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Thermal evaluation of an innovative type of unglazed solar collector for air preheating

Cristiana Croitoru[a]*, Ilinca Nastase[a], Ionut Voicu[b], Amina Meslem[c], Mihnea Sandu[a]

[a]*Technical University of Civil Engineering Bucharest, CAMBI Research Center, Pache Protopopescu, 66, Bucharest, Romania*
[b]*University of Caen Basse Normandie, LUSAC-Site de St Lô, 120 rue de l'Exode, 50000 Saint Lô, France*
[c]*LGCGM EA3913, Equipe Matériaux et Thermo-Rhéologie, Université Européenne de Bretagne, Université Rennes 1, IUT de Rennes, 3 rue du Clos Courtel, BP 90422, 35704 Rennes Cedex 7, France*

Abstract

Perforated solar walls pre-heat the fresh air introduced in the building when the air is forced to pass through this solar heated perforated facade. The heat transfer between the fluid and the metal is intensified depending especially on the flow's characteristics. An experimental campaign on an innovative solar collector was performed in the laboratory of Building Services from Technical University of Civil Engineering Bucharest. The solar collector with lobed perforations was analyzed and the results indicated that the system can attain a high thermal performance, but only for a certain range of airflow rates.

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Keywords: Solar energy; ventilated envelope element; lobed geometry

1. Introduction

The new European Directives concerning energy performance of buildings [1] imposes significant reduction of the energy consumption. For this reason, the EU Members have adopted drastic regulation in order to achieve high building performance. On the other hand, the indoor quality has become an important parameter when conceiving residential or office buildings. The requests of the occupants are more exigent and achieving the indoor comfort is one of the most

* Corresponding author. Tel.:
E-mail address: cristiana.croitoru@cambi.ro

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important challenges for civil engineers. Generally, building sector consumes 35.3% from the total energy demand [2, 3]. This energy demand is caused mainly by the HVAC (Heating Ventilating and Air Conditioning) Systems.

Nomenclature

P	heat transferred from the plate to the air [W]
m_{air}	mass flow rate [m^3/s]
ε	efficiency [%]
I_T	radiation level provided by the lamps [W/m^2]
A	surface of the plate [m^2]
$T_{air.plen}$	air temperature in plenum [°C]
T_{amb}	ambient temperature [°C]
T_{pl}	surface temperature on the metal plate [°C]

This system exploits solar radiation using collectors that are in the form of panel that can be installed on a wall or on the roof. Schematically, their general configuration is as follows:

At the outer surface of the system we find a metal sheet provided with perforations which are aspirating the air. The metal plate, installed at several centimeters from the building wall, creates a cavity (plenum) for circulating air passing through the perforations. This way, when the metal plate is heated by solar radiation, the air circulating from the bottom is heated along the latter and enters indoor with a ventilation system. A fan is placed on the top of the wall in order to create a negative pressure, forcing the air circulation.

Fig.1 - a) SolarWall Collector ; b) Maisel site using solar collectors

Such an example, using solar collectors, is the student residence "La Maisel" in Brittany[4] (see Figure 1). This site has 129m2 of solar wall and preheats by this system 2160 m3 /h fresh air for the building.

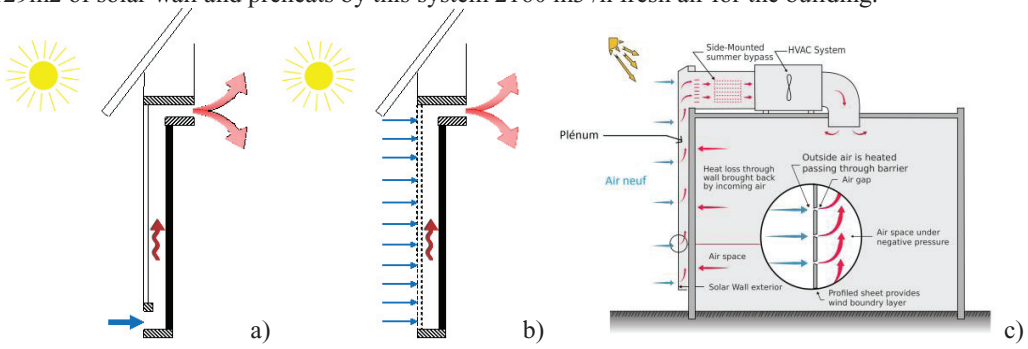

Fig.2: Sollar walls: a) Classical Trombe wall, b) Unglazed transpired solar wall, c) Mixed Glazed and Unglazed SollarWall® from Conserval Engineering Inc. [5]

Thus, the same study mentions that the site owner realizes an energy saving of 17,707 kWh per year and reduced annual greenhouse gas of about 4.24 tons. Generally, a SolarWall collector replaces, in fact, between 20-50% of