# Solar ventilated façade with PCM integration for air preheating

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## SUMMARY

The present study accents the concept of a ventilated solar façade for air heating with integrated thermal inertia elements. A Transpired Solar Collector (TSC) is made of metal cladding with perforations, installed at a certain distance from a building wall, thus creating a cavity through which the air is circulating. The metal cladding is heated by the solar radiation from the sun and ventilation fans create negative pressure in the cavity, extracting the solar heated air through the perforated panel. Studies have shown that the modification of these perforations geometry can be an important factor and leads to heat transfer increase. Thermal performance of TSC with latent heat storage was experimentally studied.

## KEYWORDS

Transpired solar collector; phase change materials.

## 1 INTRODUCTION

The renewable sources can provide low-cost energy consumption when using passive systems. Among these renewable energies, the use solar systems are easy to implement and efficient from the accessibility point of view in the zones with solar potential. The Transpired Solar Collectors (TSC) are systems recommended because of their efficiency and reduced implementation/operating costs (Wang et al., 2017). A TSC or air solar collector is made of metal cladding with perforations, installed at a certain distance from a building wall, thus creating a cavity through which the air is circulating. The metal cladding is heated by the solar radiation from the sun and ventilation fans create negative pressure in the cavity, extracting the solar heated air through the perforated panel. Usually PCM as thermal storage are implemented in the glazed solar air collectors such as Trombe walls in order to replace classic masonry (Tyagi and Buddhi 2007) to improve the efficiency and outlet temperature stability (Li 2013) but, according to the literature studied, we didn’t find a TSC with PCM integrated which acts like a solar wall (Zhang, Tan et al. 2016). This paper’s objective is to evaluate the thermal behaviour of an innovative TSC with and without PCM integrated on the back of the TSC system.

## 2 METHODS

The objective is to obtain a high energy performing element of an innovative air solar collector with high thermal inertia materials integration. The purpose is to investigate the efficiency increase due to innovative lobed geometries of collector’s perforations with the inertial components implementation, underlining the benefit of passive solar systems. The following materials were used for the experimental study: fan with variable flow, metal plates (with lobed orifices) and 6 halogen lamps in order to simulate solar radiation (800 W m-2). The cavity is insulated with 5cm of extruded polystyrene. Different temperature sensors were mounted inside the cavity and on the metal plates (4 K-type sensors: Tplate, Tcavity, Tout, Tamb). The temperature difference between inlet and outlet was evaluated. Inertial elements were introduced in order to evaluate the thermal behaviour. The total time of evaluation: 6 hours (3 hours without PCM and 3 hours with PCM).

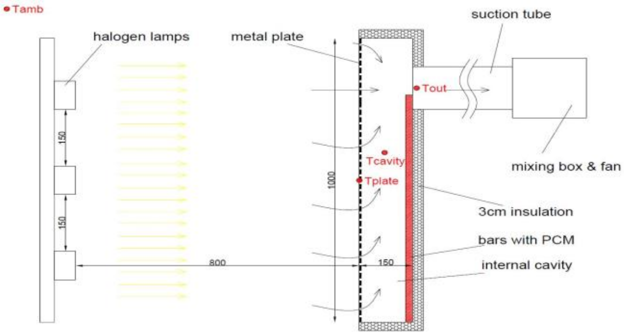

Figure 1. Experimental set-up

## 3 RESULTS AND DISCUSSION

The results indicated that the system enters in permanent regime in about 30 minutes and turning off the lamps, the outlet temperature will reach the ambient temperature in only 20 minutes for the case without PCM. The other case can be divided in 3 stages: PCM melting when the temperatures are lower, the heating process when the PCM is in liquid phase, and the cooling period, when the PCM releases the heat. In this stage, the difference between the outlet temperature and the ambient temperature can be observed for 90 minutes, due to PCM effect.

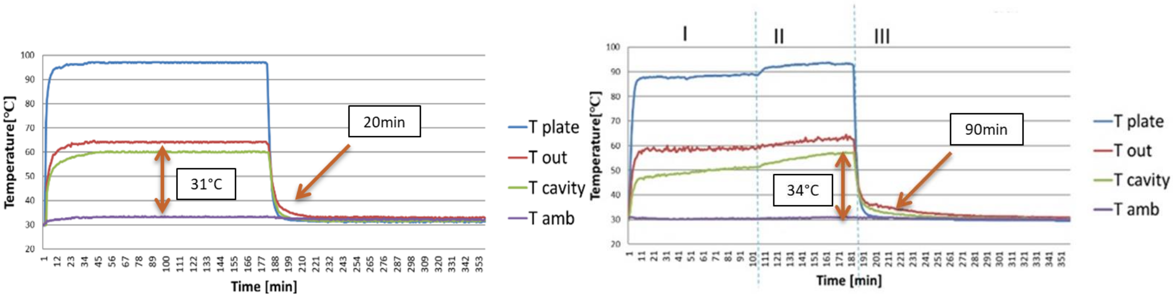

Figure2. Temperature variation for the 4 sensors: a) without PCM; b) with PCM

## 4 CONCLUSIONS

Thermal phase shift has the potential to increase the efficiency of the solar collector and the number of hours of operation by storing energy and using it when sunlight is not available, namely to improve indoor thermal comfort. The transpired solar collector with inertial elements integration can become an interesting passive system used to pre-heat the fresh air.

## ACKNOWLEDGEMENT

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