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A Review on Hybrid Solar PV Air Cooled Module

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Abstract: **The cooling of the operating area is an essential operational factor to be taken into account in order to obtain greater efficiency in the operation of photovoltaic systems. Adequate cooling can improve electrical efficiency and reduce the rate of cell damage over time, which helps maximize the life of photovoltaic modules. The excess heat dissipated by the cooling system can be used in a domestic, commercial or industrial setting. Various cooling technologies are included in the review article: hybrid photovoltaic/heating systems cooled by forced air circulation, thermoelectric cooling system, water immersion cooling technology, and improved performance of solar modules using solar cells.**

Keywords: **PV System, Thermoelectric, Hybrid, Cooling System.**

I. INTRODUCTION

A hybrid photovoltaic / thermal solar system (or, to put it simply, a PVT system) is a combination of photovoltaic (PV) and solar thermal components systems that generate electricity and heat from one component. Or an integrated system. In other words, photovoltaic are used as (part of) the heat absorber [1]. These photovoltaic and solar thermal modules, which operate side by side, therefore do not exactly fall within this terminology of "combined panel". There are alternative approaches to PVT integration. Among many others, you can choose between air, water or evaporative sensors, monocrystalline/ polycrystalline/amorphous silicon (c-Si / pc-Si/a-Si) or thin-film solar cells, with flat or concentrator plates, enameled, or unglazed panels, natural or forced liquid flow, independent or building-integrated functions, etc. thanks to the use of cheap reflectors. To optimize the overall benefit, design decisions regarding the collector type, the thermal/electrical efficiency ratio and the solar ratio must be made. All of this has a decisive impact on system operation, operating temperature, and efficiency. Figure 1 shows the main features of a plate-type PVT sensor.

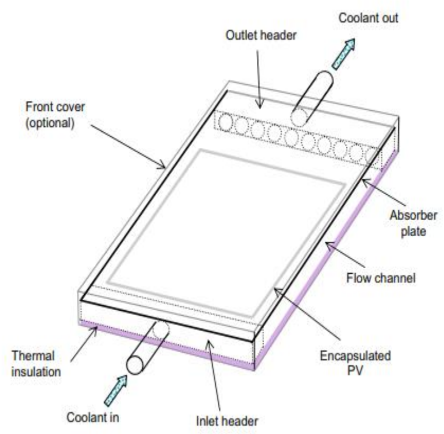

Fig. 1. Main features of a flat-plate PVT collector.

Over the past 35 years, a significant amount of research and development has been carried out on PVT technology with a gradual increase in the level of activity. After the turn of the century, a wider range of international holdings became evident. However, the applications of real projects are still limited at this stage. This article provides an overview of trends in technology development, starting with the earliest foundations and with a greater emphasis on post-2000 developments. A projection of future work is also provided.

II. LITERATURE REVIEW

Rachid Maouedj et al. [2] the article proposes a venture to improve the electrical proficiency of photovoltaic modules with a water-based photovoltaic half and half warm framework (PV-T). The point of this work is to bring down the temperature of the sunlight based cell to build its electrical change productivity. The model comprises of two indistinguishable photovoltaic modules close to one another. The primary water-cooled photovoltaic module, the second was viewed as the norm.

Shukla et al. [3] Photovoltaic (PV) sunlight based cells can ingest up to 80% of the episode sun based radiation from the sun based strip, yet just a little piece of this assimilated occurrence energy is changed over into power, contingent upon the transformation effectiveness of the photovoltaic cells and part the leftover energy expands the temperature of the photovoltaic cell. In this outline, different cooling strategies, for example, characteristic and constrained air cooling, water powered cooling, heat pipe cooling, stage change cooling and thermoelectric cooling of PV modules are talked about exhaustively.

M. Ebrahimi et al. [4] this examination endeavors to research another approach to cool photovoltaic cells utilizing characteristic fume as a refrigerant. The exhibition of the sun powered cell was analyzed in the recreation of daylight. The outcomes showed that the temperature of the PV cell essentially diminishes as the mass stream pace of the regular fume increments. Exhaustively, the temperature of the photovoltaic cells diminishes from 7 to 16 °C when the stream rate comes to from 1.6 to 5 g min-1. This prompts an increment in electrical effectiveness from 12.12% to 22.9%. The best exhibition of the photovoltaic cell can be acquired with a high common fume stream rate, a low characteristic fume temperature and the ideal circulation conditions got.

R.Rajesh et al. [5] Sustainable power sources are viewed as elective fuel sources because of developing natural concerns and the consumption of customary energy assets. In spite of the changes, Maximum Power Point Tracking (MPPT) innovation is fundamental for acquiring greatest execution from the sun based energy framework. This article presents a complete outline of the PV framework, including PV cell demonstrating, DC-DC converter geography, and greatest force point checking strategies.

III. TRANSPARENT COATING (PHOTONIC CRYSTAL COOLING)

A technique that can be used to lower the surface operating temperature of a photovoltaic module in order to obtain greater electrical efficiency involves the introduction of a transparent coating (photonic crystal cooling). This visible transparent thermal black body is based on photonic silicon dioxide crystals and is located above the photovoltaic cells. It can reflect the heat generated by the photovoltaic cells in the form of infrared light (long infrared thermal transparency window, between 8 and 30 µm) under the solar radiation towards space [6]. At the same time, the photovoltaic cells are slightly enhanced by the anti-glare and light trapping effects. Therefore, the photovoltaic cells are cooled allowing more photons to be absorbed by the photovoltaic module. A clear coated photonic crystal (PV) cooling module is shown in Figure 2 below.

Fig. 2 Water immersion cooling technique applied to PV panel.

IV. IMPROVING THE PERFORMANCE OF SOLAR PANELS THROUGH THE USE OF PHASE-CHANGE MATERIALS

One technique that can be used to reduce the surface operating temperature of a photovoltaic panel in order to achieve greater electrical efficiency is the incorporation of phase change materials (PCM), such as. photonic crystals of tungsten. PCM is a latent heat storage material located on the back of the photovoltaic module (see Figure 3). As the temperature rises, the chemical bonds within the PCM break when a phase change from solid to liquid occurs. PCM absorbs heat because phase change is an endothermic process. When the heat stored in the storage material reaches the phase change temperature, the material begins to melt [7]. The temperature then stabilizes until the melting process is complete. It is called latent heat buildup because heat is stored during the melting process (phase change process).

The numbers on the figure above represent the following components:

(1) PV module

(2) PCM module.

Fig. 3. Hybrid solar Photovoltaic/Thermal (PV/T) cooled by forced water circulation [8]

V. WATER IMMERSION COOLING TECHNIQUE

Another technique that can be used to lower the temperature of a PV module is to implement the water immersion cooling technique, as shown in Figure 4. In water immersion cooling technology, a PV module is used in large bodies of water such as rivers, oceans, lakes, canals, etc. Water is used as an immersion liquid, which absorbs heat from the photovoltaic module and maintains the surface temperature of the photovoltaic module. When the water absorbs heat from the photovoltaic module, the electrical efficiency increases [9].

The numbers on the figure above represent the following components:

(1) PV modules

(2) Plastic container

(3) Water,

Fig. 4. PV panel with Phase-change materials [10].

VI. HYBRID SOLAR PHOTOVOLTAIC/THERMAL SYSTEM COOLED BY FORCED AIR CIRCULATION

Another technique that can be used to lower the surface operating temperature of a photovoltaic module for greater electrical efficiency is the use of forced air circulation. This system consists of a photovoltaic module, which is arranged on a steel plate with an underlying air duct, as can be seen in Fig. 5. The working medium is air, which is pressed through the channels to be a fan with a nozzle. The fan is driven by the photovoltaic module, whose energy consumption increases as the speed of the cavity increases and the width of the duct and the heat exchange surface increase. The heat from the photovoltaic module is released to the air in the ducts by convection, which lowers the temperature of the operating surface for greater electrical efficiency [11]. The numbers in the figure above represent the following components:

(1) PV module

(2) Forced circulation fan

(3) Air channel

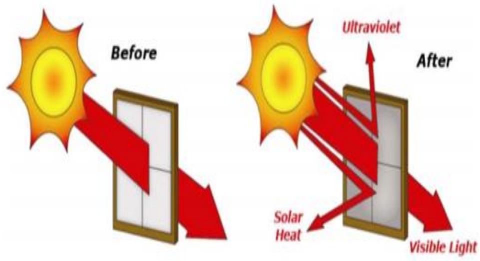

Fig. 5. PV panel cooled by transparent coating (photonic crystal cooling) [12].

VII. THERMOELECTRIC COOLING SYSTEM

Thermoelectric devices include an n-type semiconductor and a p-type semiconductor which are electrically and thermally connected in series. With a temperature gradient, most charge carriers spread by the Peltier effect from the hot side (positively charged electrode) to the cold side (negatively charged electrode), creating a voltage that leads to current flow. When voltage is applied to the material, a current flows through the material, causing the heat pump to cool on one side and heat on the other, which must be connected to a heat sink for excessive heat dissipation. The thermoelectric cooling system described can be seen in Figure 6 [13]. The numbers in the figure above represent the following components:

(1) Glass cover

(2) PV cells

(3) Insulator

(4) TEG module

(5) Fin heat sink

Fig. 6. Hybrid solar Photovoltaic/Thermal system cooled by forced air circulation

VIII. CONCLUSION

This article introduces hybrid photovoltaic/thermal forced air cooling systems, thermoelectric cooling systems, and water immersion cooling techniques that improve the performance of solar panels through the use of switching materials. This document provides a detailed overview of the various cooling techniques that can be used to improve the performance of a photovoltaic system. Proper cooling of photovoltaic systems improves thermal, electrical, and overall efficiency, reducing the degradation rate of the cells and maximizing the life of the photovoltaic modules.

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