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CONCEPTION AND STUDY OF A GALVANIZED TUBES HYBRID PV / T COLLECTOR FOR BUILDING APPLICATION

*** Khaled Touafek**
Unité de Recherche Appliquée en Energies Renouvelables, URAER, Centre de Développement des Energies Renouvelables, CDER, 47133, Ghardaïa, Algérie

Abdelkrim Khelifa
Unité de Recherche Appliquée en Energies Renouvelables, URAER, Centre de Développement des Energies Renouvelables, CDER, 47133, Ghardaïa, Algérie

Hocine Ben Moussa
University of Batna, Batna, Algeria

Ismail Tabet
Unité de Recherche Appliquée en Energies Renouvelables, URAER, Centre de Développement des Energies Renouvelables, CDER, 47133, Ghardaïa, Algérie

Mabrouk Adouane
Unité de Recherche Appliquée en Energies Renouvelables, URAER, Centre de Développement des Energies Renouvelables, CDER, 47133, Ghardaïa, Algérie

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** Corresponding author: K. Touafek, Phone: +21329870126, Fax: +21329870146*
E-mail address: khaledtouafek@yahoo.fr

ABSTRACT
During operation of a photovoltaic module, a heat is generated, which systematically increase the temperature of the photovoltaic cell with respect to the ambient temperature and this will cause a drop in performance. Several research projects aimed at developing solutions to limit the rise in temperature of photovoltaic modules, is born beyond the concept of hybrid photovoltaic thermal collectors / (PV / T), which is to superimpose both electrical and thermal energy functions. In this hybrid collector, the fluid flowing in the thermal part to be heated also cools the photovoltaic cells and thereby increases their electric yield. These absorber tubes can have different shapes: round, square and rectangular tubes. In this paper a new configuration of absorber is studied. A thermal and electrical model is performed and tested.

INTRODUCTION
Hybrid solar collector is a system that converts solar radiation into thermal and electrical energy. These systems combine a PV solar cell, which converts electromagnetic radiation (photons) into electricity, with a thermal solar collector, the remaining energy that captures and removes the residual heat from the photovoltaic module (PV), the cells were lower efficiency with increasing temperature due to such an increased resistance. Such systems can be designed to carry the heat away from the photovoltaic cells and the cells and thus to improve cooling efficiency by reducing temperature.

The heat rgenerated by the photovoltaic cells are passed through the metal and absorbed by a fluid (assuming that fluid is cooler than the operating temperature of the photovoltaic cells). Energy for closed-loop systems, the heat is transferred to a heat exchanger, where it empties its direct application. However, in open-loop systems, this heat is used, or evacuated before the return of fluid to the photovoltaic cells.

Various designs of PV / T systems have been developed and studied in theory, numerically and experimentally [1-4].

J. Bilbao et al. [5] study a hybrid solar PV / T using the model in TRNSYS 50 and modified to compare their thermal and electrical performance model. Dupeyrat P. et al. [6] applied the TRNSYS simulation for the thermal system and a solar PV / T and show the PV / T while the thermal energy to the limited installation area system performance. Xingxing Zhang et al. [7] shown the classification with different applications coolant water based, air in photovoltaic solar thermal systems.

The heating of the water, was applied to the thermosiphon flat box made of aluminum alloy, the electrical efficiency is 10.3 ~ 12.3%, the thermal efficiency is 37.6 ~ 48.6% by summer and winter day [8] .These results clearly shows an improvement in the overall system efficiency and a longer life due to the elimination of caries and the production of hot water that can be used for residential commercial or industrial applications.

The case study concerns a design of solar photovoltaic thermal hybrid PV / T, whith an absorber made from galvanized tube inclined and oriented to the south. This collector is formed by a PV module and a cooling system within the various layers of the system is illustrated below. From the outside inwards, it has a cover glass (1) PV cell (2), a layer of Tedlar (3), absorption plate (4) with tubes (5) for the circulation of coolant and the insulation (6) of the complete system at the sides and bottom.

Figure 1 shows a general description of a PV / T collector using water as coolant.

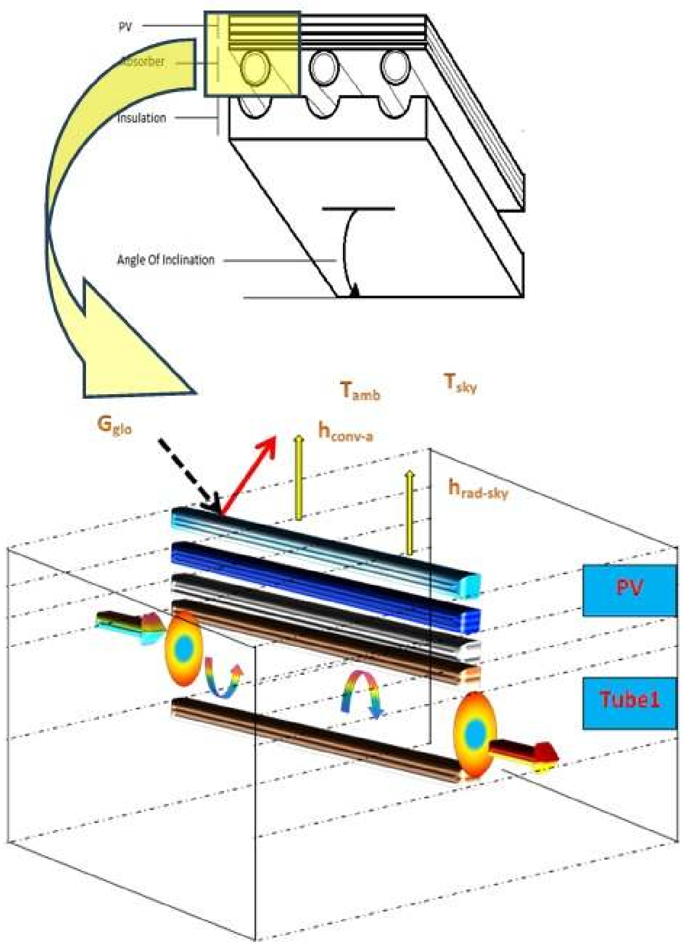


Fig. 1. Construction of PV / T collector

The aim of the study is to predict the temperatures of the collector layer in each PV / T For this, the principle of conservation of energy is used for each element of the system.

For the insulator layer:

The energy equation in the insulation; inner surface is given by:

$$M_{iso}c_{iso}\frac{dT_{iso\,int}}{dt}=Q_{cond\,p-iso}-Q_{cond\,iso} \quad (1)$$

$$M_{iso}c_{iso}\frac{dT_{iso\,int}}{dt}=h_{cond\,p-iso}A_{p-iso}\left(T_p-T_{iso\,int}\right)-h_{cond\,iso}A_{iso}\left(T_{iso\,int}-T_{iso\,ext}\right) \quad (2)$$

The energy equation in the insulation; outer surface is given by:

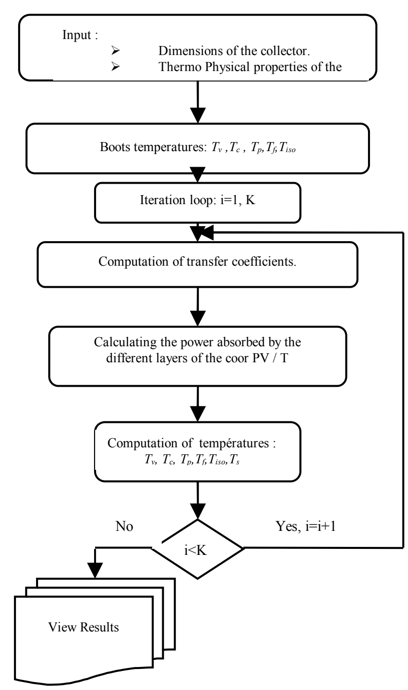
$$M_{iso}c_{iso}\frac{dT_{iso\,ext}}{dt}=Q_{cond\,tube-iso}+Q_{cond\,iso}-Q_{cond\,iso-a} \quad (3)$$

$$M_{iso}c_{iso}\frac{dT_{iso\,ext}}{dt}=h_{cond\,tube-iso}A_{iso-tube}\left(T_t-T_{iso\,ext}\right)+h_{cond\,iso}A_{iso}\left(T_{iso\,int}-T_{iso\,ext}\right)-h_{cond\,iso}A_{iso}\left(T_{iso\,ext}-T_a\right) \quad 4$$

Solving equations of the energetic balance sheet gives us the opportunity to study the temperatures for each layer of the collector.

We can use the chart below for the calculation of different parameters.

Table 1 Flow chart of calculation process



Results and discussion

The solar radiation received by a sensor typically varies as shown in the following figure 2 in a day, it increases from sunrise to reach a maximum at solar noon before decreasing again to cancel at nightfall.

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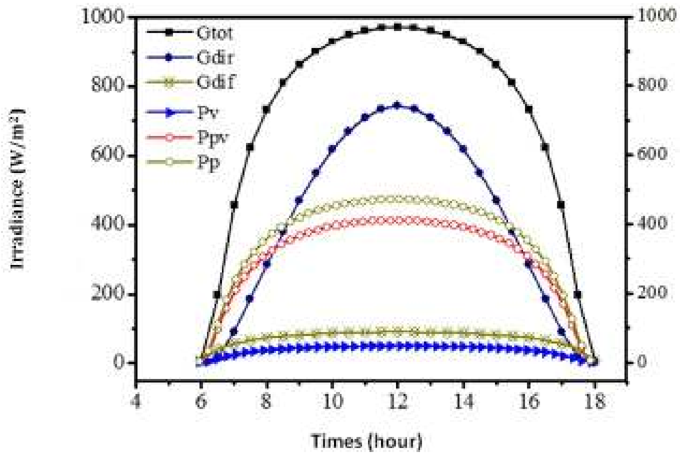

Fig.2 Evaluation of solar energy absorbed by the PV / T

Each layer of the system reaches these values of maximum temperatures between 12: 00h and 14: 00h or the intensity of solar radiation is important, they are related to the inlet temperature of the coolant, and also with the exchange coefficient by convection between the tube and the fluid on the one hand, and on the other hand with the convective heat transfer coefficient between the glass layer and the external environment (the effect of wind speed) [9].

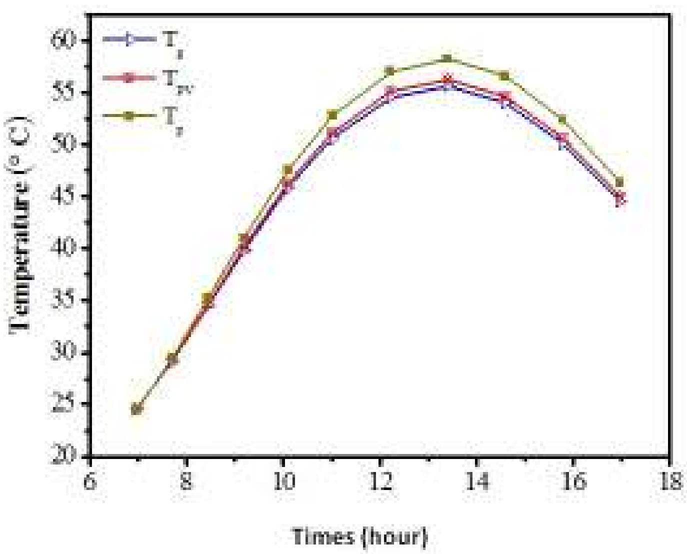

Fig. 3 the temperature distribution in the layers of the hybrid sensor

To accurately track any change in thermal and dynamic fields, particularly in the region where the gradients are important, we adopted a uniform mesh, highly tightened throughout the area studied (Fig. 4). The mesh has been checked before being adopted; a finer resolution then gives the same numerical solution (see Figures 2, 4).

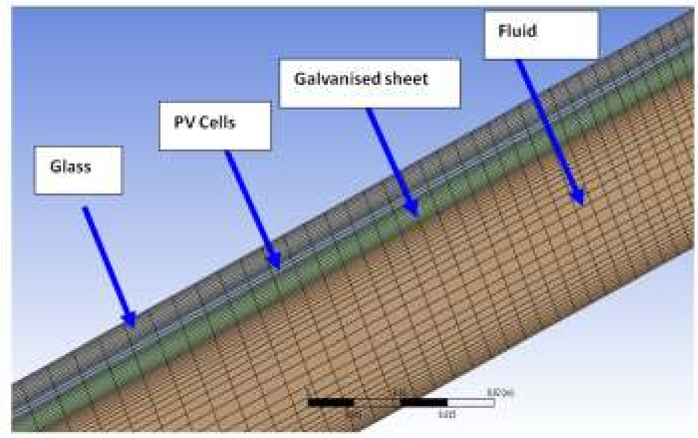

Fig. 4 layers of mesh sensor.

The temperature of the coolant (water) at various points throughout the PVT system is shown in Figures 14. The graph shows that the water temperature increases along the length of the duct and around the upper portion the conduit (PVT absorbent plate), it reaches a maximum of 45 ° C under a solar illumination intensity of 1000 W / m2 and an inlet temperature of 25 ° C.

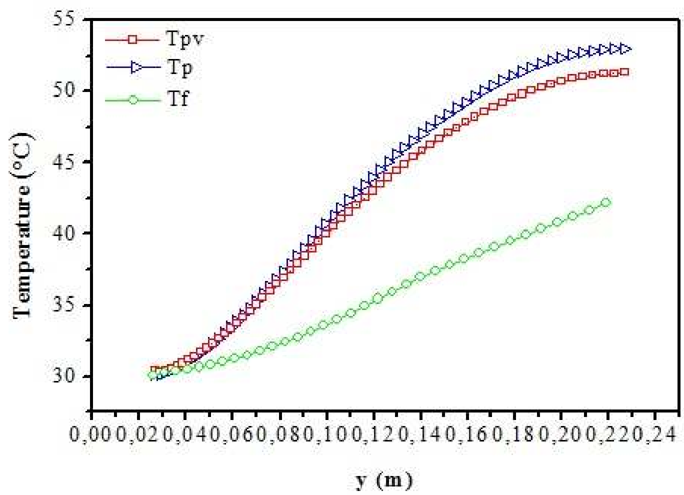

Fig. 5 Temperature of fluid along the length of the conduit

Figure 6 shows the temperature distribution in the various layers of the hybrid sensor in a steady state (stationary state) with coolant (water) still for the duration of the simulation.

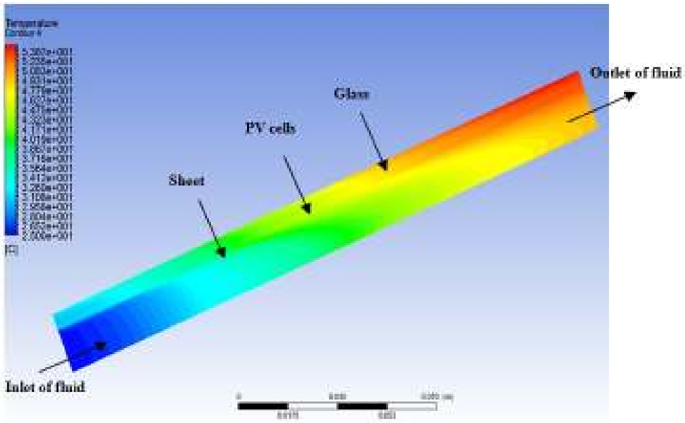

Fig. 6 Distribution of the temperature in the hybrid collector

We note that the output temperature of the fluid reaches 42 ° C to the simulation for an inlet temperature set at 25 ° C which shows the gain in thermal energy produced. At the same time, the temperature of the cell has dropped to around 45 ° C. Recall that above 75 ° C only in photovoltaic modules in which there was no cooling.

Conclusion

The goal of combining PV module with the solar thermal collector was to answer some of the problems noted with conventional photovoltaic modules and develop a solution that allowed for PV permanent solution renewable energy for homes. Both problems noticed during operation of photovoltaic PV module are the fall in energy efficiency and the degradation of solar PV cell. Hybrid PV / T system provides a solution to both problems.

The performance of PV / T system was established by theoretical and experimental and studying. The results show that by adding a component to the heat PV photovoltaic module increases the total energy efficiency of over 50%, compared to 8 to 20% electrical efficiency for most only photovoltaic modules. It was found that the heat of the PV panels, captured by the absorber was also greater than the electrical energy produced by the PV module. This means that being able to capture this excess heat evenly and using it in various applications, it becomes possible to improve energy production by 20% (for the PV module) to 50% (for a PVT), as the coolant used, the mass flow rate and other technical componentsof the system. Test data also showed that the increase in temperature by the PV modules is between 1 ° C and 10 ° C.

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