RESEARCH ARTICLE OPEN ACCESS

Performance Enhancement of solar PV Panel by water cooling technique

C. Anbumeenakshi[*1], G .Yokesh Narayanaa[□2], A. Boopathy Murugan [□3], G. Hari Haran[□4], N .Vineeth[□5], M. R. Thansekhar[#]

[*]*Assosiate Professor,* [#]*Professor,* [□]*Student*

Department of Mechanical Engineering, K.L.N. College of Engineering,
Madurai,Tamil Nadu, India

ABSTRACT

Today the requirement of electricity is increasing day-to-day, due to increasing in human population, industries, hardware and software companies, IT parks and so on. These improvements are considered as the country's development. These developments are assisted by electricity. The electric demand is also increasing every day as the consumers grow. Major electricity generation is done by thermal power plant and other non-renewable sources.

Due to depletion of these fuels there is great necessity for power generation by renewable sources. In these work we are using solar as my primary source of power for power generation. This solar energy can be converted into electrical energy by using PV cell.

The efficiency of the PV cell is greatly influenced by the temperature. In this work on experimental study is carried out to analyze the performance of the PV cell without cooling and with cooling by use of Desalinized water through a macro channel cooling technique. It was identified that the PV panel efficiency increases with the help of cooling technique.

KEYWORDS: PV cell, Temperature, Desalinized water, cooling technique

---

Date of Submission: 22-03-2020 Date Of Acceptance: 08-04-2020

I. INTRODUCTION

Global climate destabilization as a result of the anthropogenic emission of greenhouse gases is today's most urgent issue because more than half of anthropogenic greenhouse gas emissions are comprised of carbon dioxide from fossil fuel combustion. These toxic emissions lead to climate change, air pollution and also health hazards to human beings. Good rains contribute to prosperity of the country, but climate change creates problems". The alleviation of these harmful emissions in the future can be performed using PV technology as a sustainable energy generation method.

The overall performance of solar panels is strongly dependent on the PV cells' operating temperature. Typically the efficiency of solar cells is around 15%. The remaining 85 % of the incident solar radiation absorbed in the cell transforms into thermal energy. This causes the temperature of the cell to increase and consequently energy conversion efficiency to decrease. By devising a cooling system, the efficiency can be increased and the extracted heat can be utilized for solar distillation, thereby harnessing the incident solar energy in the most effective manner.

Revati and Natarajan[1] performed an experimental study with solar PV Panel without cooling, solar PV panel placed on the green field and solar panel by air cooling. From the experimental study it was identified that solar panel with air cooling give higher electrical efficiency due to improved power generation.

Irwana et al. [2] investigated experimentally to increase the electrical efficiency of the PV panel in indoor test conditions by using water cooling mechanism for maintaining low operating temperature during the operation period. It was identified water spraying can reduce the heat on the front surface of the panel and it improve the electrical efficiency.

Matias et al.[3] experimentally investigated the Photovoltaic Panel by allowing the water to flow over the front surface of the panel by gravity as a cooling technique and found increase in efficiency with decrease in operating temperature and increase of voltage with the increase in energy produced.

Mahajan et al.[4] experimentally investigated the cooling of PV panel with Jute wick structures. It was identified that average increment in the electrical efficiency of water cooled PV panel with jute wick structures and it improves the efficiency of PV panel

Yogesh et al. [5] reviewed various cooling techniques to achieve cooling action in photovoltaic modules. It was identified that liquid cooling offers better alternative shows lower module temperature and yields higher electrical efficiency.

Jee et al. [6] elaborately reviewed the overview of the different solar flat plate PV/T technologies, their efficiencies, applications, advantages, limitations and research opportunities available and concluded that several testing is needed to promote the photovoltaic PV technology.

The progress in science & technology is a non-stop process. New things and new technology are being invented. As the technology grows day by day, we can imagine about the future in which thing we may occupy every place. A detailed experimental investigation is carried out to avoid degradation of cells as well as performance enhancement to minimize the economy hence water cooling technique using channels were used below the panels and it cools the panel.

II. EXPERIMENTAL SETUP

This experimental setup comprises of 2 solar panels, LXI Data acquisition, thermocouples, charge controller, battery and connecting wires, 300 liters tank, water flow meter, gate valve, ball valve and brass square tube and fan.

These are two solar panels, one is used with water cooling and the other is used without water cooling. The thermocouples are usually connected with 8 equally divided places in the solar panel. These thermocouples are also connected to the LXI Data acquisition unit to find the temperature of that point. The positive terminal and negative terminal from the solar panel is connected to the charge controller. DC charge from the solar panel is converted to the AC charge and store in the battery.

Fig. 1. PV panel Setup with (C-TYPE) cooling

Fig .2. PV Panel Setup with (U-TYPE) cooling

III. EXPERIMENTAL PROCEDURE

The solar panels are placed against the direction of the sunlight. Solar panel converts light energy into electrical energy. The sunlight falls over the solar panel. We have to solar panels one is with cooling and other one is without cooling. At certain temperature, the efficiency of the solar panel would be high. The temperature can be reduced by the continuous cooling. The material of channel, type of flow and type of liquid used for cooling are some of the factors to be maintaining at that temperature. Here we used brass channel and water as a cooling liquid.

For the continuous supply of water into the channels, the water is stored in the overhead tank by using the pump. From the pump the water is directed into the channels by its inlet and water from the channels are get back into the underground storage by using its outlet.The thermocouples are placed in 8 different positions to measure the temperature of the solar panel at that particular point. By using the temperature of inlet and outlet water, we can measure the temperature emitted.

J-Type thermocouples from the solar panel is connected to the LXI Data acquistitation to measure the temperature and to display the temperature at that particular point. The charge controller is used to converts the DC current from the solar panel into the Ac current. The battery is used to store the energy, On the other hand, we can use the current directly for running fans, motors etc. The some procedures and connection is followed in the non cooling solar panel also except the cooling system. By this project, we can found the difference of energy generated in both the solar panels.

IV. RESULTS AND DISCUSSION

The experiments were performed in the solar panel with cooling and without cooling. The solar panel with cooling was performed with two types of water cooling technique. The experiments were repeated on different days with cooling and without cooling and the results were compared

4.1 Effect Of Temperature

It is recommended that cooling solar panels after 45 degrees Celsius is a necessary in our experimental setup. We cool panel from 12PM-4PM and simultaneously we recorded temperature readings in panel with cooling and without cooling. So we cooled our panels to maintain it below 55 degrees Celsius. But yet more cooling is needed at mid noon especially at 1PM-2PM. At this time the panel without cooling reaches 65 degrees Celsius, which will leads to degradation of cells soon and as well as conversion rate of photons to electron movement to produce current is dropped up to some extent.

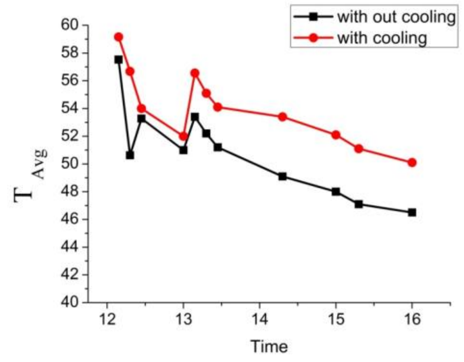

Fig. 3. C Type Average Temperature versus Time

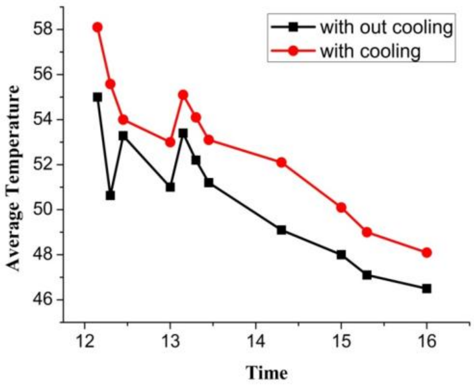

Fig. 5. U type Average temperature versus Time

4.2 Effect Of Electrical Efficiency

In computing electrical efficiency of solar panel we recorded open circuit voltage and short circuit current value for every 15 minutes of hour from 12PM – 4PM.

Observations are made on both cooled panel and without cooled panel at same instant of time. It graphically shows that panel cooled is giving more electrical power compared to panel without cooled. From the graphical observation the efficiency of cooled panel increases to 0.6 percent compared to without cooled panel measured at same instant of time at same location. So, we had enhanced the performance of solar panel by cooling in our experimental setup.

In general the efficiency of solar panel ranges from 14-17% from the literature survey for every one degree Celsius above 25 degree Celsius there is a drop of 0.45% in efficiency approximately, if we consider at 2 noon the efficiency temperature is 53-65 degree Celsius. So, there will be drop of 7-8 % in efficiency. We got maximum of 8.9 % efficiency. It correlates with literature review,

$$\eta = [(\text{voltage}*\text{current})/\text{power input}] * 100$$

Power input = 1200w/sq.m

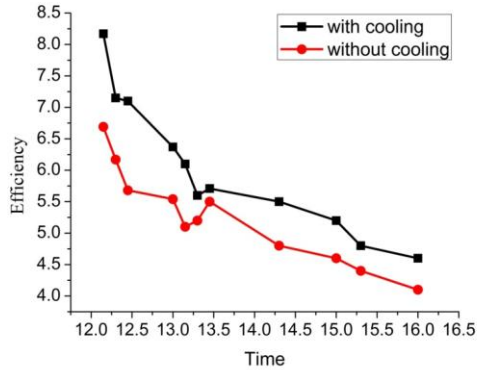

Fig. 6. Efficiency of cooling with C type cooling and without cooling

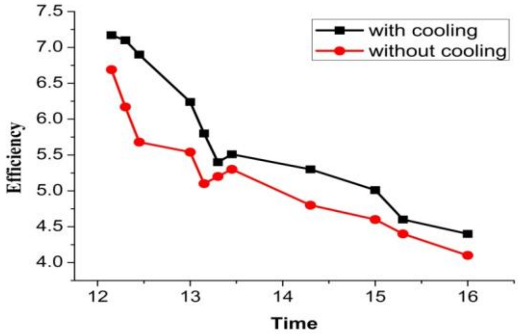

Fig .7 . Efficiency of cooling with U type cooling and without cooling

4.3 Effect Of Thermal Effectiveness

In general cooling will increase the heat transfer compared to without cooling as because of temperature as driving potential. As like in fins we compare heat transfer with fins and heat transfer without fins. Ratio between these two is effectiveness. Here also we found out thermal effectiveness of solar panels with cooling and without cooling and we showed graphical illustrations for experimental setup.

Effectiveness = [1 - ((Avg.Temp (with cooling)) – Amb.Temp) / (Avg.Temp (without cooling) – Amb.Temp))].

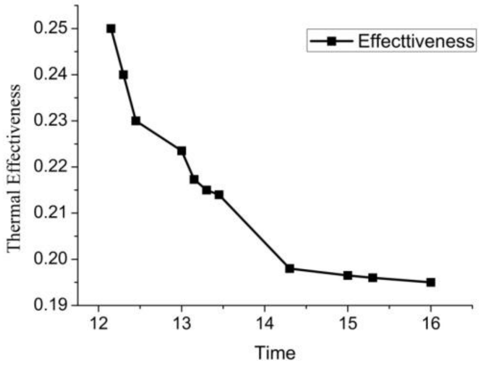

Fig .8 . C Type Effectiveness

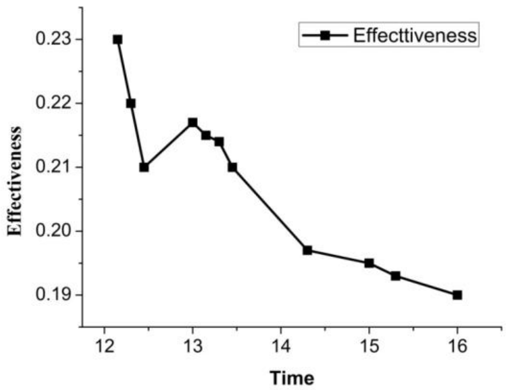

Fig. 9. U Type Effectiveness

4.4 Comparison Of Electrical Efficiency Of C-Type channel Vs U-Type Channel

In computing electrical efficiency of C-TYPE AND U- TYPE solar panel we recorded open circuit voltage and short circuit current value for every 15 minutes of hour from 12PM – 4PM.

From the graphical observation the efficiency of C-TYPE cooled panel increases the cooling percent compared to U-TYPE cooled panel measured at same instant of time at same location. So, we suggest to implement C-TYPE panel for the better performance of C-TYPE solar panel by cooling in our experimental setup.

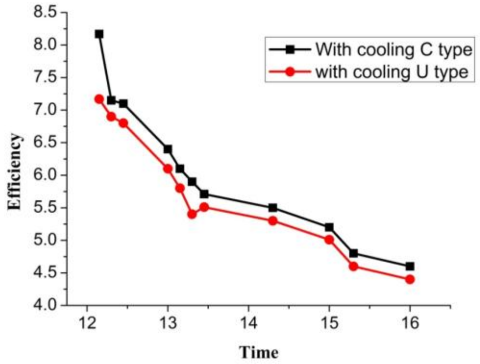

Fig .10 . Comparison of electrical efficiency of C type and U Type

V. CONCLUSION

In our experimental setup comparison of with and without cooling of solar panel using water is carried out through capillary action. We concluded that cooling lends 0.5% increase in solar panel compared to solar panel without cooling. Cooling of panels maintains below 50 degrees Celsius most probable time. It avoids the degradation of solar cells when it’s exposed to high temperature. Finally, effectiveness of our cooling is carried out compared to without cooling. By observation cooling is necessary at 12.00 PM – 4.00 PM. It is possible to cool and clean the PV panels using the proposed cooling system in hot regions. Maximum temperature difference attained is 11.5 degree Celsius with and without cooling.

The PV panels yields the highest output energy if cooling of the panels starts when the temperature of the PV panels reaches the maximum allowable temperature (MAT), i.e., 50˚c.. In our experimental setup we use the two different type of panels such as C-TYPE panel and U-TYPE panel. We identify the performance of that two panels by the observation. From the basis of graphical observation the efficiency of C-TYPE cooled panel increases the cooling percent compared to U-TYPE cooled panel measured at same instant of time at same location. So, we conclude our result with the suggestion to implement C-TYPE panel in Solar Panel cooling setup for the better performance of C-TYPE panel by cooling in our experimental setup.

REFERENCES

[1]. D. Revati, E. Natarajan, “ Enhancing the Efficiency of Solar Cell by Air Cooling”,

[2]. Indian Journal of Science and Technology, Vol 9(5),DOI:10.17485/ijst/2016/v9i5/87274, February 2016

[3]. Y.M.Irwana,, W.Z.Leowa , M.Irwantoa, Fareq.Ma, A.R.Ameliaa, N.Gomesha,I.Safwatia, “Indoor Test

Performance of PV Panel through Water Cooling Method", Energy Procedia 79 (2015) 604 – 611

[4]. Calebe A. Matias, Licinio M. Santos, Aylton J. Alves, Wesley P. Calixto, "Increasing Photovoltaic Panel Power Through Water Cooling Technique," Transactions On Environment And Electrical Engineering Issn 2450-5730 Vol 2, No 1 (2017)

[5]. Mohit Mahajan, Brij Bhushan, Tarun Mahajan, Rakesh Kundra, " Experimental Investigation Of Water Cooled Photovoltaic Panel With Jute Wick Structures", International Journal of Advance Research in Engineering, Science & Technology, Volume 3, Issue 12, December-2016

[6]. Yogesh S Bijjargi, Kale S.S and Shaikh K.A, "Cooling Techniques For

[7]. Photovoltaic Module For Improving Its Conversion Efficiency: A Review", International Journal of Mechanical Engineering and Technology (IJMET), Volume 7, Issue 4, July–Aug 2016, pp.22–28

[8]. Jee JoeMichael, IniyanS, RankoGoic, "Flat plate solar photovoltaic–thermal (PV/T)systems: A reference guide", Renewable and Sustainable Energy Reviews, 51(2015)62–88

C. Anbumeenakshi,etal. "Performance Enhancement of solar PV Panel by water cooling technique." *International Journal of Engineering Research and Applications (IJERA*), vol.10 (04), 2020, pp 32-36.