Analysis Temperature and Relative Humidity Effects on Polycrystalline Solar Panel Power Output during Transition Monsoon Climate

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Abstract – Solar power generation had been used since years ago as renewable energy to support non-renewable energy such as diesel, coal, natural gas etc. The main cause of why solar power generation is most popular solution for renewable energy is the type of the energy itself. This type of energy is very clean, no harm to environment and the most important is it unlimited source. This paper presents the analysis of temperature and relative humidity effects on polycrystalline solar panel output during transition monsoon climate. The efficiency of solar panel is measured in term of power produce from the solar panel by converting sunlight into electricity. The data for voltage and current value of the solar panel had been collected from 0730 until 1900 for three weeks. Meanwhile, the value of temperature and relative humidity measured using thermo hygrometer (H105AB) with the same time interval with voltage and current data. Result show that temperature and relative humidity during transition monsoon have no effect on the power output of the polycrystalline solar panel. In another hand, transition monsoon characteristic has affected the power output of the polycrystalline solar panel.

Keyword-temperature effect, relative humidity effect, polycrystalline solar panel, transition monsoon

I. INTRODUCTION

Solar energy is one of renewable energy that widely use in this world. There a lots of advantages of solar energy. One of the advantages is the solar energy has not harm the environment because it has no waste produce. Others advantages are the most important in renewable energy such as solar energy is it unlimited energy, long lasting energy and free [1]. These advantages make a lot of researches and development had been done to intensify the potential of this energy as it is shown very important to creating a good and save environment for human being life.

Malaysia is located near the equator between 1 to 7 north latitude and between 100 to 119 east longitudes; the type of climate in Malaysia is tropical climate. The average temperature in most of Malaysia is between 21 °C to 32 °C. In addition, the average relative humidity in Malaysia is in between 70% to 90% and the average wind speed is below 3 m/s [2].

There three type of monsoon season in Malaysia; southwest monsoon, northeast monsoon and transition monsoon. Southwest monsoon usually started second half of May and ended on September bring along with below 8 m/s wind speed. Meanwhile, Northeast monsoon started early November and ended on March and the wind speed is up to 10m/s. Last but not least, the inter monsoon season. This season happen two times in year, first on second half of April until second half of May and October. In this season bring along with very small amount of wind and convective rain [3].

Convective rain occurs when the sun heats up the air on the earth's surface from morning until evening. Hot air expands and rises to the top because the air is lighter than the surrounding air. This process called convective. The air will rise until a thousand meter above and condensation took place, this process convert air into cloud. Clouds are formed is called cumulonimbus. Eventually the clouds will turn into heavy rain [3].

II. METHODOLOGY

This experiment was conducted in the inter monsoon in the second half of April on 16th April 2013 until second half of May on 8 May 2013. The polycrystalline silicon photovoltaic module was located at the football field at 3.090160 Latitude and 101.504394 Longitude.

Before installing the photovoltaic module, the most important things is to make sure the photovoltaic module is facing the sun directly to get the maximum power generate by the photovoltaic module. In this experiment the photovoltaic module is in fixed position, so to maximizing the power production, since the experiment is located in the Northern Hemisphere this photovoltaic module will facing due to the South [1]. After facing to the South, the photovoltaic module tilt angle also required. Below is the list of the tilt angle [4].

TABLE 1
Photovoltaic Module Tilt Angle

Latitude Site	Tilt Angle
0-15°	15°
15-25°	Same as Latitude
25-30°	Add 5° to local latitude
30-35°	Add 10° to local latitude
35-40°	Add 15° to local latitude
40°+	Add 20° to local latitude

Since the latitude at the location of the experiment is 3°, so the tilted angle for the photovoltaic module is 15° from horizontal to allow the maximum amount of the direct sunlight on the photovoltaic module surface[5].

This photovoltaic module is connected with 12V 3W LED halogen light bulb as load. The value of voltage, current, temperature and relative humidity measured manually for 3 weeks, every 15 minutes started from 0730 until 1900[6]. All the data measured manually. Refer to figure 1 for the circuit connection and the reading value were measured [7]. For the temperature and relative humidity parameter value, both data measured by thermo hygrometer (H105AB).

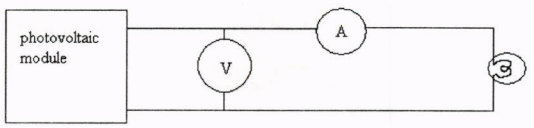

Figure 1: The ammeter and voltmeter located to measure the value of current (A) and voltage (V)

Figure 2 below shows the design flow step taken to complete the project.

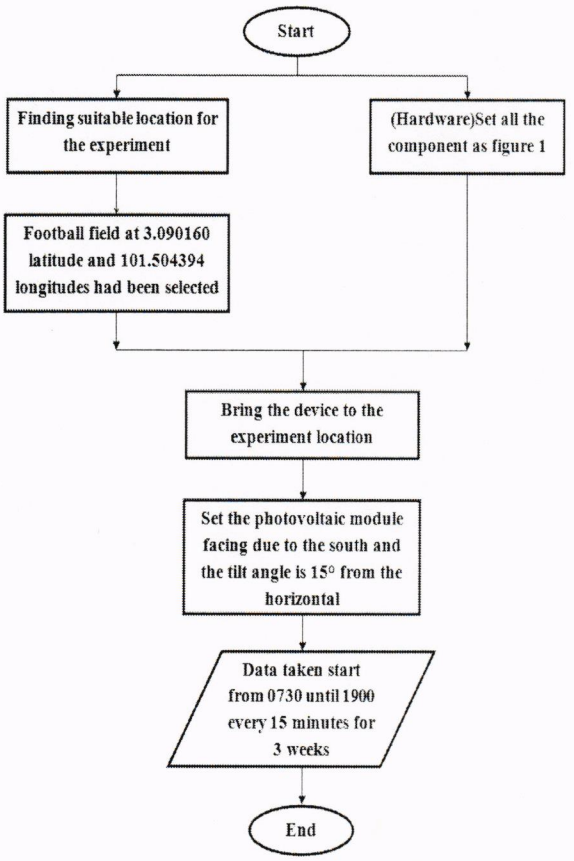

Figure 2: Project flow chart

III. RESULT AND DISCUSSION

To conduct this experiment the suitable location has to be carefully select. In this case the hardware has to locate at no shaded area, far away from buildings and trees. The chosen location for this experiment is at football field, where this place quite far from buildings and trees and no shaded area. All the data collected for three weeks, from 16 April to 8 May 2013.

From the figure 3, it shows the variations of average values for relative humidity and temperature during the period of experiment with time of the day during transition monsoon climate. From the graph it shows that the maximum value of relative humidity is 94% recorded at 0730 hour and the minimum value is 52% recorded at 1330 hour. Relative humidity starts to decrease from 0730 hour until 1330 hour (due to sun rise), at 1345 hour start to increase until 1645 hour (due to rain at the evening) and at 1700 hour to

1900 it start to decrease back (due to sunshine after the rain). Meanwhile, the maximum value of temperature is 39°C recorded at 1200 hour and the minimum value is 27°C recorded at 0730 hour. Temperature start to increase from 0730 hour until 1200 hour (due to sun rise) and the value of temperature almost consistent from 1215 hour until 1715 (due sun at the peak point) and decrease start from 1730 hour until 1900 hour (due to sun set).

In figure 4 shows the graph of daily average power output during transition monsoon climate. In the graph show that the maximum value of power produces is 2.3624W recorded at 1130 hour and the minimum value is 0.0528W recorded at 0730 hour. Power production start to increase from 0730 hour to 1000 hour (due to sun rise), suddenly decrease from 1015 hour to 1045 hour (due to random huge cloud), power start to increase back at 1100 hour until 1215 hour, at 1230 hour it start to decrease until at 1345 hour to 1530 hour a huge drop out happen to power production (due to rain at the evening), at 1545 hour until 1615 hour at the power start to increase back (due to rain has stop) and 1630 hour until 1900 hour the power production start to decrease (due to sun set). Since the characteristic of transition monsoon it comes with a random wind blow direction which it brings along cloud and a convectional rain during evening it proven with this power production graph tabulation.

Figure 5 show the average variations of voltage, temperature and relative humidity versus to time of the day. The graph show that the maximum value of voltage recorded is 17.64V at 1115 hour and the minimum value recorded is 9.23V at 0730 hour. A voltage value starts to increase from 0730 hour until 1200 hour (due to sun rise), almost recorded a consistent value from 1215 hour to 1330 hour (due to sun at peak point) and starts to decrease at 1345 hour to 1900 hour (due to sun set). In the graph also shows that the relative humidity and temperature has not affect the voltage value because there no significant changes due to increasing or decreasing of relative humidity and temperature value to the voltage value.

Figure 6 show the average variations of current, temperature and relative humidity versus time of the day. Refer to the graph it shows that the maximum value of current recorded is 0.2085A at 1000 hour and minimum value recorded is 5.72mA at 0730. A Current value start to increase from 0730 hour to 0915 hour but rapidly a huge gap of current value increases from 0930 hour to 1000 hour (due to sun rise), at 1015 hour it decrease rapidly and consistent until 1330 hour. At 1345 hour current value start to decrease until 1530 hour, suddenly at 1545 hour the current is increase rapidly and start to decrease slowly (due to sun set). Same as in figure 5 discussion, the graph shows that the relative humidity and temperature has not affect the current value because there no significant changes due to increasing or decreasing of relative humidity and temperature value to the current value.

Last but not least, figure 7 show the average variation of power, temperature and relative humidity apposed to time of the day. In the graph also shows that the relative humidity and temperature has not affect the power production value because there no significant changes due to increasing or decreasing of relative humidity and temperature value to the power production value.

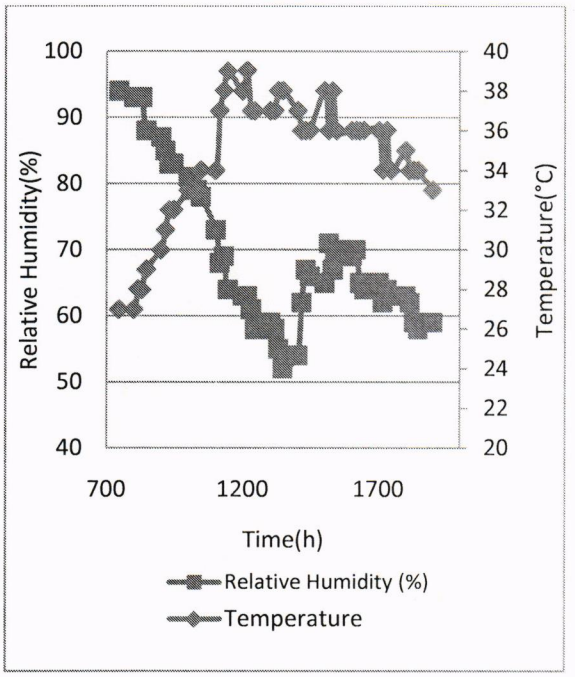

Figure 3: Daily average of relative humidity and temperature

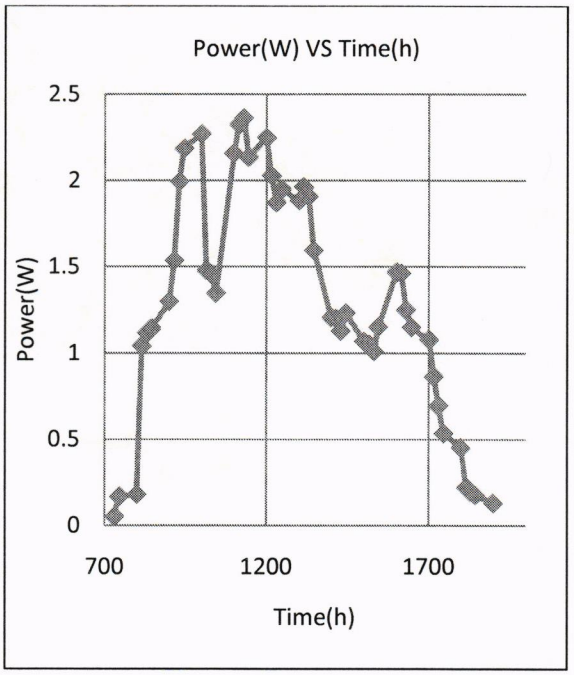

Figure 4: Daily average power

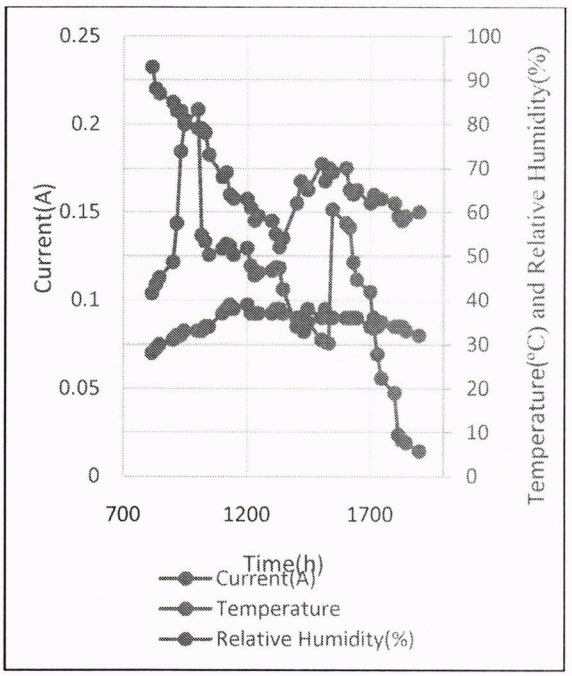

Figure 6: The average variations of current, temperature and relative humidity versus time of the day

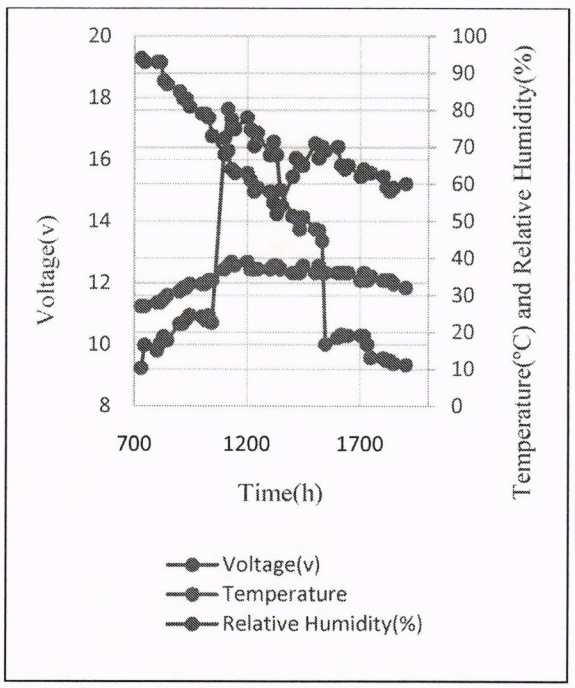

Figure 5: The average variations of voltage, temperature and relative humidity versus to time of the day

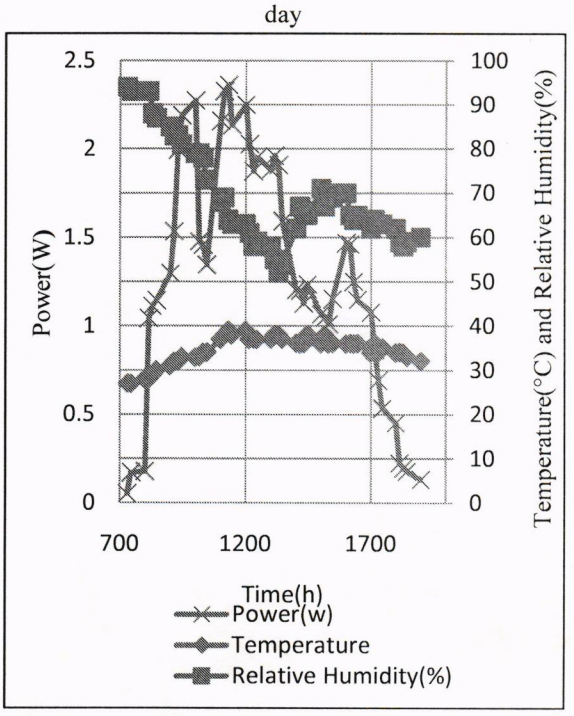

Figure 7: The average variations of power, temperature and relative humidity opposed to time of the day

After all discussion in figure 3,4,5,6 and 7, it can be conclude that relative humidity and temperature has no effect on the photovoltaic solar panel power production but the transition monsoon climate characteristic has an effect on the power production.

CONCLUSION AND RECOMMENDATION

Malaysia is naturally receiving a lot of sunlight daily. But the weather in Malaysia will be affected by seasonal monsoons. In this experiment all the reading of voltage, current, temperature and relative humidity is affected by transition monsoon climate. From the result it shows that temperature and humidity have no effect on the power production from the photovoltaic module. In addition, transition monsoon climate characteristic has effect the power production of polycrystalline solar panel. Furthermore from the performance of polycrystalline solar panel, Malaysia has a huge potential great potential to use the solar energy as an alternative energy. In future, the same experiment can be done with another type of monsoons climate such as southwest monsoon, northeast monsoon and add new parameter such as solar irradiance and wind speed.

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