"Experimental Investigation of Photovoltaic Panel Cooling Using Passive Inserts" A Review

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ABSTRACT

The performance of PV panel depends on the environmental factors, which is solar radiation and operating temperature. These environmental factors will be reduced the effectiveness of PV panel due to increase in operating temperature of PV panel. To improve the performance of Photovoltaic cell different types of augmentation technique are used which include active, passive and combine technique. The passive technique is widely used because it is not required extra power. In passive technique use twisted tape or wire coil different type of insert's which is placed in flowing fluid in tube then turbulence will create. Then laminar flows gets convert in to turbulent flow which result increases in heat transfer rate is used to overcome the problem of low efficiency of Photovoltaic panel with water flow to the backside of PV panel. This water cooling mechanism is one way for maintaining a low operating temperature during its operation period. The experimental results mentioned that the decrement of operating temperature and increase the power output of the PV panel with water cooling mechanism based on different fixed of solar radiation.

Keywords: ***Photovoltaic panel, Heat transfer, Augmentation technique, Insert, Operating temperature.***

1. *INTRODUCTION:*

Nowadays, with the fast development of the global health, the energy crisis has developed into one of the principal issues. The solar energy utilization very less as compared to the complete energy consumption. In India. with the raise of residential area buildings amounts in India, the energy issue has been very serious. For the moment the environment issue brought by the conventional energy consumption structure (coal mainly) and the high solar energy consumption will certainly limit economic development in the future. The solar energy utilization for in the North of India occupies a large percentage of the whole solar energy consumption. The resource of Sun energy in India is abundant, and the annual sunlight hours are more than 2000 h. The solar energy is particularly huge in most heating region in the North of India, which makes the solar buildings possible. Photovoltaic cell is the direct conversion of solar energy in to electric energy by using the photovoltaic principle of semiconductor, is one of the most hopeful utilization technology of solar energy. The photovoltaic technology is rarely restricted by region because the solar energy that reaches the earth is spread out over a large area. Moreover, photovoltaic is a noiseless, pollution-free safe Eco friendly and reliable technology.

However, the photovoltaic effectiveness of common solar cells is between 4% and 17%, which is with sensitivity affected by working temperature. In practical applications, a large portion of solar energy will be stored by solar cells in the form of heat. This part of heat energy is very difficult to be removed from solar cells by natural convection and the resulting increasing working temperature of solar cells leads to a declining photovoltaic efficiency consequently. To improve the performance of Photovoltaic cell different types of augmentation technique are used which include active, passive and combine technique. The passive technique is widely used because it is not required extra power. In passive technique use twisted tape or wire coil different type of insert's which is placed in flowing fluid in tube then turbulence will create. Then laminar flows gets convert in to turbulent flow which result increases in heat transfer rate. is used to overcome the problem of low efficiency of Photovoltaic panel On the other hand, solar thermal is also common application of solar energy. Via heat collectors, the solar thermal energy can be used for heating working fluid. If water is used as the working fluid, the hot water can be produced for domestic use.

Generally, enhancement techniques can be classified in three broad categories:

A. Active Method

Active augmentation, which has been studied extensively, involved some external power input to bring about the desired flow modification for enhancement and has not shown much potential owing to complexity in design. Furthermore, external power is not easy to provide in several applications.

B. Passive Method

This method does not need any external power input and the additional power needed to enhance the heat transfer is taken from the available power in the system .Tube insert devices including twisted tape, wire coil, extended surface and wire mesh inserts are considered as the most important techniques of this group; in which, twisted tape and wire coil inserts are widely applied than others

C. Compound Method

A compound method is a hybrid method in which both active and passive methods are used in combination. The compound method involves the complex designs and hence it has limited applications.

2. LITERATURE REVIEW:

2.1 H. Bahaidarah , Abdul Subhan , P. Gandhidasan , S. Rehman

The performance of PV cell (photovoltaic) module is highly dependent relative on its operational temperature. Generally the Sun energy absorbed by the solar cell is changed to heat energy which is usually lost and provides no value. In order to study the performance of a hybrid PV water cooled system, a numerical model (electrical and thermal) is developed using EES (Engineering Equation Solver) software. The model predicts various electrical and thermal parameters affecting its performance. The effect of cooling the module by incorporate a heat exchanger (cooling panel) at its rear surface is also investigated experimentally. The results of the numerical model are found in good agreement with the experimental measurements performed for the climate of Dhahran, Saudi Arabia. With active water cooling, the unit temperature fall noticeably to about 20% leading to an increase in the PV panel efficiency by 9%.

2.2 Ming-Tse Kuo and Wen-Yi Lo:

In this paper, concentrator photovoltaic (CPVs) were used to integrate the removal of Sun light energy and thermal energy. The water cooling system that is proposed in this paper provides effective cooling by circulating cold water to remove heat from the photovoltaic's module. The practical results were consequently analyzed and compared with the power generation efficiency of the examined photovoltaic cell. The use of cooling system

improves the power generation capacity of the solar cell by 2%–15% and increase the power generation efficiency of the photovoltaic by 2.29%–3.37%. Through the combined application of photovoltaic and thermal technologies, the total energy of the overall system can be improved by 37%–59% even after accounting for the energy consumption of the cooling system. As a result, environmental safety energy reserves, and raise in the effectiveness of sunlight utilization can be achieved. Finally, neural network was used to optimize this increase in effectiveness.

2.3 Karima E. Amori, Mustafa Adil Abd-AlRaheem:

In the existing work a effective study for thermal and electrical performance of different hybrid PV/T collector's designs for Iraq climate conditions have been carried out. Four various types of air based hybrid PV/T collectors have been produce and tested. The PV/T collectors consist of four important parts namely, channel duct, glass cover, axial fan to circulate air and two PV panels in parallel connection. The measured parameters are, the temperature of the upper and the lower surfaces of the PV panels, air temperature along the collector, air flow rate, pressure drop, power produced by solar cell, and climate conditions such as wind speed, solar radiation and ambient temperature. The thermal and hydraulic performances of PV/T collector model IV have been analyzed theoretically based on energy balance. A Mat lab computer program has been developed to solve the proposed mathematical model. The obtained results show that the combined efficiency of collector model III (double duct, single pass) is higher than that of model II (single duct double pass) and model IV (single duct single pass). Model IV has the better electrical efficiency. The pressure drop of model III is lower than that of models II and IV. The root mean square of percentage deviations for PV outlet temperature, and thermal efficiency of model IV are found to be 3.22%, and 18.04% respectively.

2.4Tony Ho, Samuel S. Mao and Ralph Greif:

The solar concentration limit for densely packed, high-concentrated photovoltaic (HCPV) cells was analyzed for a novel two-phase cooling design. Eight working fluids were examined in the two-phase cooling analysis: R134a, R11, R113, R114, R123, R141b, water, and ammonia. In addition, the study investigated the concentration limit for mass flow rates ranging from 10 À3 to 1 kg Results from an analysis of a novel HCPV two-phase cooling system [9] showed that the practical limits of solar concentration for the design to be approximately 2000 suns for the six organic fluids examined, whereas the limits approached 4000 and 6000 suns for water and ammonia, respectively. This observed higher concentration limit for water and ammonia at a given flow rate can be attributed to their larger heat capacities and latent heats when compared with the organic fluids examined. Using a thermal analysis developed by Royne et al. the temperature for typical, densely packed silicon PV cells was plotted.

2.5 Feng Shan, Fang Tang, Lei Cao, Guiyin Fang:

Building integrated photovoltaic (BIPV), a new concept in solar power generation field, refers to integrating the photovoltaic array into the retaining structure surface of buildings to provide electric power. Photovoltaic (PV) is the key technology in the applications of BIPV, and how to improve the photovoltaic conversion efficiency has obtained more and more attention. In this paper, a brief review on the photovoltaic–thermal (PVT) solar collector and system using various working fluid was presented. Via simulation, the performance of a hybrid PVT collector using refrigerant as working fluid was evaluated and analyzed for the typical weather condition in Nanjing, China. The simulation results show the influence of the meteorological parameters and the evaporating temperature on the photovoltaic and thermal performance of the hybrid photovoltaic–thermal collector. With the increase of the solar radiation intensity under the constant evaporating temperature, the temperature of the solar cell and the

temperature of the backplane rise, the photovoltaic efficiency reduces, and the overall photovoltaic power of the hybrid PVT collector increases.

2.5 Jin-Hee Kim, Se-Hyeon Park, Jun-Tae Kim:

In this study, a PVT air collector with a mono-crystalline PV module was designed, and an experiment was performed in order to confirm its electrical and thermal performance in an outdoor environment. From the experimental results, it was found that the heated air from air-based PVT collector had, on average approximately 5ć higher temperature than the outdoor air. The experimental results indicated that the thermal and electrical efficiencies of the PVT collector were, on average, 22% and about 15%, respectively. For the electrical efficiency, the PVT air collector was operated as the maximum output due to the prevention of PV temperature rise through forced exhaust. These mean that the performance of the PVT air collector was similar to performance of standard test condition (STC) without a decrease in efficiency due to PV temperature. Therefore, it was concluded that the heated air taken from the PVT collector can be supplied into the ventilation system in building as pre-heated fresh air, and contribute to better electrical performance at the same time**.**

2.7 Alok Kumar, Manoj Kumar , Sunil Chamoli:

This paper focuses on comparison of some of the most commonly used insert geometries. Insert geometry selected for this comparison is collection of core fluid disturbance, surface modification and combination of both. Different geometries taken in this study include twisted tape, twisted tape with ring, circular band, multiple twisted tape, twisted tape with conical rings, and so on and used air under turbulent flow regime as working fluid. On the basis of comparison made, it is observed that, in case of ‘‘single twisted tape insert” the thermal performance factor was maximum and in the event of ‘‘twisted tape with circular ring” the overall heat transfer rate is maximum. Future aspect is also proposed, which includes perforation in circular ring, and causes decrease in friction factor value because of less flow blockage.

2.8 Mohammad Sardarabadi , Mohammad Passandideh-Fard , Saeed Zeinali Heris:

In this research, the effects of using nanofluid as a coolant on the thermal and electrical efficiencies of a PV/T (photovoltaic thermal unit) are experimentally studied. Coolant fluids in the experiments are pure water and silica (SiO2)/water nanofluid 1% and 3% by weight (wt %). A brief uncertainty analysis is per- formed which shows that the measurements are sufficiently accurate. By converting the output electrical energy of the PV/T system into an equivalent thermal energy, it is found that the overall energy efficiency for the case with a silica/water nanofluid of 1 wt% is increased by 3.6% compared to the case with pure water. When using the silica/water nanofluid of 3 wt%, however, the increase is 7.9%. The thermal efficiency of the PV/T collector for the two cases of 1 wt% and 3 wt% of silica/water nanofluids are increased by 7.6% and 12.8%, respectively. The total energy of the PV/T system, with and without nanofluids, is also compared with that of the PV system with no collector. It is observed that by adding a thermal collector to a PV system, the total energy for the three cases with pure water, 1 wt% silica/water nanofluid, and 3 wt% silica/water nanofluid is increased by 19.36%, 22.61% and 24.31%, respectively.

2.9 Shashank S. Choudhari

Studied wire coil of different material like as copper, aluminium and stainless steel. He concluded that Nusselt number for tube in which coil wire insert are higher than that of without coil wire insert tube. Because of coil wire insert it creates some disturbance between flowing fluid and it develop boundary layer near the wall of pipe. Then temperature of the fluid is increases because contact surface area is increases. Similarly turbulence and whirling motion to water also create. He found that the maximum Nusselt number is obtained for copper coil wire than the

aluminium and stainless steel coil wire. The copper, aluminium and stainless steel coil wire insert in test section cause heat transfer enhancement up to 1.58, 1.41 and 1.31 respectively. From above data he is concluded that copper can be used as coil wire insert due high heat transfer than other material. Also concluded that coil wire insert in double pipe heat exchanger enhances heat transfer with considerable pressure drop.

2.10 Mr. Amit Waghode ,Mr. M.D. Shende:

The present review paper is on the performance of tube in tube type heat exchanger with different types of inserts. Heat exchanger are widely used in many mechanical industries, power plant etc. it is required to optimize the performance of heat exchanger. Therefore augmentation technique is used which include active, passive and combine technique. The passive technique is widely used because it is not required extra power. In passive technique use twisted tape or wire coil which is placed in flowing fluid tube then turbulence will create. Then laminar flows gets convert in to turbulent flow which result increases in heat transfer rate.

3. SUMMARY OF REVIEW

1. with an active water-circulation system and those of the photovoltaic without an active water circulation system at various temperature intervals, thereby obtaining actual-time projections regarding the finest time to start and stop the cooling system at every temperature interval.
2. The PV panel efficiency is sensitive to the panel temperature and decreases as the temperature of the panel increases. With active cooling technique, the working temperature of the module dropped extensively to about 20% and an increase of 9% in the electrical efficiency was observed.
3. The passive technique does not ne**]** The operating temperature increase reduces photovoltaic power generation efficiency and damages the solar cells. Therefore, a water-circulation system has been used to cool the heated surface of the solar cells, and increasing efficiency of PV panel due extraction of heat form surface water was heated stored in a storage tank.
4. During calculation, a neural-arrangement algorithm has been used to compare the power outputs of the photovoltaic ed any external power input and the additional power needed to enhance the heat transfer is taken from the available power in the system .Tube insert devices including twisted tape, wire coil, extended surface and wire mesh inserts are considered as the most important techniques of this group; in which, twisted tape and wire coil inserts are widely applied than others.
5. Several investigator using the twisted tape inserts were found to be increased up to 3.85 and 4.2 times and heat transfer performance was achieved to be 1.44 as compared to other insert.
6. The increment in thermal enhancement efficiency is higher for higher width ratio and it decreases with decreasing width ratio of twisted tape at constant pumping power. In general observation, it is found that the heat transfer, friction factor and thermal efficiency increased with increasing width ratio.

4. OBJECTIVES:

1. To re-evaluate the explore of different investigators in terms of inserts, which can improve convective heat transfer in heat exchanger and solar air heaters with minimum raise in friction losses.
2. To categorize different type of insert so that for a specific purpose particular form of insert can be selected as per the need.
3. To inspect the performance of photovoltaic cell with heat exchanger.
4. To verify the Nusselt number distribution of the heat exchanger.
5. The major purpose in this research is to enhance the PV module performance using back panel water cooling technique for the climate of India.
6. The hybrid system thus enabled the module to work at lower operating temperature and resulting in a higher power output.

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