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Heat recovery versus solar collection in a ventilated double window

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ABSTRACT

The ventilated double window, as a passive heating system, acts as a heat reclaiming device. Part of the heat loss from inside through the window is returned back to the room by the air flow, acting as a heat recoverer. Incident solar radiation upon the window warms its components being part of that heat removed by the air flow delivering it into the room, acting as a solar collector. The effect of these two functions were analysed in this study, through numerical simulation based on outdoor tests under real weather conditions. It was found that solar collector function plays a small role in the pre-heating of the air. First of all this is due to the system's transparency, which allows most of the solar radiation to enter directly to the indoor space. Secondly, in a 24 h period there are only some hours of sunshine. Instead, heat recovery works all the time, the conclusion being that this passive heating device can be used on any facade orientation.

1. Introduction

Using a double window in building facades has become current practice in the coldest regions of Portugal. Transforming this double window into a passive air heating system has the advantage of providing pre-warmed air for winter ventilation which, otherwise, would enter the building at outdoor air temperature. The air channel between the two windows is then used as a path to the ventilation air. This air is pre-heated within the air channel between the windows by heat that is lost from the building and also by solar gains, before it is delivered inside warmer than it is outside.

Most of the experimental work reported in scientific publications has been carried out under laboratory or real weather conditions for different sorts of passive heating systems that use heat loss and solar radiation to pre-heat the ventilation air. Baker and McEvoy [1] studied the heat exchange conditions within the supply air window in a laboratory and real house conditions. Onur et al. [2] investigated the thermal performance of a window collector under actual outdoor conditions. Dickson [3] analysed double facade configurations. Leon and Kumar [4] presented a mathematical model that predicts the thermal performance of unglazed transpired solar collectors. Yun et al. [5] studied a ventilated photovoltaic facade working as a pre-heating device in winter and as a natural ventilation system in summer. A numerical model was developed by Richman et al. [6] to predict the amount of heat recovery from the air that is drawn from the outdoors, between the façade by recovering heat from the masonry. Although these systems have the same modus operandi, they all have different results, as for instance, some of them have better performances under incident solar radiation than others.

The aim of this paper is to investigate the influence of both heat sources (heat escaping from the building and solar radiation) to pre-heat the ventilation air through the ventilated double window, under Portuguese climatic conditions and compare it to the performance of the system in more severe conditions. Tests were conducted under real outdoor conditions, having provided useful data to characterise the performance of the system with and without solar radiation. Analysis based upon local weather has shown that this heating system is suitable in any facade orientation, due to the contribution of the heat recovery function.

2. Experimental facility

Two windows were mounted on the same facade facing south aperture, being both with a white aluminium frame of 1.43 m width and 1.00 high, having an absorptance of 0.4 and reflectance of 0.6. Two air inlets were installed at the bottom of the outer window and at the top of the inner window. The cavity between the two window panes has become an air path for incoming airflow through those vents (Fig. 1). Having been pre-heated by the heat transferred from indoors through the inner window pane and by the solar radiation, the air enters the building warmer than outside.

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