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Comparison between DC Brushless Fan and DC Hybrid Solar Panel Cooling System

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Abstract. The purpose of this paper is compare between DC brushless fan and DC hybrid solar panel cooling system. The efficiency of PV module is depending on solar irradiance and ambient temperature. As temperature of PV module increase, the output current will increase but output voltage and output power will decrease and also vice versa. As solar irradiance increase, output current and output power will increase with linear and output voltage will increase with marginal and vice versa. The DC cooling system is a way to fix the issue of low efficiency of PV module with the intention to generate more electrical energy. To make an attempt to cool down the PV module, DC brushless fan and water pump with inlet/outlet manifold are built for constant fresh air movement and water flow circulation at the backside and front surface of PV module. The PV module with DC brushless fan cooling system increase 3.47 %, 29.55 %, 32.23 % in term of output voltage, output current, and output power respectively. It decrease 6.1 ˚C compare than to PV module without DC brushless fan cooling system. While PV module with DC hybrid cooling system increase 4.99 %, 39.90 %, 42.65 % in term of output voltage, output current, and output power respectively. It decrease 6.79 ˚C compare to PV module without DC hybrid cooling system. The efficiency of PV module with cooling system was increasing compared to PV module without cooling system, for the reason that the ambient temperature dropped significantly. An increase in efficiency of PV module, investment payback period of the system can reduce and the lifespan of PV module will be prolonged.

Introduction

Nowadays, energy is thus one of the essential issues for continuous progress and economic growth. Energy can be classified into two groups which are conventional energy sources and non-conventional energy sources. As the result of world economic development and growing demand for energy, the conventional energy (coal, oil and natural gas) is rapidly increasing. Environmental phenomenon, such as global warming and depletion of the ozone layer attributed to emissions from massive fuel combustion are slowly but surely causing widespread problems to every living thing on earth [1]. Non-conventional energy generally known as renewable energy which is solar energy, biomass energy, tidal wave energy, wind energy, hydropower and so on. As the renewable energies become famous in the energy market, the requirement of conventional energy will be reduced.

PV energy is a process that electrical energy is produced from sunlight. PV is an attractive energy; it is renewable, abundant, silent and environmental friendly, and it can apply in different applications. PV technology is one of a very effective solution for renewable energy, because it is a natural resources and pollution-free. Besides that PV technology can to reduce greenhouse gas emission.

The ambient temperatures and solar irradiance participate in major part for efficiency of the PV module. If the ambient temperature of PV module is increase, the efficiency of PV module is decrease and also the other way around. If solar irradiance of PV module is increase, the PV module

efficiency furthermore increases. This general rule is above all the decline from the open cell voltage and short circuit current drop is determined. Therefore, an efficient PV performance conditions needed cooling.

So J., H. outlined [3] as a solution for the depletion of conventional fossil fuel energy sources and serious environmental problems, focus on the photovoltaic (PV) system has been increasing around the world. Only around 15 % of solar radiation is converted to electricity [3]. The PV module temperature increases, solar irradiance absorbed by PV module converted into heat because of the PV module conversion efficiency is low. Indeed, the conversion efficiency of the PV modules is decreased by about 0.4–0.5 % per each degree rise in temperature [4]. The decreasing rate of temperature effect in electrical efficiency was also found to be 0.1 %/°C [4]. Therefore, the cooling system of PV modules is an important key to improving the efficiency of the PV system.

Krauter, S [5] outlined due to the water spray and additional cooling by evaporation, the cells operating temperatures were significantly reduced in comparison with a module without having water spray which was measured simultaneously. Odeh S. [6] carried out the heat energy generated by the modules due to high temperature sunlight will be absorbed by the water particles, allowing the temperature of the module not to rise very high.

Sharp Solar Module ND-130T1J has been chosen to analysis PV modules performance within this investigation. The primary concentration is compared with parameter performances of the PV module with and without cooling system. A summary of research consists of the key parameters and the provisional result via the component to the user.

Methodology

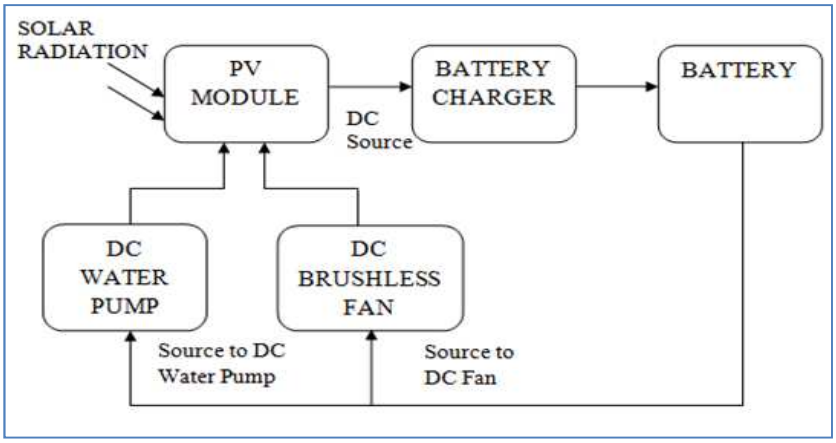

Fig.1 Block diagram overview of the investigation.

Figure 1 shows the block diagram summary of the investigation. As a way to satisfy the requirement of investigation, the solar energy is chosen as a main supply of this design. The PV module produces electrical energy and provides DC supply to battery charger. The output power of PV module is used to charge the 12 V_{DC} batteries by using battery chargers. It continually charges the battery until it shows at the sign of complete condition on which will cut-off charging process. The utilization of battery is used to store electrical energy that generate by PV module. Battery provide DC source to DC cooling system that is placed at the back side (DC brushless fan) or front side (DC water pump) of PV module. DC cooling system to reduces temperature for improving efficiency output power of PV module.

The output voltage of both PV modules were measured and collected by using Midi Logger GL220 also. The output current of both PV modules were measured and recorded by using Digital Multimeter in every ten minutes. A Davis Vantage PRO2 Weather was used to determine the daily ambient temperature and solar irradiance.

Experimental results and discussion

This investigation was conducted at Centre of Excellence Renewable Energy (CERE) on 1 April 2014 from 9:00 a.m until 5:00 p.m. The DC brushless fan cooling system and DC hybrid cooling system were experimented at the outdoor CERE.

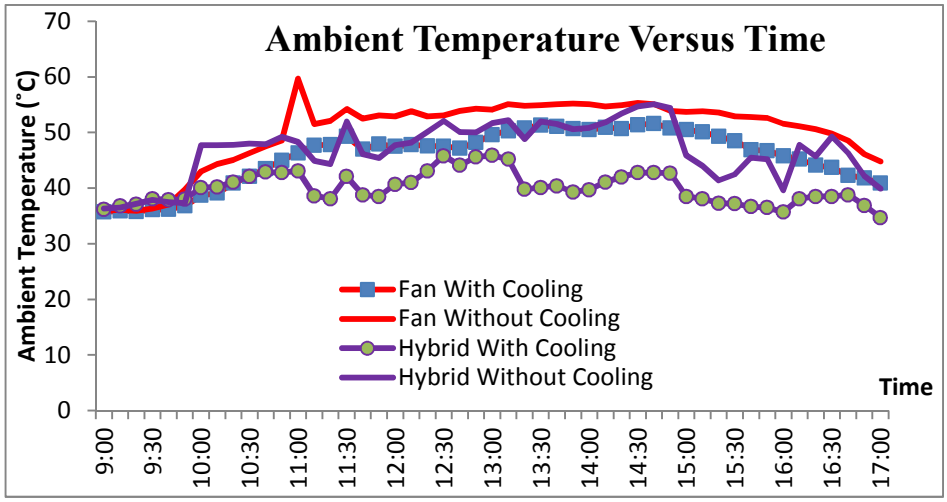

Fig. 2 Comparison of ambient temperature versus time between DC brushless fan and DC hybrid.

The average temperature of PV module along with DC brushless fan cooling system seemed to be reached 44.77 ˚C while the average temperature of PV without cooling system seems to be 50.87 ˚C. The temperature variant of PV module without DC brushless fan cooling system seemed to be raise 6.1 ˚C review to be able PV module along with DC brushless fan cooling system. Besides that, the average temperature of PV module with DC hybrid cooling system was reached at 37.65 ˚C while the average temperature of PV without DC hybrid cooling system was 45.74 ˚C. The temperature variation of PV module without DC hybrid cooling system was increase 6.1 ˚C compare to PV module with DC hybrid cooling system as shown in Figure 2.

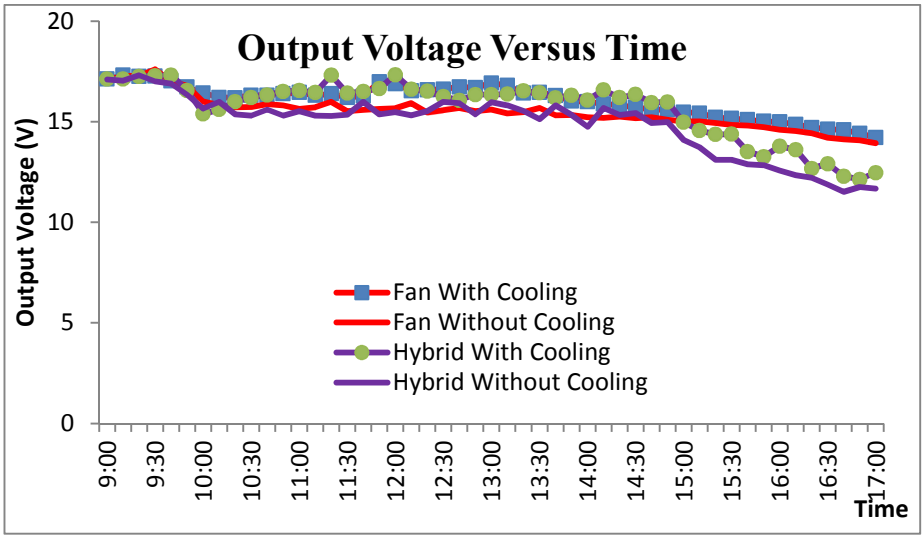

Fig.3 Comparison of output voltage versus time between DC brushless fan and DC hybrid.

Figure 3 presents comparison of output voltage versus time between DC brushless fan and DC hybrid. The figure displays maximum output voltage of PV module with DC brushless fan cooling system was 17.31 V and average output voltage as 16.05 V. The output voltage of PV module with DC brushless fan cooling system increase 3.47 % compared to PV module without DC brushless fan cooling system. Besides that, the maximum output voltage of PV module with DC hybrid cooling system was 17.33 V and the average output voltage was 15.67 V. Compared between these

both DC hybrid cooling systems, the output voltage increased 4.99 % when using of PV module without DC hybrid cooling system. PV module with DC hybrid cooling system will generate more 1.52 % output voltage compared to PV module with DC brushless fan cooling system.

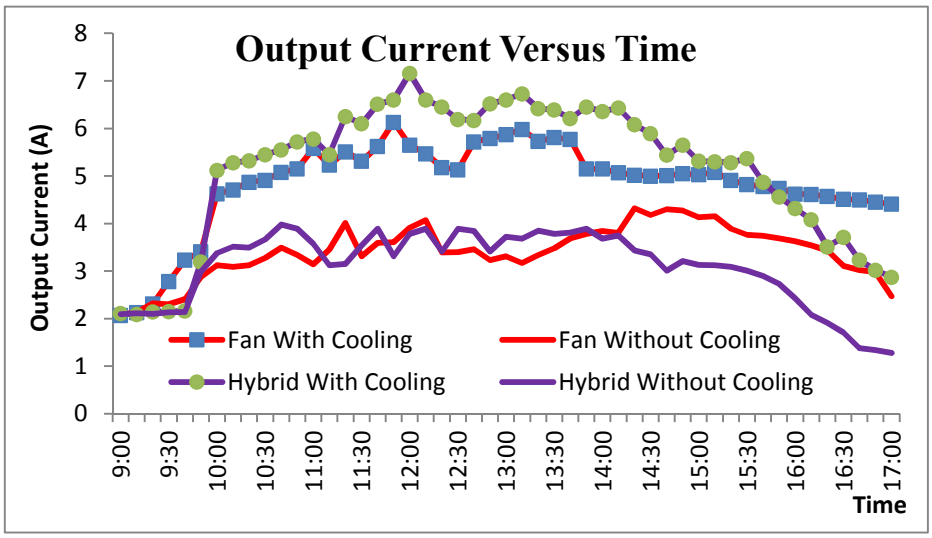

Fig. 4 Comparison of output current versus time between DC brushless fan and DC hybrid.

Figure 4 shows comparison of output current versus time between DC brushless fan and DC hybrid. It could be discovered maximum output current that is generated by PV module with DC brushless fan cooling system was 6.13 A and average output current seemed to be 4.842 A. Through in comparison concerning these kinds of each system, the output current improved 29.55 % when using DC brushless fan cooling system. Furthermore, maximum output current that produced by PV module with DC hybrid cooling system was 7.16 A and average output current was 5.146 A. By compared between these both DC hybrid cooling systems, the output current increased 39.90 % when using cooling system. PV module with DC hybrid cooling system will generate more 10.35 % output current compared to PV module with DC brushless fan cooling system.

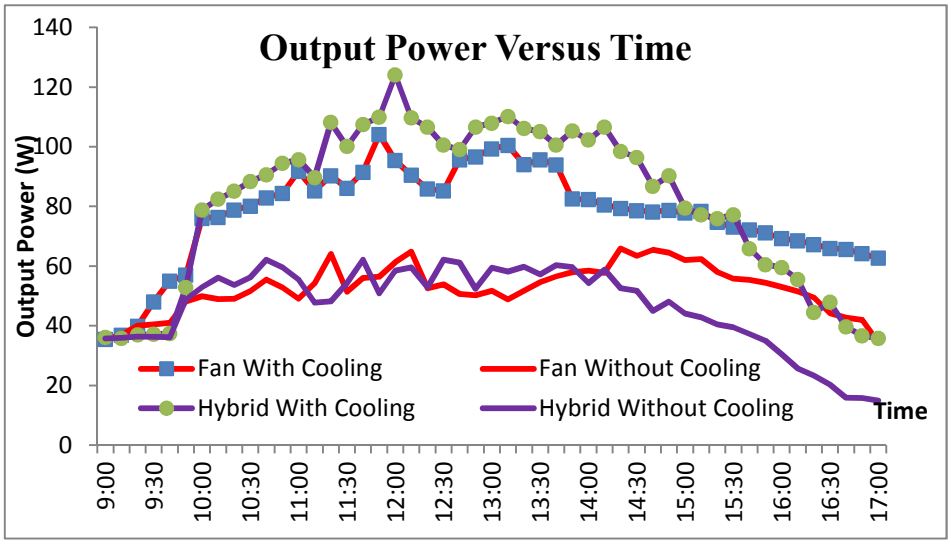

Fig. 5 Comparison of output power versus time between DC brushless fan and DC hybrid.

Figure 5 presents the comparison of output power versus time between DC brushless fan and DC hybrid. The maximum output power of PV with DC brushless fan cooling system was measured and calculated at 104.09 W and average output power of was 77.63 W. In the comparison concerning these kinds of each system, the output power improved 32.23 % when using DC brushless fan cooling system. Besides, the maximum output power of PV module with DC hybrid

cooling system was measured and calculated at 124.08 W and average output power was 81.33 W. The increase percentage in the output power in unit of electricity is calculated to be 42.65 %. PV module with DC hybrid cooling system will generate more 10.42 % output power compared to PV module with DC brushless fan cooling system.

Conclusion

This paper has discussed different type of DC cooling system with this PV module cooling system. Solar irradiance and ambient temperature could be the have effect on the efficiency of PV module. Any time temperature increase, output current is going to be increase but output voltage and power will probably reduce and the other way around. When the solar irradiance increase, output current and power will increase with linear and output voltage will increase with marginal and vice versa. The comparison between both the systems of various types DC cooling system, the PV module with DC hybrid cooling system is most efficient compared to DC brushless fan cooling system. The PV module with DC hybrid cooling system increase 4.99 %, 39.90 %, 42.65 % in term of output voltage, output current and output power. The DC brushless fan cooling system increase 3.47 %, 29.55 %, 32.23 % in term of output voltage, output current and output power. The efficiency of PV module with cooling system was improving as compared to PV module without cooling system, the reason being that the ambient temperature decreased considerably. An increase in efficiency of PV module, investment payback period of the system can reduce and the lifespan of PV module will also be prolonged.

Acknowledgements

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