Study of Photovoltaic Panel by Nano-Fluid

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ABSTRACT:-
Utilizing nanofluid as an absorber fluid is an effective approach to enhance heat transfer in solar devices. The purpose of this review is to summarize the research done on the nanofluids' applications in solar thermal engineering systems in recent years. The operating temperature of the PV system greatly affect the system efficiency. To resolve this problem, cooling techniques are used to dissipate the heat from PV/T module. An experimental has been setup to investigate the thermal efficiency of the PV/T module using nanofluid at constant mass flow rate. $AL_2 O_3$ water nanofluid is used to reduce the operating temperature of PV/T panel.

Keywords:- Photovoltaic (PV), ANSYS Software, Nano-fluid, Al_2O_3

I. INTRODUCTION

Both energy utilization and population are expanding correspondingly and dramatically as time moves. The majority our daily required energy are currently met by conventional(fossil) fuels. The majority of our current equipment is reliant on conventional (fossil) fuels such as gasoline, diesel, and coals. The disadvantages of this technology are that they are restricted and are a major contributor to global warming, which raises a slew of difficulties that can, may, or are causing harm to the ecosystem that allows life on Earth to thrive. Because our fundamental daily requirements, excluding travel, rely fully on electricity generated by fossil fuel as an energy source, attempts have been made to develop green energy sources that will not harm the environment. Hydroelectric plant, nuclear plant (though radiation emission is a concern), solar cell, geo-thermal energy, tidal power plant, and other options were presented. The importunacy of solar cells (photovoltaic cell) is one of the best source of energy as it uses the Sun energy, which is clean energy sources.

The Sun generates a total of 3.846×1026 W each second. The Sun spews 4.3 ×1010 J onto the Earth's surface per hour. In comparison, the total annual energy usage of humans is approximately 4.1×1020 J. That's why the world is moving towards solar energy [1, 2]. A device known as a photovoltaic cell is used to utilizes the sun energy and transform this energy into electric power energy directly. Now, governments all over the world are promoting and applauding the uses of solar cell (Photovoltaic Cells).

The main problem with photovoltaic cell is its efficiency. Our Photovoltaic Cell's efficiency determines how much solar energy it can capture. Photo-voltaics Silicon based cell are 20-22% efficient, unfortunately. Other material is being developed that may increase its efficiency, but in the meantime, some simple methods and approaches are to boost the performance of photo-voltaic cells are proposed. As the temperature rises inside the semiconductor material the band gap comes closes, raising a little non perceptible current while simultaneously lowering the voltage, resulting in a 2.2 mV reduction per °C [3, 4].

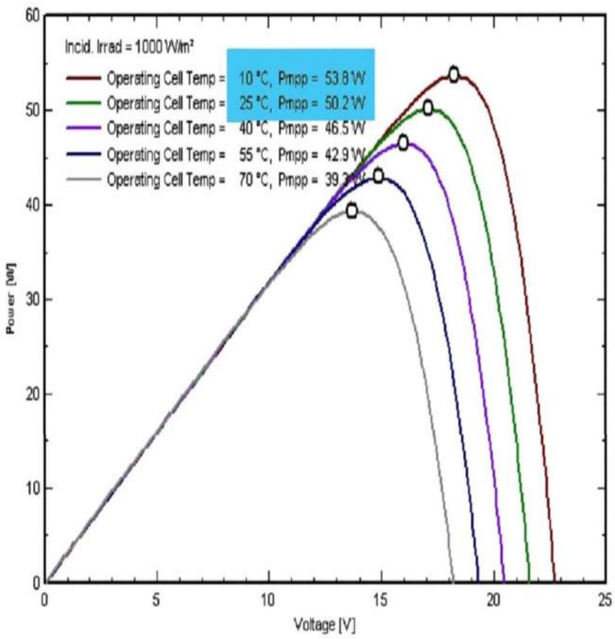

Figure 1: Power vs Voltage of PV-panel [4]

As the surface of the solar panel is under high temperature due to sun light, the panel get heated up to 65°-70° C, lowering its efficiency. When there rise in temperature, a small increment in current is noted, but a significant loss in the voltage also get noted. Silicon (Si) semiconductor was employed in this project. Increased temperature helps to narrow the bandgap, allowing for a slight increase in current. However, because of reverse saturation current is directly dependent on temperature, it also increases, lowering the photovoltaic cell voltage nearly around 2.20 mV for each °C increase [5, 6].

II. LITERATURE REVIEW

A. Almuwailhi et al. (2020) have investigated the effect of solar photovoltaic panel cooling under the climatic conditions of Riyadh. As the air velocity increased the forced heat transfer coefficient also increased. An enhancement of 4.4% in efficiency was observed in the panel efficiency. A 4% of temperature drop was also observed. Average temperature drop of 6 °C observed at velocity of 3m/s.

M. Abdolzadeh et al. (2008) investigated the experimental analysis to improve the conversion efficiency of photovoltaic water pumping system by spraying water on the front of photovoltaic cells. The efficiency of PV panel subsystem efficiency and its total efficiency increased by 3.26%, 1.40% and 1.35%, respectively, at 16 m head have increased.

Abdulhammed K. Hamzat et al. (2021) have investigated the performance analysis of nanofluids application in PVT systems as a coolant or optical filter that enhances the net exergy and energy efficiencies of the system as compared to the other PVT cooling systems.

Mohamed R. Gomaa et al. (2020) done experimental investigation on observed that power generated, solar thermal conversion efficiency of closed water and passive coolings methods are 11.6 W, 4.5%, and 12.75 W, 4.76%, respectively. After analysis concluded that the conversion efficiency increases in case of passive cooling methods more than the conventional methods.

Xinyue Han et al. (2020) investigated the experimental analysis at different concentration ratio and sun's position and found that with the concentration ratio of 5, there was increase in the instantaneous total efficiency was 73.20% at 17: 00 and with 7.55% coming from the electricity and its average total efficiency for the whole day is around 53.66% with 7.64% coming from electricity.

Tsai et al. (2009). have investigated the thermal conductivities of $Fe3O4$ and $Al2O3$ and reached on a conclusion that if there is increase in the thermal conductivity of nanofluids such as $Fe3O4$ it imparts the Brownian motion. However, this motion imparts minor impact on the thermal properties of $Al2O3$ nanoparticles thermal conductivity.

Hu et al. (2016). investigated the thermal performance of solar photo voltaic cell on the impact of variable climate conditions. The results obtained during analysis showed high electrical output and enhancement in thermal energy efficiency.

Hazami et al. (2016) done experimental investigation on houses and buildings under Tunisian climatic conditions. After analysing the data obtained during analysis, they reached on a conclusion that the maximum electrical and thermal energy efficiencies obtained to 15 and 50%, respectively, in active mode.

Mojumder et al. (2016) investigated the system by single air pass cooling system. Rectangular fins were used to dissipate the heat from the surface. The performance was analysed by equation solver to analyse the electrical output and thermal efficiencies. 13.75% maximum electrical and 56.19% increase in thermal efficiency was obtained.

Ibrahim et al.(2014) investigated the cooling system of PV panel and it was used to analyse the performance of a multi-crystal photo-voltaic (PV) panel used in BIPVT application. The polycrystalline silicon PV panel system consisted of a single glazing sheet attached with a flat plate collector. Water was used as cooling fluid. The thermal efficiency of the PV/T system obtained was about 55–62% and 11.4% was the maximum electrical efficiency achieved.

Alzaabi et al. (2015) investigated the cooling system by implementing a hybrid photovoltaic thermal (PV/T) system and water was used as a cooling fluid. The performance of PV panel was increased by the water employment. The study was conducted in the climatic conditions of UAE during spring season (April) 2014. The results indicated an increment in the electrical efficiency of the PV system from 15 to 20% compared to PV panel without hybrid system. The thermal efficiency of the proposed system was between 60 and 70%.

III. PV COOLING TECHNQIUE

There are different types of cooling methods and of them are quite simple and easy to use, and widely used world over.

Air cooling

Air cooling is simply the process of transferring heat from the surface of a photovoltaic cell to the ambient environment through the use of air. Experiments with various air-cooling technologies have been done by researchers.

Figure 2: solar cooling by forced air [5]

The experiment examined the power output of the Photovoltaic Panel when different air-cooling systems were used against when no cooling was used. When the temperature was raised, the total efficiency declined in both cases, but the air-cooled Pv panel outperformed the uncooled Photovoltaic panel. Forced air movement with a fan or a blower, as well as natural convection, were used to apply air to the panels. The fan reduced the power output because it was powered by the solar panels.

Cooling by water

Water sprays splash over the panel's surface with 11 or more than nozzles in a water cooling system, which cools the panel. The water sprinklers were tested in three different configurations:

(A) Single Side Cooling: In Grubisic-research, Cabo's either the front or back side of the cooling apparatus was sprayed on the cooling system. The Power developed was 40.1 W for the front side only, and 39.9 W for the back side. Irwan also carried out an interior experiment in which a 500 W bulb was utilised as a solar simulating device. Two pv cell, each rated at 50 watts, were used. One of the panels drove a DC pump that water was sprayed on the panels top surface. The temperature of panel in working condition is decreased by 6-24 degrees Celsius as a result of the experiment. (B) Double Side Cooling: When it came to overall performance both side cooling was the best. The maximum power given was 40.8 W, with a 7.7% increase in efficiency. (C) Without cooling: When no cooling is applied the lowest of the values, which are about 34 W of maximum power given and 14 percent efficiency.

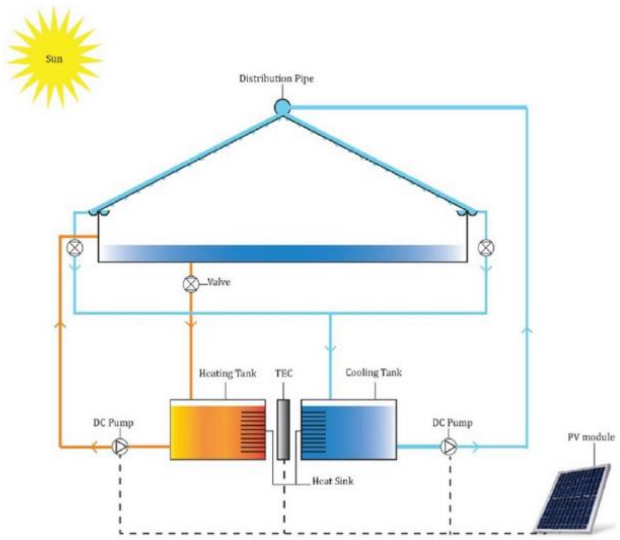

Figure 3: Water cooled solar panel [8]

Hybrid pv system/thermal (PV/T)

Water is beneficial since it can be utilised for a variety of other general and home functions. This is the most common and widely used PV cell method. As shown in Fig. 4, the hybrid system uses a cooling device to keep a PV panel array cool. The coolant goes through the Panel when heated and can either be recycled and reused.

The most popular coolants are water and air. The efficiency of a water-cooled photovoltaic panel increased by 50% when tested in the warmest months of the year, June and July. The optimum months to conduct Cooling system experiments are June and July, because each parameter influencing the Cooling system and the efficiency of the pv panel is minimised. There will be loss of some amount of water due to evaporation because the system is open to the environment, 5% loss of water was observed when compared to the Tank volume. The measurements were collected at a span of 15 minutes during a constant solar irradiance to the pv panel, and were based on the correlation between the efficiency of pv panel, total irradiance, and power output.

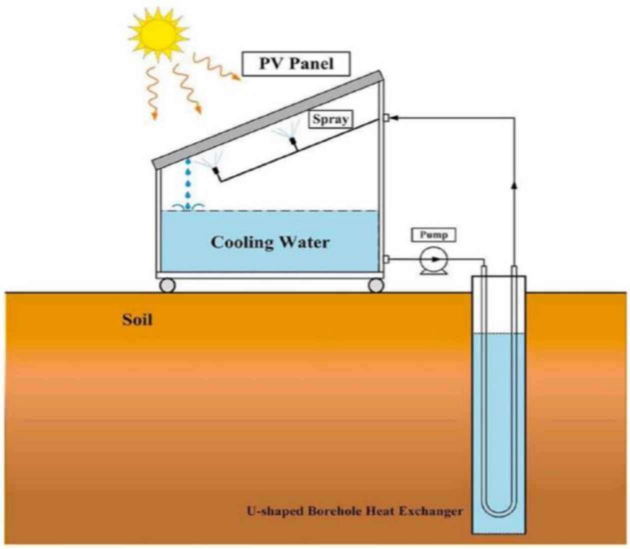

Figure 4: Photo-voltaic thermal cooling [9]

IV. CONCLUSION

Nanofluids have been utilized to improve the efficiency of several solar thermal applications. Theoretical and experimental studies on solar systems proved that the system performance enhances noticeably by using nanofluids. A number of investigations presented the existence of an optimum concentration for nanoparticles in the base fluid. Adding nanoparticles beyond the optimum level no longer enhances the efficiency of the solar system. Optimal conditions are a function of nanoparticles size and concentration, base fluid, surfactant and pH as discussed throughout this article. Nanofluid utilization in the solar thermal systems is accompanied by important challenges including high cost of production, instability, agglomeration and erosion. This review article is an attempt to elucidate the advantages and disadvantages of nanofluids application in the solar system.

REFERENCES

[1] Matalqah, Mohammed. Development and experiments with the Ionospektroskop and a comparison with selected ionospheric parameters. Technische Universitaet Berlin (Germany), 2015.

[2] Paul, Sam Joseph, Uddeshya Kumar, and Siddharth Jain. "Photovoltaic cells cooling techniques for energy efficiency optimization." Materials Today: Proceedings 46 (2021): 5458-5463.

[3] Zaini, N. H., M. Z. Ab Kadir, M. Izadi, N. I. Ahmad, M. A. M. Radzi, and N. Azis. "The effect of temperature on a mono-crystalline solar PV panel." In 2015 IEEE Conference on Energy Conversion (CENCON), pp. 249-253. IEEE, 2015.

[4] Moharram KA. Improving the performance of the photovoltaic panel in hot and desert areas, M.Sc. thesis, Faculty of Engineering and Material Science, German University in Cairo, Egypt; 2012.

[5] Hamzat, Abdulhammed K., Ahmet Z. Sahin, Mayowa I. Omisanya, and Luai M. Alhems. "Advances in PV and PVT cooling technologies: A review." Sustainable Energy Technologies and Assessments 47 (2021): 101360.

[6] Anand, Abhishek, Amritanshu Shukla, Hitesh Panchal, and Atul Sharma. "Thermal regulation of photovoltaic system for enhanced power production: A review." Journal of Energy Storage 35 (2021): 102236.

[7] Rosa-Clot M, Rosa-Clot P, Tina GM, Ventura C. Experimental PV-thermal power plants based on TESPI panel. Sol Energy 2016;133:305–14.

[8] A. Homadi, T. Hall, L. Whitman, Study a novel hybrid system for cooling solar panels and generate power, Appl. Therm. Eng. 179 (2020) 115503

[9] Gomaa, Mohamed R., and Hegazy Rezk. "Passive cooling system for enhancement the energy conversion efficiency of thermo-electric generator." Energy Reports 6 (2020): 687-692.

[10] Han, Xinyue, Xiaobo Zhao, and Xiaobin Chen. "Design and analysis of a concentrating PV/T system with nanofluid based spectral beam splitter and heat pipe cooling." Renewable Energy 162 (2020): 55-70.

[11] Fesharaki, V. Jafari, Majid Dehghani, J. Jafari Fesharaki, and Hamed Tavasoli. "The effect of temperature on photovoltaic cell efficiency." In Proceedings of the 1stInternational Conference on Emerging Trends in Energy Conservation–ETEC, Tehran, Iran, pp. 20-21. 2011.

[12] Almuwailhi, A., and O. Zeitoun. "Investigating the cooling of solar photovoltaic modules under the conditions of Riyadh." Journal of King Saud UniversityEngineering Sciences (2021).

[13] Abdolzadeh, M., and M. Ameri. "Improving the effectiveness of a photovoltaic water pumping system by spraying water over the front of photovoltaic cells." Renewable energy 34, no. 1 (2009): 91-96.

[14] Gomaa, Mohamed R., and Hegazy Rezk. "Passive cooling system for enhancement the energy conversion efficiency of thermo-electric generator." Energy Reports 6 (2020): 687-692.

[15] Xinyue Han et al.(2020). Under the solar irradiance in a typical day with concentration ratio of 5 suns, the instantaneous total efficiency of the system reaches a maximum value of 73.20% at 17: 00 with 7.55% coming from electricity and its average total efficiency for the whole day is around 53.66% with 7.64% coming from electricity.

[16] Tsai TH, Kuo LS, Chen PH, Yang CT. Thermal conductivity of nanofluid with magnetic nanoparticles. In: Progress in electromagnetics research symposium, Beijing, China, March 23–27, 2009.