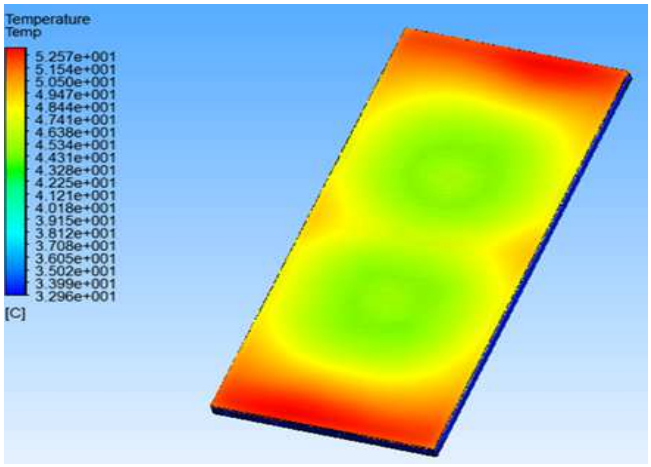

Fig. 6 Temperature distribution of PV panel with 4 m/s of DC fan flow rate

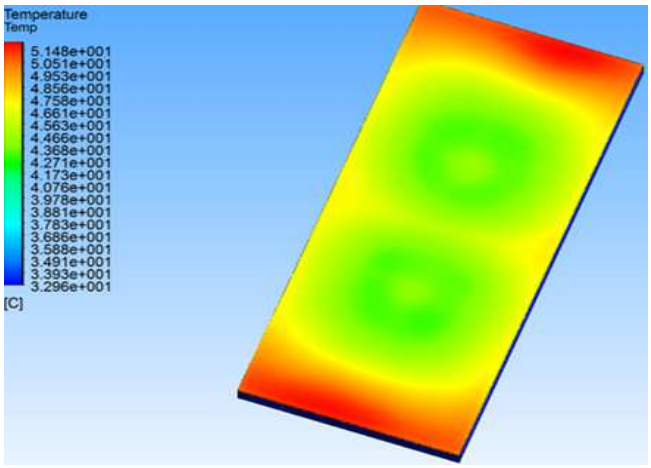

Fig. 7 Temperature distribution of PV panel with 6 m/s of DC fan flow rate

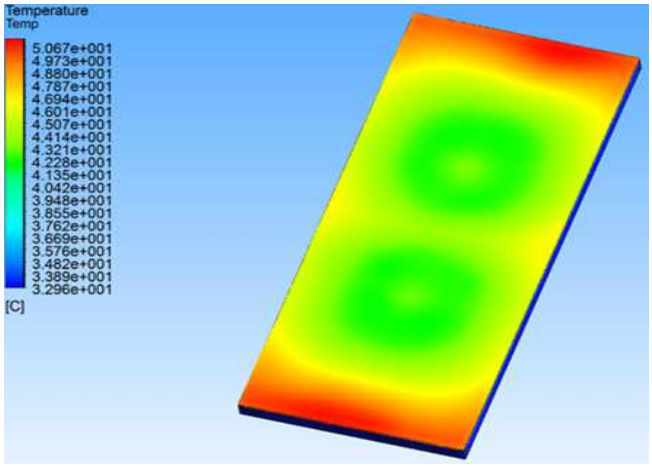

Fig. 8 Temperature distribution of PV panel with 8 m/s of DC fan flow rate

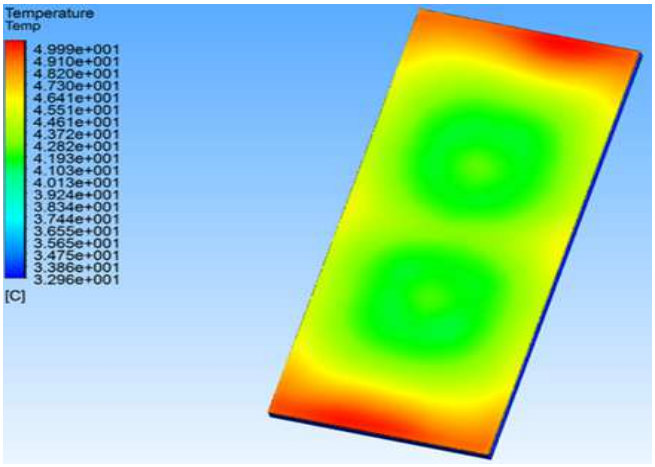

Fig. 9 Temperature distribution of PV panel with 10 m/s of DC fan flow rate

Fig. 4 displays the temperature distribution on the PV panel without cooling system. While, Fig 5-9 shows the temperature distribution on the PV panel with a cooling system for the effect of DC fan flow rate. The selected range of DC fan flow rate was taken from 2 m/s to 10 m/s. From these figures above, each of the PV panels consists of a contour plot of temperature distribution. Various colour of a contour plot is represented different values of temperature. The bright-red colour is represented the hottest area of the geometry model that consists of the highest temperature. On the other hand, the dark-blue colour is a sign of the coldest area of the geometry model. This represent the lowest temperature that produced by the PV panel.

It can be observed that the surface of the PV panel without cooling system is majority covered by the bright red colour. Which means that PV panel was generated more heat energy. This is because the natural convection just employed to transfer heat energy from the PV panel to the surrounding. Therefore, it can dissipate less heat energy to surrounding. On the contrary, the PV panel with cooling system was applied natural convection and forced convection to exhaust the heat energy from the PV panel to surrounding. As a result, it leads to the PV panel generated low temperature. It can find out that the surface of PV panel with the cooling system was appeared two large circles. This is because the DC fans are blowing fresh air into the air channel to provide the cooling effect for the PV panel. It can be discovered that the surface of the cold circle is the smallest and majority surface of the PV panel is covered by orange colour at 2 m/s of DC fan flow rate than other DC fan flow rates. However, the surface of cold circle at the PV panels has been bigger as increased in flow rate of the DC fan. This can be seen that the surface of cold circle is the biggest at 10 m/s of DC fan flow rate than other DC fan flow rates. Additionally, it can also be dissipated more heat energy from the PV panel lead to generate lower temperature.

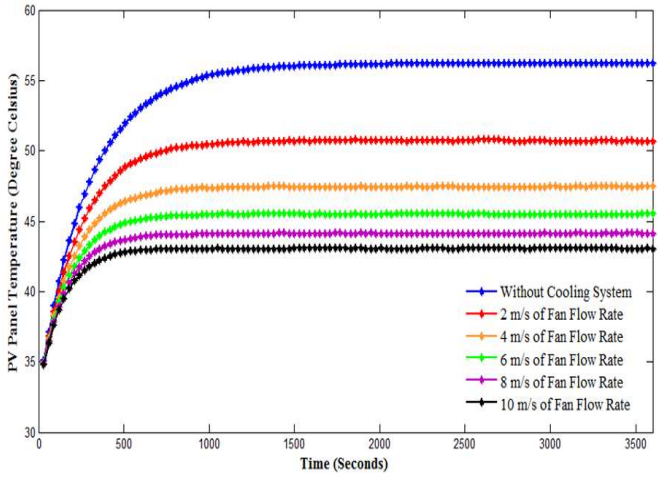

Fig. 10 Performance of PV panel with and without DC fan cooling system

Fig. 10 shows the effect of cooling system and effect of DC fan flow rate in the performance of PV panel. The selected range of DC fan flow rate was taken from 2 m/s to 10 m/s. The average temperature for the PV panel without cooling system was 55 °C. While, the average temperature for the PV panel with cooling system decreased from 50 °C to 43 °C as the flow rate of DC fan increases from 2 m/s to 10 m/s. When the flow rate of DC fan was applied at 2 m/s and 4 m/s, the average temperature of the PV panel is 50 °C and 47 °C, correspondingly. While, the flow rate of DC fan was applied at 6 m/s, 8 m/s and 10 m/s, the average temperature of the PV panel is 45 °C, 44 °C and 43 °C, respectively. It can be clearly that PV panel with cooling system can be generated lower temperature than without cooling system. In addition, the increment in flow rate of DC fan leads to decrease the temperature of PV panel. It can be proved that higher flow rate of DC fan applied for PV panel that it produces lower temperature performance.

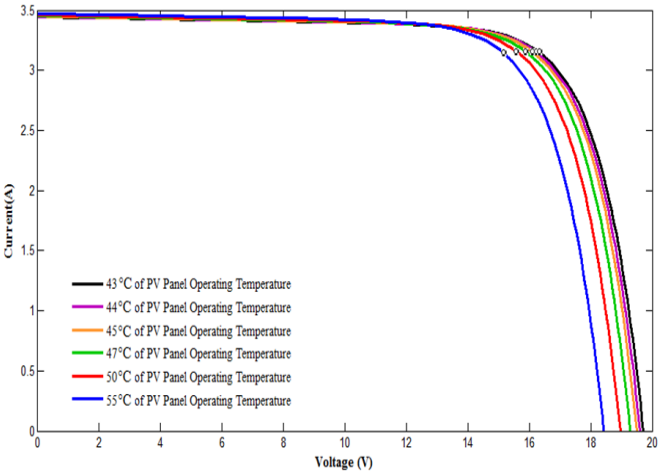

Fig. 11 Output power generated by PV panel with and without DC fan cooling system

Fig. 11 illustrates the output power of the PV panel with and without cooling system. The average solar irradiance and the average operating temperature of the PV panel were used to calculate the output power that generated by the PV panel. When the temperature of PV panel without cooling system is 55 °C, the PV panel can be generated 47.7 W as its output power. Whereas, for the PV panel with cooling system, PV panel can be generated 49.2 W, 50.2 W and 50.8 W of output power at the temperature of 50 °C, 47 °C and 45 °C, correspondingly. Moreover, when temperature of PV panel is 44 °C and 43 °C, it can be produced 51.1 W and 51.4 W of output power, respectively. It can be observed the PV panel with cooling system can be generated more output power than PV panel without the cooling system. This can be seen that a slight increase in output power from 49.2 W to 51.4 W as the temperature of PV panel decreased from 50 °C to 43 °C by increasing the flow rate of DC fan. Therefore, the higher flow rate of DC fan is recommended for better thermal behaviour and electrical behaviour of PV panel.

IV. Conclusions

This research work is to predict the thermal behavior and electrical behavior of the PV panel by using a three-dimensional geometry model. For given environmental and operating condition, the PV panel without cooling system was generated higher temperature than PV panel with the cooling system. This result lead to PV panel with the cooling system generated higher output power compare than PV panel without the cooling system. It was shown that PV panel with cooling system can be increased the output power from 49.2 W to 51.4 W in the DC fan flow rate range of 2 m/s to 10 m/s at a solar irradiance of 589.3 W/m^2 and ambient temperature of 32.97 °C. It shows that higher flow rate of DC fan will assist to heat dissipation and enhancement in output power generated by PV panel.

Acknowledgment

The authors gratefully acknowledge to Kementerian Pengajian Tinggi Malaysia supported under Knowledge Transfer Program (KTP) and the contributions and cooperation from member Centre of Excellence for Renewable Energy (CERE), University Malaysia Perlis (UniMAP) for their work on the original version of this document.

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