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Comparative Study of Two New Configurations of Solar Photovoltaic Thermal Collectors

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Abstract**—**Hybrid photovoltaic thermal (PV/T) solar system comprises a solar collector which is disposed on photovoltaic solar cells. The disadvantage of a conventional photovoltaic cell is that its performance decreases as the temperature increases. Indeed, part of the solar radiation is converted into electricity and is dissipated as heat, increasing the temperature of the photovoltaic cell with respect to the ambient temperature. The objective of this work is to study experimentally and implement a hybrid prototype to evaluate electrical and thermal performance. In this paper, an experimental study of two new configurations of hybrid collectors is exposed. The results are given and interpreted. The two configurations of absorber studied are a new combination with tubes and galvanized tank, the other is a tubes and sheet.

Keywords**—**Experimental, Photovoltaic, Solar, Temperature.

I. Introduction

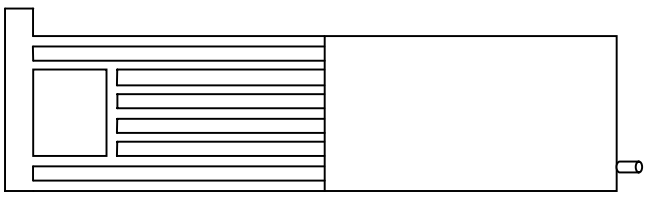
THE photovoltaic thermal collector PV/T is an integration of PV module and a photovoltaic solar collector in a single unit, which can simultaneously generate electrical and thermal energy. In addition, heat carriers, such as water or air, take the heat extracted from the cells of the PV module and cool it, thereby improving the electrical efficiency of the photovoltaic panel.

Several studies and investigations on hybrid systems such as (PV/T) have been made previously. The hybrid collectors using air and water absorber were evaluated experimentally [1]-[3], analytically [4]-[6] and economically. Work has been conducted for three years at the Massachusetts Institute of Technology. The most important conclusion of this work stated that the viability of the hybrid collector (PV / T) will be decided by the system's ability to meet the thermal and electrical loads required. G. N. Tiwari and Swapnil Dubey realized an integrated photovoltaic thermal (PV/T) as (CES) system combined with a capacity of 200 liters, the collector test and the system were conducted during February-April 2007 [7]. Christian et al. make a simulation model describing a finite difference of the heating water using a hybrid collector where the absorber is made of a copolymeric material and operational they recognized that Use of a copolymer of the total design of the solar collector has many advantages such as reduced weight, which facilitates manufacturing and reduce costs [8]. Arif Hasan and K. Sumathy present a review of the available literature covering aspects of the latest photovoltaic modules from different hybrid collectors and their performance in terms of power and heat production. The review includes a detailed description of (PV/T) systems plans and concentration [9]. Pei Gang et al. provide a dynamic look at the performance of (PV/T) system and is validated by experimental results model, the average heat gain and the average gain of electricity are 276.9 and 62.3 W/m^2, respectively, the corresponding yields were 41.9% and 9.4%, respectively, in the test period, with average intensity of solar radiation of 661 W/m^2 [10]. N. Amrizal, D. Chemisana, J. I. Rosell developed and implemented a solar photovoltaic PVT with simple diode model, the efficiency and heat loss values obtained after application of this method showed a good level of agreement with the results are obtained by testing the steady-state thermal performance [11].

In this paper we present two types of absorber geometry for hybrid collectors, the coolant circulates here in combination with tubes and galvanized tank form for PVT1 and parallel tubes for PVT2.

II. Experimental Study

We present in this paper the two configurations of absorbers used to form the two hybrids collectors PVT1 and PVT2 (Fig. 1). The material used is galvanized steel for its low cost.



PVT1



PVT2

Fig. 1 Both configurations of hybrid collectors

A. Materials Used

- Monocrystalline silicon for photovoltaic module.
- Galvanized steel tubes 12/17 Ø
- Galvanized steel tube 20/27 Ø
- Two sheets of galvanized steel [1mm-3mm]
- 20mm angle iron

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- 30mm aluminum angle
- Polystyrene
- Glass wool
- Paintings (black and white).

Fig. 2 shows the absorber used for the first hybrid collector PVT1.



Fig. 2 Absorber made by tubes and galvanized tank

The aim of our experimental study described in this article in the first place is to take the electrical performance and to determine the temperature distribution of the hybrid collector. For this we put on the same structure the two collectors in order to compare their performances.

Fig. 3 shows a photo taken in the unit of applied research in renewable energy in Ghardaia in the south of Algeria.

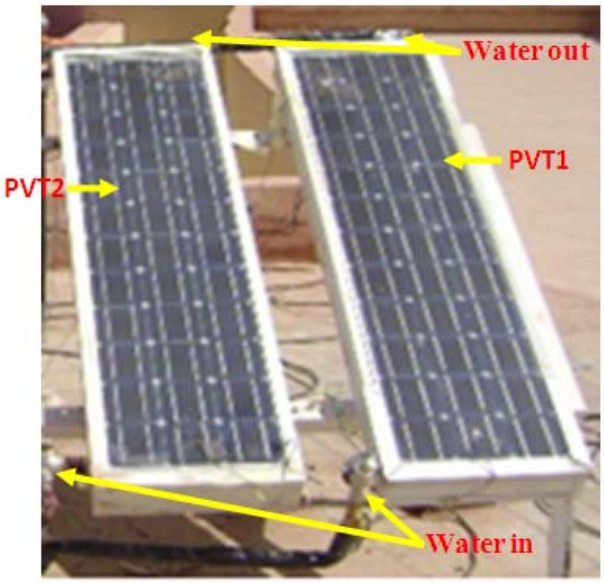


Fig. 3 Test bench mounted unit URAER

III. Results and Discussion

A. Temperature Distribution of the Various Sensors and Solar Radiation with Time G

We measured the temperature at each layer of the two collectors. Figs. 4 and 5 show the temperature distribution in both PVT1 PVT2 collectors. The maximum temperature for PVT1 is 49°C and it is 54°C for PVT2 hybrid collector. This shows the importance of the shape of heat exchanger at the collector which causes the temperature of the hybrid sensor reduced taking heat to heat the heat transfer fluid.

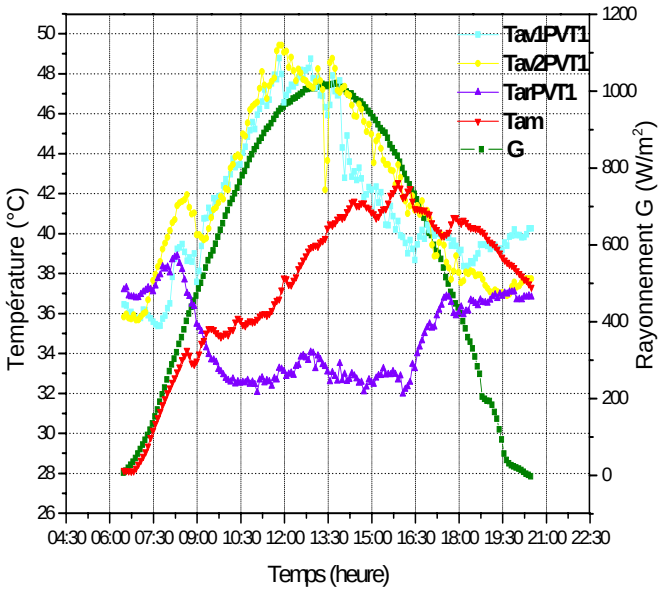


Fig. 4 Temperatures of PVT 1

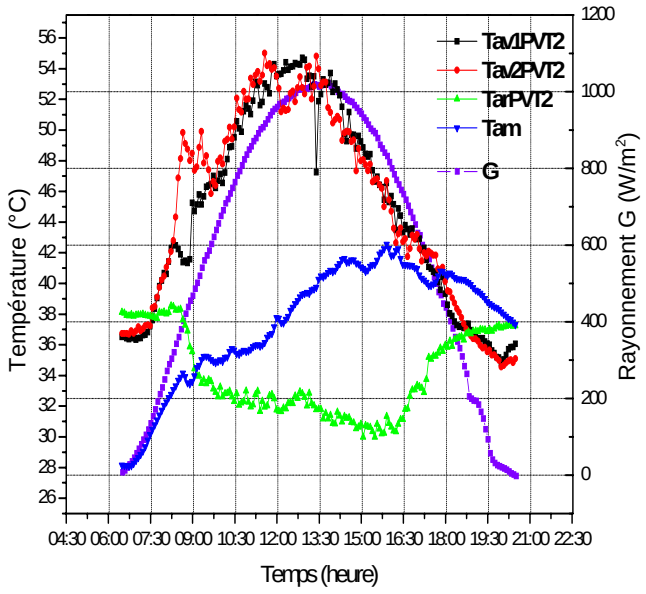


Fig. 5 Temperatures of PVT 2

B. Inlet and Outlet Temperature Distribution of the Two Collectors

Fig. 6 shows the temperature distribution of the fluid at the inlet and outlet of the two collectors (PVT1, PVT2) versus time for the same flow rate of coolant.

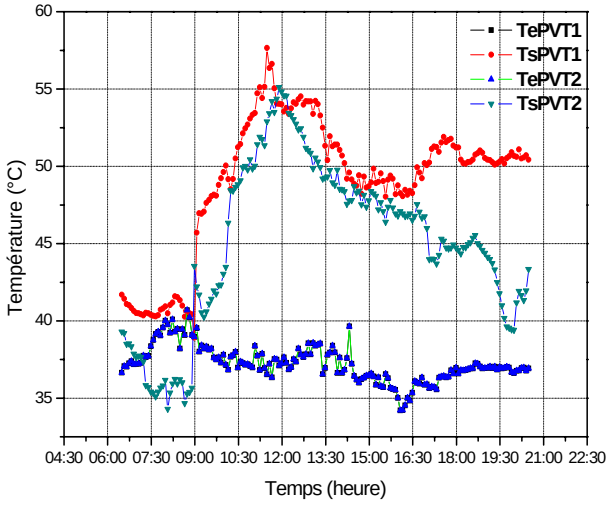


Fig. 6 Input and output Temperature for the two collectors

VI. Conclusion

The idea of combining a photovoltaic module with a solar thermal collector to create a PV/T hybrid system can be a solution to improve the energy efficiency per unit area of PV solar module.

Photovoltaic Thermal hybrid solar system / sheet and tube with two forms of absorbers have been built and tested. The test results on the energy performance have been very encouraging.

The thermal efficiency was found around 50% of the radiation conditions chosen.

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