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Review of Photovoltaic and Effective Front Cooling Method for Power Improvement

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Abstract: Performance of Photovoltaic module decline when PV surface temperature exceed specified operating temperature and causes drop in power generation and life of PV cell. The present work provides a basic concept of photovoltaic cell, photovoltaic effect, need of photovoltaic cooling and vigorous research and development conducted in past year about front cooling technologies. Many experimental, theoretical studies performed in a globe that demonstrates effectiveness of the front PV cooling technology. Observations stated that front cooling offers dual benefits of PV cooling and self-cleaning. Conclusion provided from the current study that photovoltaic cooling by front side offers better cooling and improves the performance in terms of electrical power enhancement

Keywords: Solar energy, Photovoltaic, excess heat, front cooling

I. INTRODUCTION

Renewable energy sources are becoming more and more popular, about the pollution and non-sustainability of common energy sources. With increasing human population, a question arises about next reliable energy source after the reduction in fossil fuels. The solar energy is promising alternative to fulfill energy demand of coming era [1]. There are two distinct types of energy that can produced: electrical energy and thermal energy. Electrical energy has ability to easily transferred to work, is more valuable than thermal energy. The most efficient way to get electrical energy is from direct solar irradiance via photovoltaic cells References

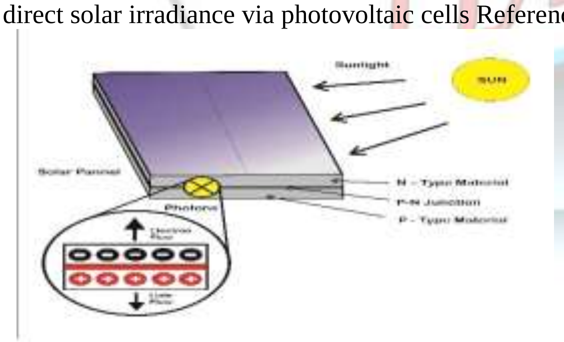

Fig 1 Schematic of Photovoltaic cell and internal features

Commonly known as solar cells, individual PV cells is electricity-producing devices made of semiconductor materials. When light gets absorbed by matter, photons are given up to excite electrons to higher energy states within the material. Particularly, this occurs when the energy of the photons making the light is larger than the forbidden band gap of the semiconductor. But the electrons which excited relax back quickly to their original or ground stat the extra energy of the excited electrons generates a potential difference or electron motive force (e.m.f.). These forces drive the electrons through a load in the external circuit to do electrical work.

Although the overall efficiency of PV cells ranges from about 5 % - 20 % [2], it is still higher than the total indirect efficiency when it comes to wind and biomass efficiency. However, it shows that the overall efficiency of photovoltaic cells drops drastically with an increase in temperature. The rate of decrease ranges from 0.25 % to 0.5 % per degree Celsius [3], depending on the cell material used. Especially for concentrated PV cells, which use concentrated sunlight to produce larger amounts of power, and reduces the cost of generally expensive PV equipment, the observations state that high temperatures greatly decrease the working life of the PV system.

In order to avoid limitation of PV and increase yield per unit PV area, Cooling mechanisms have already been proposed and development of cooling techniques continues. Nevertheless, a large amount of irradiated energy (up to 87 %) converts into heat. More recent developments are concentrating on harnessing that waste heat into useful thermal energy [4]. Generally, hybrid elements that harness both electrical and thermal solar energy called photovoltaic-thermal units.

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II. Literature review

Front cooling methods considered as those methods that continuously consume power to cool the PV module. Most of the methods used based on air or water cooling. Hence, in main consumption system pump or fan is necessary for maintaining fluid circulation. The active cooling method produced more power, but when power consumption taken into account, question arises if cooling system can support itself. When there is use of concentrated PV cells, active cooling system can easily be used, mainly because of fluid-to-cell mass ratio and the ability to use less cooling fluid. So that, the power required is less to maintain the system

Dr.Baskar, Gopikrishnan M, Dr P. Radhakrishnan: In this paper the system efficiency improved by maintaining the temperature of PV cell in certain limit. With the help of water sprayer solenoid valve and micro controller unit were used but some problems are there like anti reflective coating are not durable and design is expensive. At the end the gain of 8-9% can achieved with this system including power needed to run the pump.

Haitham M.S. Bahaidarah, Ahmer A.B. Baloch , Palanichamy Gandhidasan : In this study, investigation of uniform and non-uniform cooling techniques for PV string carried out subjected to the climatic data of Dhahran, Saudi Arabia. For the uniform cooling of PV panels, jet impingement configuration modeled and studied. Also to check the effect of non-uniformity, a rectangular channel heat exchanger investigated and compared with without cooled PV string. It is found that the jet cooling has higher efficiency, minimum cell temperature and temperature uniformity when compared with performance of heat exchanger. The two cooling techniques selected by the type of PV system involved, concentration ratios of system, pumping power and economic constraints.

Muhammet Kaan, Yesil Yurt, Mansour Nasiri, Ahmet Numan Ozakin: Different techniques used in this paper are for maintaining the temperature of PV cell for electrical efficiency and PV system. Liquid immersion water spraying , pvc systems PV thermal air system, photonic crystal cooling, are some of the active and durable techniques used for the decreasing the temperature of PV cell unit and avoid it from thermal degradation and decrease in electrical efficiency and hence this techniques are very useful for efficiency improvement.

Muhammad Adil Khan, Byeonghun Ko, Esebi Alois Nyari: The net electric power delivered by the solar PV system decreases with increasing temperature and decreasing solar radiation. In this paper silver-coated plane and spherical convex were less efficient and expensive than the Al foil used as a reflector. Experimental results showed that inexpensive Al foil as a reflector with the proposed BRPVS system increases the output power from 20–35% or more, which depend on the time of day and position of the solar panel. This study used for different cooling systems with the water sprinkling system. The active air-cooled fan system and closed loop system are comparatively more efficient that the heat sink-based passive cooling but both methods require continuous electric power for its operation.

Husam Abdulrasool Hasan, Kamaruzzaman Sopian, Ahed Hameed Jaaz found that back jet impingement cooling of photovoltaic module panel with nano namely SiC , TiO_2 , SiO_2 particle with base fluid as water significantly improves electrical as well as thermal efficiency of module. The cooling with SiC-Water fluid reported highest electrical, electrical thermal and thermal efficiencies were 12.7 %, 97.7 % and 85% at mass flow rate of 0.166 kg/s and solar irradiance of 1000 watt/square meter. The combined efficiencies of system followed by SiC , TiO_2 , SiO_2, water were 62.5% , 57%, 55%, 50%.

SandhyaS,Narciss Starbell R, Jims John Wessley G used water spray cooling method with 1kg/s mass flow rate of water is sufficient to drop temperature of PV panel to normal PV operating temperature and reported an increase electrical efficiency of 2.5 % to 3% when compared with non cooled PV panel. They also reported that un cooled PV panel temperature varies between 55 to 57 degree Celsius, electrical efficiency decreases by 0.53 % per increase in °C , solar radiation varies between 839 to 939 watt/ square meter for Coimbatore (Tamilnadu) site.

Lyth Mohasin, Ahmad sakhrieha, Ahmad Aboushi, Mohammed Hamdhana used prototype cooling and cleaning system for PV panel with comparison with non cooled and non cleaned PV panel its reported that there is increase in 8% of energy of cooled and cleaned PV panel when PV panel surface temperature maintained below 30°C

Salih Mohammed Salih, Osoma Ibrahim Abd experimentally present water spraying technique to improve photovoltaic efficiency and net power saving. A forced-water spraying and cooling technique with constant flow rate of water on PV surface designed. In this paper electrical performance of PV was also studied. The cooling rate of panel surface for 5min=4degee celcius per minute in middy. The economical result achieved as result of the power saving increase 7w/degree at midday. The total obtained power during the testing period is 18858 W (with spraying) and 16283 W for without cooling.

S. Nizetic, D.Coko, A. Yadav, F. Grubisic –Cabo studied simultaneous water spray cooling technique (back surface cooling + front surface cooling) used for reducing

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temperature of monocrystalline PV panel. The result show that relative increase in power output is 16.3% which is more than back surface cooling technique (14.0%) and front surface cooling technique (14.6%).

III. Conclusion

In the present work, effective conversion technique through photovoltaic effect is thoroughly studied. Its seen that PV system has huge capability to harness solar energy but restricted due to material characteristics. Hence front cooling method was successfully demonstrated by research community in resent period. Literature survey shows that water is commonly preferred cooling medium for front cooling technique. The various arrangement and flow pattern can incorporated for harnessing thermal power that will also optimize performance of PV system. It can said that, front cooling technique has enormous potential to improve efficiency but need further research on environmental and socio-economic factors.

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