Journal of The Gujarat Research Society
ISSN: 0374-8588
Volume 21 Issue 9, September 2019

IMPROVEMENT OF SOLAR PANEL EFFICIENCY

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Abstract

With the increase in surface temperature of solar cells or panels their efficiency decreases quite dramatically. To overcome the heating of solar cell surface, water immersion cooling technique can be used i.e. it can be submerged in water so as to maintain its surface temperature and provide better efficiency at extreme temperatures. Temperature effect on the performance of a photovoltaic module is one of the main concerns that face this renewable energy, especially in hot arid regions. Overheating of the PV modules significantly decreases the open circuit voltage and the modules' performance. Water-cooling is created in this work to boost the efficiency of PV modules. Under hot arid weather conditions, various situations are tested: front, back and double cooling. If a direct contact water system is used for the back cooling, a spraying system is used for the front cooling.

Keywords: *Cooling, Cell Energy, Solar panel, Temperature.*

I. INTRODUCTION

One of the most important forms of renewable energy is solar photovoltaic energy. It has undergone a huge research and development in the recent past and is still developing. A solar cell is a device that directly converts the energy in sunlight to electrical energy through the process of photovoltaic. Charles Fritts, who used junctions created by coating selenium (a semiconductor) with an extremely thin layer of gold, constructed the first solar cell around 1883. A thin film cell sandwiched between two glass layers was made in 2009. This source proves to be a highly effective, economic and environmentally friendly type of energy source for countries that have high solar irradiation reception. There are different variables that influence a solar cell's production. Cell temperature and efficiency in energy conversion are some of them[1]. The explanation for solar cells' low performance is their low efficiency of energy conversion. The photon that has higher energy than the band difference will also only add to the electrical energy output. Cell temperature has a remarkable influence on its performance as well. In addition to the patents and papers reviewed in this field, more and more patents have recently been filed in this area. The efficiency of the electric cell decreases as the operating temperature increases. Earlier, solar cells had less than 1% efficiency. Many studies have been done and are still going on to increase a solar cell's efficiency, keeping the cost

ISSN: 0374-8588
Volume 21 Issue 9, September 2019

constraint in mind[2]. The researchers have left no stone unturned in developing technologies to increase solar cell performance, from improving the cell material to figuring out the optimum operating conditions. The overall photovoltaic research efficiency is over 40 percent. Some of the innovations from the material perspective include polymer solar cells, Dye sensitized solar cells. Cooling also offers a good solution to the issue of low performance. Via studying the efficiency of solar cells using various technologies and different cooling liquids, several attempts have been made to find an effective cooling technology. Immersion cooling using water as the coolant is one such technique. Using water as the immersion liquid, panels are fitted with liquid super-concentrators having liquid imaging lenses externally disposed of. The efficiency and output power of the PV module have been found to be inversely proportional to its temperature. The efficiency of a commercial panel placed in water is improved by two main effects[3].

Photovoltaic cell is one of the most popular renewable energy devices to directly convert the solar radiation into electricity. However, during operation conditions its performance can be affected by various factors and may significantly decrease its electrical performance. Temperature is one of the key factors influencing electrical performance, especially in hot weather, such as in the UAE, when the temperature of the cell can reach 70 ° C. The output power will decrease by up to 0.65 percent /K under these conditions, the fill factor to 0.2 percent /K and the conversion efficiency of the PV module to 0.08 percent /K above the operating temperature. In fact, more than 80 percent of the solar radiation falling on photovoltaic (PV) cells is reflected or converted to thermal energy rather than converted to electricity[4]. A cooling system is necessary for high solar irradiation and warm conditions in order to overcome this problem. Generally, some techniques like air-cooling and water-cooling are used to cool the PV module to increase its efficiency. Water-cooling is one of the most important methods for cooling photovoltaic modules, as it is more coolant that is efficient. In this paper, back front and combined cooling are investigated and compared to enhance the performance of a photovoltaic module[5].

In order to prevent a decrease in electrical efficiency, both water and air are ideal for use as a cooling fluid to cool the PV module. A typical value for temperature loss of PV efficiency is 0.5 percent /oC, although this varies with the cell type. Solar cells have also shown to improve performance directly immersed in silicone oil. Under high illumination, solar cells can have temperature increases with the resulting decreases in cell efficiency. Direct liquid immersion cooling of CPV cells shows substantial benefits compared to passive cooling and traditional active cooling. The author used a water cooling system on the front and back of the PV module and discovered that during clear days, the cooling system could increase the performance of the PV module, while during cloudy days it had disadvantages. However, cell submergence has been an effective way of reducing surface temperature. The work in this paper aims to evaluate the performance of a solar panel submerged for cooling in water at different depths and compare the results to achieve an optimal depth for maximum increased efficiency. Several experiments and studies on increasing the efficiency of PV by various cooling techniques have been carried out[6]. By substituting the front glass layer with a thin layer of 1 mm running directly over the PV face, the author proposed a method of minimizing reflection to cool the PV. As a result, the temperature of the PV decreased to 22 ° C and the electrical output improved over the day to 10.3 per cent. The non-homogeneous thickness of the water film, which is important to decide the optimum water film in order to improve optical efficiency, is one of the disadvantages of this design. Not only are electrical parameters such as maximum power, maximum power current, maximum power voltage, fill factor (FF), open-circuit voltage (Voc), tolerance valued value percent, short-circuit current (Isc) the key indicators in measuring the efficiency of a solar PV system, but also environmental factors and negative impacts such as ambient temperature have to be taken into account. In the process of energy conversion, PV panel temperature plays a crucial role. The temperature of the operating panel determines the velocity of induced electrons and holes moving through a circuit (by photons). This is due to the fact that with the rise in temperature, the material resistance increases linearly. Similarly, resistance decreases as the temperature decreases. This merely pointed to a point in which the panel's efficiency increases when the temperature decreases or remains below 45 C. All previous works seconded this point and agreed that the panel efficiency increases when the panel temperature or operating temperature decreased[7].

Air cooling was also reported to be an alternative way of cooling parts of the panels via backside of the panel. Mazón-Hernández et al. reported backside cooling the solar panel by air method. Air cooling can be divided into two strategies that are forced by natural convection or air. The various sizes of the underlying space of the solar panel were checked for air convection. The team found that the performance of the solar panel with larger underlying space improved by 0.9 percent compared to smaller underlying solar panels. One of the solar panels with a fan was mounted for the air-forced approach. Mazón and his group discovered that the electrical strength of the fan-cooled solar panel is 3-5 percent greater than that of natural convection. PV array improvement based on the technique of water spraying. This experiment was carried out for a day in Ramadi, Iraq, during the daytime. The process was conducted for the cooling purpose by thin continuous film water flowing on the front of the panels and also minimizing reflection loss[8]. Five solar panels were used by the team and linked in parallel. The process by which the solar panel is cooled by intermittent cooling (ICT) and continuous cooling techniques (CCT). The team used and positioned two mono-crystalline solar panels for orientation. Thin water layers were continuously sprayed on one of the solar panels for 35 minutes (CCT). For ICT, thin film water layers were sprayed on the solar panel for 30 seconds and then stopped spraying for three minutes and the work was repeated.

With the emergence of the micro-nano-systems, one research team tapped and integrated this technology into cooling of the panels as reported by Micheli. Kermani et al. proposed the use of miniaturized manifold micro-channels to cool in achieving higher panel efficiency On a similar course, Tang et. Al. showed proof-of-principle using the latest series of micro heat pipes to cool the solar panel[9]. The heat pipe has been split into two sections, the evaporator section and the condenser section. In the evaporator portion, the heat from the solar panel vaporizes the liquid and is transferred to the condenser section. The theory that the team used was the technique of heat transfer. Compared to ordinary solar panels, the efficiency of using air cooling increases by 2.6 percent, while the efficiency of using water cooling increases by 3 percent compared to the form of air cooling. Water cooling of the solar panel by the sponge process of water absorption. To maintain the temperature of the solar panel, water circulation droplets through the sponge were used. A polycrystalline solar panel with an area of 36 x 27 cm2 and 12 watts was tested. A solar panel cooling system consists of five liters of water cane, a flowing knob tube, water absorbing sponge and a drain pipe for collecting water. Solar cell efficiency improved by 12 percent when temperatures fell by a maximum of 4 ° C.

 ISSN: 0374-8588
Volume 21 Issue 9, September 2019

II. CONCLUSION & DISCUSSION

This article has presented electrical performance of the solar photovoltaic using water. Immersion cooling technique. The electrical performance of a PV panel is sensitive to its operating temperature and can significantly affect when cell temperature starts to rise. In order to overcome this problem, a cooling system is required to decrease the temperature and enhance the electrical performance. Different cooling methods are presented and analyzed to improve the operation of the photovoltaic system. Electrical efficiency of the panel was observed, which clearly depicts the improvement in the performance of the panel and encourages the use of water immersion cooling technique in Concentrated Photovoltaic (CPV) systems where the cell temperature increases and results in the decrease of electrical efficiency of the cell. Therefore, after this a high concentration photovoltaic system will be used with array of convex lens as concentrator. This will further increase the electrical efficiency of the panel and the system will be highly efficient.

III. REFERENCES

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