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A Review On The Cooling Technique Of Solar PV System

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ABSTRACT

Being the most widespread renewable energy generation system, photovoltaic (PV) systems face major problems, overheating and low overall conversion efficiency. The electrical efficiency of PV systems is adversely affected by significant increases in cell temperature upon exposure to solar irradiation. There have been several ways to remove excess heat and cool down the PV to maintain efficiency at fair levels. A hybrid photovoltaic/thermal system cooled by forced air circulation blown by a PV-powered fan can set up, and a rectangular control volume with cylindrical ends has been built at the back of the PV panel where aluminum fins have been placed in different arrangements and numbers.

Keywords: photovoltaic/thermal solar cells; fins; electrical efficiency; heat transfer.

1. Introduction

A photovoltaic/thermal (PV/T) collector is considered to be a solar collector combined with a photovoltaic module and produces electricity and heat at the same time. Different kinds of solar energy systems are used in various engineering fields. There are mainly two types of PV/T collectors depending on the medium used to collect the thermal energy, air-based and water-based. PV/T air collectors are significantly advantageous than are PV/T water collectors, which require a variety of thermal collection materials depending on PV modules. One of the most important components of a solar energy system is the collector. The various applications of the solar energy collectors have been well recorded. Solar collectors can be used in various areas especially for drying, floor heating, and solar desalination and so on conventional solar air collectors have inherent disadvantages in lower thermal efficiency.

Two main systems are utilized from solar energy potential. The first one is solar photovoltaic (PV) system, which produces electricity with photon energy, and the other is solar panel (collector) systems, which use solar energy. The principal factor that influences the electrical performance of a PV panel is the type of PV cells being used.The efficiency of PV modules are highly dependent on which called as sustainability parameters surface temperature, dusting, radiation intensity and climatic conditions. The most important of these parameters is undoubtedly the panel surface temperature.

2. Literature review

A.Fudholi et al. [1] this paper is a review of these types of solar dryers with aspect to the product being dried, technical and economic aspects. The technical directions in the development of solar-assisted drying systems for agricultural produce are compact collector design, high efficiency, integrated storage, and long-life drying system. Air-based solar collectors are not the only available systems. Water-based collectors can also be used whereby water to air heat exchanger can be used. The hot air for drying of agricultural produce can be forced to flow in the water to air heat exchanger.

MuhammetKaanYeşilyurt et al. [2] in this study, a review was made on methods developed to increase the thermal and electrical efficiencies of PVT panels. The Demand for electricity generation from solar energy, which is a clean and renewable resource, is increasing day by day. It is desirable that the panel surface temperature is not excessively hot while generating electricity with PVT panels. High temperature causes thermal degradation and panel electric efficiency decrease. There are many studies in the literature about active thermal cooling of PVT panels used for electricity generation as well as for storing thermal energy.

GökhanÖmeroğlu et al. [3] in this paper proposed by the being the most widespread renewable energy generation system, photovoltaic (PV) systems face major problems, overheating and low overall conversion efficiency. The electrical efficiency of PV systems is adversely affected by significant increases in cell temperature upon exposure to solar irradiation. There have been several ways to remove excess heat and cool down the PV to maintain efficiency at fair levels.

A.-K. Hamid [4]The paper proposes a design to improve the electrical efficiency of PV panels using Water Hybrid Photovoltaic Thermal (PV/T) system. A prototype of a PV/T system is built and the electrical and thermal performances of the system are investigated under ambient temperature conditions. The system is composed of a polycrystalline PV panel with a solar thermal collector adhered to its backside. Experiments were performed with and without cooling process to observe the improvement in the PV panel efficiency.

O.V.Ekechukwua et al. [5]The efficient design and construction of solar-energy air-heating collectors are critical to the overall performance of the distributed (indirect mode) and mixed-mode designs of either active or passive solar-energy crop dryers. A review of the various designs and the performance evaluation technique of flat- plate solar-energy air-heating collectors for low temperature (i.e. temperature elevations between 10°C–35°C above ambient) solar-energy crop drying applications are presented. The appropriateness of each design and the component materials selection guidelines are highlighted.

3. Photovoltaic/Thermal Air (PVT-Air) Systems

In this method, the electrical efficiencies of the PV panels are increased by moving air over the panel surface to remove heat from the PVT system either through natural convection or forced convection. Forced convection systems, where air is blown or sucked by means of an electric fan, can be even classified into continuous or intermittent cooling. Efficiency calculations must account the power to operate the fan, which should surely no greater than the reclaimed power. Emphasizes that the fan should be a suction pump in order to prevent the fan itself heat up the feed air due to self-body heat after a certain period of operating time. An air channel with a steel frame is placed on the bottom of the PV panel. The air used as a working fluid is circulated through the channel to the surface of the PV panel via a fan, or buoyant flow created within a cooling duct attached to the back of the PV module can draw some heat and discharges to the atmosphere naturally. Eitherway an additional cooling that lowers the operating temperature of the PV module is achieved and hence the efficiency is increased. Air type collectors do not have specific classification, but how the air as the thermal fluid is used, defines the collector's types, such as above the absorber, below the absorber and both sides of the absorber in single or double pass ways.

The power of the fan powered by the PV module increases as the cavity velocity increases, as the channel sizes increase, and as the heat exchange from the surface increases. The heat from the PV panel surface is transferred to the air in the channel by convection. Thus, the PV channel surface temperature decreases and the electrical efficiency reaches higher values.

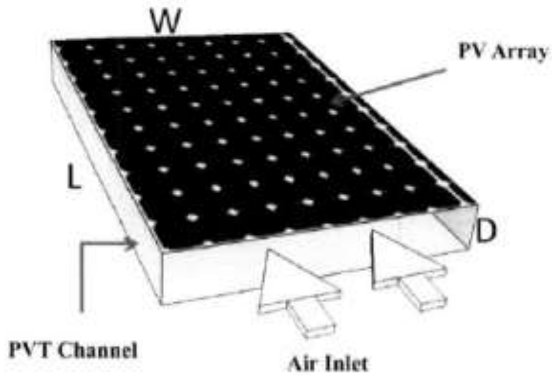

Figure 1: A typical PVT-Air collector

Figure 2. Photovoltaic/Thermal-air system with forced air convection configurations

4. Conclusion

In this study, the reduction of the electrical efficiency of the hybrid PV/T system cooled by forced air circulation was investigated by experimental and CFD analysis in terms of thermal and electrical performance. The increase in thermal efficiency caused a linear increase in electricity efficiency. There are many studies in the literature focused on increasing the electrical efficiency of PV systems by reducing the module temperature of PV systems. In these studies, which use the methods mentioned in the previous section, the electrical efficiency of the PV panel has been maintained.

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