International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 06 | June 2019 www.irjet.net p-ISSN: 2395-0072

Improving Efficiency of Solar Panel using Simple Cooling System

Gautam Jahagirdar[1], Pankaj Khot[2], Prof. S.H. Joshi[3]

[1,2]UGScholar, Dept. of Mechanical Engineering, Zeal College of Engineering and Research, Pune, Maharashtra, India
[3]Assistant Professor, Department of Mechanical Engineering, Zeal College of Engineering and Research, Pune, Maharashtra, India

---

Abstract - *Output and efficiency of solar PV system depends on the intensity of solar radiations, but temperature also plays important role in the performance. As high temperature significantly reduces output and eventually results in drop of efficiency. As temperature plays a critical role in influencing the output and efficiency of electrical output of solar PV system it is necessary to examine and find out different ways for maintaining the appropriate temperature. This research aims on finding a way of decrease the working and surface temperature of solar panels by a cooling system. Experimental work was carried out and variations in output power, output voltage, current and efficiency was observed when the solar PV system is working with and without the cooling system.*

Key Words: Solar Panels, Photovoltaic Effect, DC Pump, Temperature Effect, Cooling of Solar Panels

1. INTRODUCTION

Electrical energy has been in demand for many years. It is a fundamental need of mankind. It ensures better quality of life. It is necessary to have uninterrupted flow of energy for easy living. Energy generation has been leading issue all over the world and every country is looking for energy resources. It is a fact that non-renewable energy sources are in high demand and are also expensive, but also this is a fact that these sources are now becoming difficult to extract. This leads to the exploration of Renewable energy sources. These sources include hydro energy, wind energy, solar energy, etc. Hydroelectric is very cheap renewable energy source but it is not available everywhere, while on the other hand solar energy has potential to take over the whole power generation.

There has been continuous development in solar PV technology, scientists have been able to improve the efficiency significantly. However, it is observed, the solar PV's efficiency is achieved in lab up to 35%, but the commercial efficiency is much lower around 11-17%. This needs to be examined, why efficiency drops so drastically and how to maintain and increase the efficiency during practical application. It has been noticed that working temperature and surface temperature of solar PV panels is been significantly influencing the performance. Conducting materials consist of free electrons and some electrons are held tightly by the nucleus of atoms. When the radiation increase, more photons strike the panel and this energy is absorbed by the atoms and electrons, thus temperature rises. Increase in temperature increases resistance of flow. The output performance of solar PV system decreases at high temperature. Some research shoe that, an increase in temperature around 1° C leads to decrease in efficiency about 0.5%. Therefore, to achieve high efficiency it is necessary to investigate different possible techniques for obtaining low temperature for solar panels, particularly during high radiation condition. From different resources, it is found that 12%-60% improvement of electric efficiency could be expected when solar PV panels were cooled by cooling system. Meanwhile, some research show that from different fluids used for cooling system, water cooled PV-Thermal system is most efficient. This research aims at investigating the effect of temperature on variation of output voltage, output power, current and efficiency of solar PV system used for pumping water to storage tank which then will be used for irrigation purpose. A cooling system is proposed and experimental test is conducted for duration of 6-7 hours in month of May when solar radiations are 5.44kWh/m^2/day. This test give result when system runs with cooling and without cooling.

1.1 Principle of Solar Cell

Solar Cells are made of semiconductor material like silicon doped with impurities to create uneven electron distribution in n-type conductor and excess holes in p-type junctions. The solar energy has photons which excites the electron from solar cell to higher level creating electron-hole pair across the p-n junction and hence electricity is generated.

1.2 Effect of Temperature on Efficiency

Electricity is generated when photons from solar energy strikes the semiconductor material of solar cell. When radiations increases more photons strike the solar cell which increases the number of electrons excited to higher state. These electrons collide with each other forming more electrons from atom thus results in increased temperature. The increased temperature resists the flow of current. At higher temperature, the output of the solar panel is less than that of output at lower temperature. The efficiency of solar panel reduces by 0.5% per degree

Celsius rise in temperature. Generally, solar panel are made to work at standard temperature i.e. 250C.

1.3 Cooling of Solar Panel

As the efficiency of solar panel reduces with increase in temperature, hence effective cooling system is required to get maximum output from solar panel. There are two types of cooling system, one is active cooling system and other is passive cooling system. The difference between active and passive cooling is active system requires external power source and passive system does not require any external source.

1.4 Experimental Setup

The output of the solar panel is taken in month of May for maximum efficiency. The system consists of a solar panel, a pump, a water source and connections for cooling system. The iron frame is designed for mounting solar panel at 190 at south direction.

The water from the water source is pumped to a height where solar panel is located and then water is made to flow on the solar panel. The heat generated from the panel is absorbed by water flowing on it. Hence efficiency of system is increased.

2. Result

The observations are taken on the above experimental setup with 10W solar panel and water cooling system. The observations are taken in month of May for maximum solar exposure. The observations are taken to find out change in power output of panel due to temperature difference

Table -1: Output of system without cooling system

Time(t)	Voltage(V)	Current(A)	Power(W)
08:30AM	9.1	0.26	2.366
09:00AM	9.1	0.29	2.639
09:30AM	9.6	0.360	3.456
10:00AM	9.75	0.440	4.290
10:30AM	9.50	0.510	4.845
11:00AM	9.53	0.520	4.955
11:30AM	9.65	0.540	5.211
12:00PM	9.65	0.564	5.442
12:30PM	9.65	0.583	5.625
01:00PM	9.54	0.572	5.456
01:30PM	9.94	0.582	5.785
02:00PM	10.01	0.531	5.310
02:30PM	9.70	0.544	5.280
03:00PM	9.60	0.520	4.992
03:30PM	9.82	0.400	3.982
04:00PM	9.30	0.340	3.162

Table -2: Output of system with cooling system

Time(t)	Voltage(V)	Current(A)	Power(W)
08:30AM	8.80	0.215	1.8920
09:00AM	9.46	0.291	2.7528
09:30AM	9.99	0.390	3.8961
10:00AM	10.12	0.401	4.0580
10:30AM	10.20	0.50	4.5900
11:00AM	10.30	0.500	5.1500
11:30AM	10.30	0.531	5.4600
12:00PM	10.35	0.550	5.6925
12:30PM	10.20	0.560	5.7120
01:00PM	10.20	0.560	5.7120
01:30PM	10.20	0.570	5.8140
02:00PM	10.10	0.530	5.3530
02:30PM	10.20	0.520	5.3040
03:00PM	10.50	0.500	5.2500
03:30PM	10.10	0.410	4.1410
04:00PM	10.10	0.366	3.6966

Table -3: Increase in efficiency due to cooling system

Time(t)	Power(Without Cooling)	Power(With Cooling)	%increase
08:30AM	2.3660W	1.8920W	-02.000%
09:00AM	2.6390W	2.7528W	04.3010%
09:30AM	3.4560W	3.8961	12.730%
10:00AM	4.2900W	4.0580W	-05.400%
10:30AM	4.8450W	4.5900W	-05.260%
11:00AM	4.9556W	5.1500W	03.922%
11:30AM	5.2110W	5.4600W	04.778%
12:00PM	5.4426W	5.6925W	04.591%
12:30PM	5.6250W	5.7120W	01.630%
01:00PM	5.4560W	5.7120W	04.676%
01:30PM	5.7850W	5.8140W	0.900%
02:00PM	5.3100W	5.3530W	0.700%
02:30PM	5.2800W	5.3040W	0.500%
03:00PM	4.9920W	5.2500W	5.168%
03:30PM	3.9280W	4.1410W	05.400%
04:00PM	3.1620W	3.6966W	16.900%

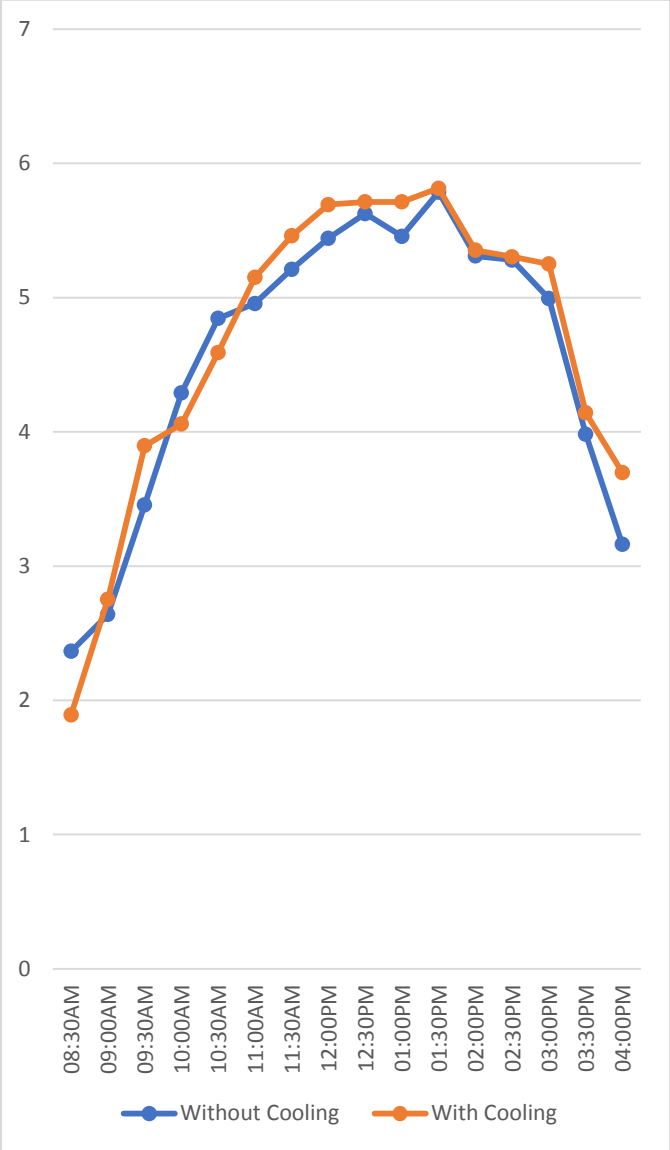

Chart -1: Comparison of power output with/without cooling system

3. CONCLUSION

The research shows the solar PV system working with water cooling system. The graph shows results of two trial performed on system with and without cooling of solar panels. It can be observed that during 8:30 to 10:00 there is increase in efficiency of the system with cooling. Then from duration 10:00 to 2:00 we can see that the efficiency of system with cooling is more than that of system running without cooling of solar panels. There is decrease in efficiency of both the trial after 2:00 to 4:00 but the efficiency of system with cooling is much more than system without cooling. From above result we can conclude that with cooling of solar panels there is increase in efficiency and better function even in low solar radiation intensity. As temperature affects the efficiency and life of panel, with the cooling system not only efficiency is increased but also the life of panel increases. The temperature of panel increase up to 60^0 Celsius and with cooling system it is possible to maintain temperature of panel in 25^0 to 30^0 Celsius temperature range.

4. FUTURE SCOPE

1. In recent years we can increase the efficiency of system using concentrator and cooling system
   - I) Single mirror system with cooling
   - II) Double mirror system with cooling
   - III) Three mirror system with cooling

   These systems increase the efficiency of solar panel.
2. Another way of increasing power output of solar panel is to use solar tracking system with panel cooling. The solar tracking system tracks the position of sun and changes the position of panel for achieving maximum concentration ratio. The tracking system continuously generates maximum output through the day.

REFERENCES

[1] Rizwan Arshad, Salman Tariq, Muhammad Umair Niaz , Mohsin Jamil, 2014 International Conference on Robotics and Emerging Allied Technologies in Engineering (iCREATE) Islamabad, Pakistan, April 22-24, 2014

[2] F. Kreith and D. Y. Goswami, Handbook of Energy Efficiency and Renewable Energy. CRC Press, Taylor & Francis Group, 2007.

[3] M. Brogren, "Optical efficiency of low-concentrating solar energy systems with parabolic reflectors," Doctoral thesis, 2004

[4] R. M. Swanson, "The promise of concentrators," Progress in Photovoltaics: Research and Applications, vol. 8, no. 1, pp. 93–111, 2000.

[5] A. Luque and S. Hegedus, Handbook of Photovoltaic Science and Engineering. John Wiley & Sons, 2011.

[6] R. B. Pettit and E. P. Roth, Solar Mirror Materials: Their Properties and Uses in Solar Concentrating Collectors. Solar Materials Science,1980.

[7] A. Luque, G. Sala, and I. L. Heredia, "Photovoltaic concentration at the onset of its commercial deployment," Progress in Photovoltaics: Research and Applications, vol. 14, no. 5, pp. 413–428, 2006.

[8] S. Guha, "Manufacturing technology of amorphous and nanocrystalline silicon solar cells", Physics of Semiconductor Devices, IWPSD 2007.

[9] V.L. Dalal,"Design considerations for high□intensity solar cells", Journal of Applied Physics (Vol.48 , Issue: 3) 1977.

[10] C.H Lin and W.L Hsieh, "Optimization of Photovoltaic Penetration in Distribution Systems Considering Annual Duration Curve of Solar Irradiation", Power Systems, IEEE Transactions on (Vol.27 , Issue: 2)2012.

[11] T. Kozak and W. Maranda, "Influence of ambient temperature on the amount of electric energy produced by solar modules" Mixed Design of Integrated Circuits & Systems, MIXDES '09. MIXDES-16th International Conference. 2009

[12] P. Prudhvi and P. Chaitanya Sai, "Efficiency improvement of solar PV panels using active cooling" Environment and Electrical Engineering (EEEIC), 11th International Conference. 2012.

[13] G. LÃ¶f, "Design, Analysis, and Control Methods" Active Solar Systems, MIT Press. 1993

[14] T. Yoshino et aI., "Power Electronics Conserves the Environment for Better Future", Proceedings of PESC2008, pp. XCIX-CIV, June 2008.

[15] T. Yoshino et aI., "MW-Rated Power Electronics for Sustainable and Low Carbon Industrial Revolution", Proceedings of ISIE201O, pp. 3811- 3816, 4- 7 July 2010