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ScienceDirect

Energy Procedia 126 (201709) 621–627

Energy Procedia

www.elsevier.com/locate/procedia

72nd Conference of the Italian Thermal Machines Engineering Association, ATI2017, 6-8 September 2017, Lecce, Italy

Experimental characterization of a hybrid industrial solar tile

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Abstract

In this work an innovative hybrid solar panel is presented. The panel is particularly resistant. It is walkable and can be used as a tile to cover places, terraces and roofs. It consists in a photovoltaic cell layer placed in contact with an aluminium heat sink which transfers heat from the cells to a water flow. The lower part of the heat sink and the hydraulic and electrical connectors are encapsulated in an opaque and insulating resin. The upper part and the cells are covered with a transparent resin. The heat sink consists in an aluminium block in which some channels and the input and output plena are created. In the prototype version of the panel, a circular section has been assigned to the channels. Some preliminary results are presented, which have been obtained on the hybrid panel prototype. In particular the efficiency of the photovoltaic cells has been investigated by changing the water temperature and flow under different solar conditions.

Peer-review under responsibility of the scientific committee of the 72nd Conference of the Italian Thermal Machines Engineering Association

Keywords: solar energy; tile; exergy; efficiency.

1. Introduction

In most diffused solar panels, a large amount of the incident solar energy is still wasted due to the low solar to electrical energy conversion efficiency. Despite the recent update, not more than 25 % efficiency is obtained by the commercial photovoltaic cell as shown by Green et al. [1] and Polman [2]. Higher values of the photovoltaic cell efficiency can be obtained by providing the panels of a cooling system which let the cells operate at a lower temperature. Photovoltaic Thermal (PVT) collectors (also called hybrid solar panels) are devices that allow the direct transformation of solar radiation incident on the same surface into both electrical and thermal energy. Such panels not only exploit the solar energy amount which is converted into heat when affects on the photovoltaic cells, but also keep these latter at a lower temperature, thus increasing their efficiency [3,4].[1]

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1876-6102
Peer-review under responsibility of the scientific committee of the 72nd Conference of the Italian Thermal Machines Engineering Association
10.1016/j.egypro.2017.08.243

Different kinds of PVT panel have been studied in the last years for different application as shown also by Tiwari [5], Michael [6] and Fabbri [7]. Another study has focused on equilibrium thermal characteristics of building integrated PV glass tile (Mei [8]), showing how high radiation levels and elevated ambient temperatures could be really problematic if back ventilation is restricted. Also D`Orazio in [9], evaluating the performance assessment of different roof integrated PV modules under mediterranean climate, has verified experimentally the poor or absent ventilation under BIPV panels that causes overheating and efficiency reduction.
In the present work a prototype of a new hybrid solar panel is proposed, which can be used as a tile to pave driveways, areas, and terraces or to cover roofs due to its particular robustness and compactness. Such a panel is covered by two different resins that protect it from atmospheric agents and provide a good thermal insulation. A compact heat exchanger transfers the heat captured by the photovoltaic cells to a water flow. The main feature, that characterizes the new hybrid tile, is its walkability and the simple laying procedure. A preliminary experimental analysis of the performance of the proposed prototype is also presented.

2. The panel prototype

The proposed hybrid prototype is composed of a layer of high efficiency mono-crystalline photovoltaic cells, placed on an aluminium heat sink (Fig. 1). The cells are soldered together and then mechanically connected to the heat sink through a thermally conductive paste, which ensures a satisfactory thermal contact.

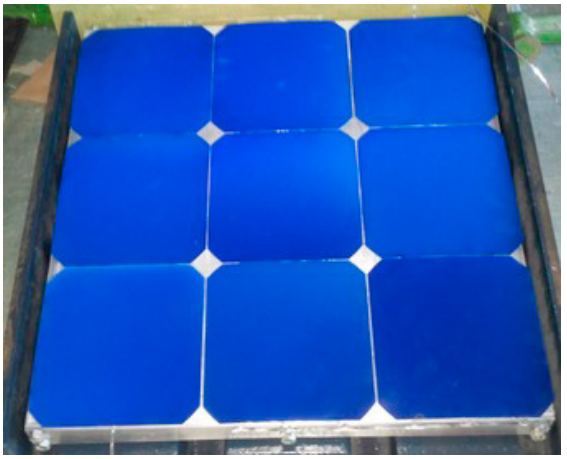

Fig. 1. The photovoltaic cells layer

The heat sink consists in an aluminium block with internal parallel channels disposed in staggered rows as shown in Fig. 2.

Fig. 2. Cross section of the heat sink

An inlet ad an outlet plenum have also been created in the aluminium block. A water flow passes through the channels, absorbing the heat captured by the cell layer. The heat sink is 37.5 cm long, 37.5 cm wide, and 2.5 cm