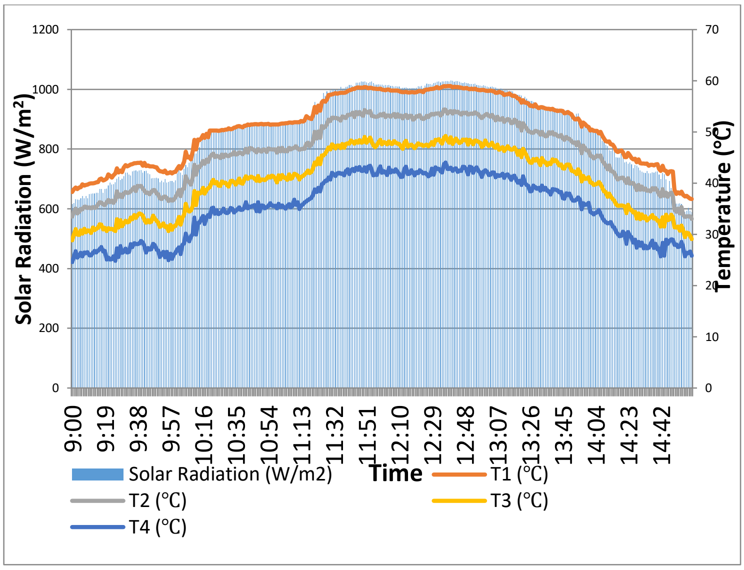

Fig. 5. Result of Solar Radiation Versus Temperature

4.4. Result of Humidity Versus Temperature

It can be seen from the graph in Fig.6 when the lowest humidity is 12%, the resulting temperature on PV1 without perforated aluminum plate(T1) is 50.3 ℃, on PV2 using a perforated aluminum plate with a hole diameter of 10 mm (T2) is 45.3 ℃, on PV3 using a perforated aluminum plate with a hole diameter of 12.5 mm (T3) is 40.2 ℃, on PV4 using a perforated aluminum plate with a hole diameter of 15 mm (T4) is 34.7 ℃. Meanwhile, when the highest humidity is 45%, the resulting temperature on PV1 without perforated aluminum plate (T1) is 51.5 ℃, on PV2 using a perforated aluminum plate with a hole diameter of 10 mm (T2) is 46 ℃, on PV3 using a perforated aluminum plate with a hole diameter of 12.5 mm (T3) is 40.8 ℃, on PV4 using a perforated aluminum plate with a hole diameter of 15 mm (T4) is 35.1 ℃.

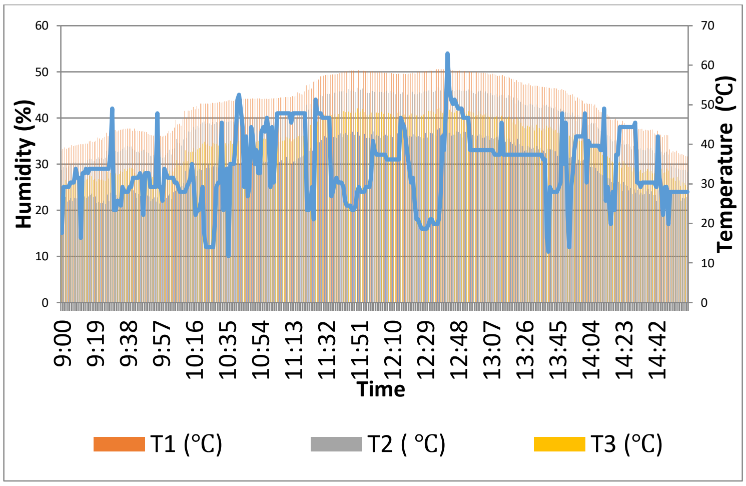

Fig. 6. Result of Humidity Versus Temperature

9.Conclusion

Based on the results of the research that has been done, the following conclusions can be drawn: Datalogger device measuring voltage and current can work with a measuring range of voltage ranging from 0-25 volts DC and current in the range of 0-5 Ampere. With a maximum voltage tolerance of 0.025%. The datalogger device for measuring air temperature and humidity has been calibrated. The results obtained are the maximum temperature tolerance of 0.0081% and the maximum air humidity tolerance of 0.025%. The use of Datalogger as a real-time data recording tool is very effective and efficient. In this experimental research, one data logger was used to record the parameter data measured in 4 polycrystalline 100 WP PV modules. The use of perforated aluminum plates affects increasing the output power of the PV modules when the solar radiation is 1030 W/m^2, the highest temperature decrease occurs at T4 on Fig 5 and the largest PV output power using a perforated aluminum plate with a hole diameter of 15 mm (P4) is 65.52 Watt as shown in Fig 4. The highest increase the output power of 39.19%. with the largest hole diameter of 15 mm.

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