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Thermal Performance of Building-integrated Solar Wall during Stagnation

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Abstract

This paper analyzes the thermal performance of a typical building-integrated solar wall (we'll call it solar wall later in this paper) which integrates flat plate solar thermal collector with building wall. The thermal performance of the solar wall during stagnation, temperature of the absorber plate and heat flow on the inner wall, is studied by space state method in summer and winter respectively. If the collector of solar wall stops running, the maximum absorber plate temperature during summer daytime can reach 92.2 ºC, and the total heat flow on the inner wall in one day is 1063 kJ/m² which is about 5 times of the normal operation condition. In winter, the temperature and heat flow of solar wall is higher too, which is beneficial to reduce the space heating load and the room can obtain heat from the outside in some time.

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Keywords: Building-integrated; *Solar wall; Stagnation*

1. Introduction

The integration of building with solar collectors to reduce building energy consumption has become a tendency in building sector. Many experts and scholars have been attracted on this topic and great achievements have been obtained in recent years. When there is no need of heating load, the collectors stop running while the solar irradiance is very high, that is called "stagnation" in this paper. Stagnation happens commonly. Studying the thermal performance of the solar wall under stagnation condition is important to the safety of collectors. Thorsten Siems [1] developed a standardized stagnation measurement to characterise solar collector modules as they are marketed. Robert Hausner [2] investigated the behavior of combisystems at stagnation and discussed the design practice which

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prevents the activation of safety valve in the collector loop. Guoqing Yu presented a state space model [3] for thermal analysis of an integrated structure of flat plate solar collector and building envelope, and the state space model was verified by FLUENT simulation and experiment [4] respectively. The paper introduces a typical solar wall and analyzes the thermal performance of the solar wall during stagnation by space state method.

2. Description of the solar wall and research method

2.1. Description of the solar wall

The typical structure of the active solar wall is shown in Fig.1. It is the integration of a flat plate solar thermal collector and building wall, which includes glass cover, absorber plate, tubes, insulation layer, back sheathing and building wall from outside to inside. The heat collected by the absorber plate is delivered to other place for heating by the fluid in tubes when the collector is in normal operation. Compared with separate solar collector or wall, the design of solar wall is intended to improve the thermal insulation of a building while producing heat.

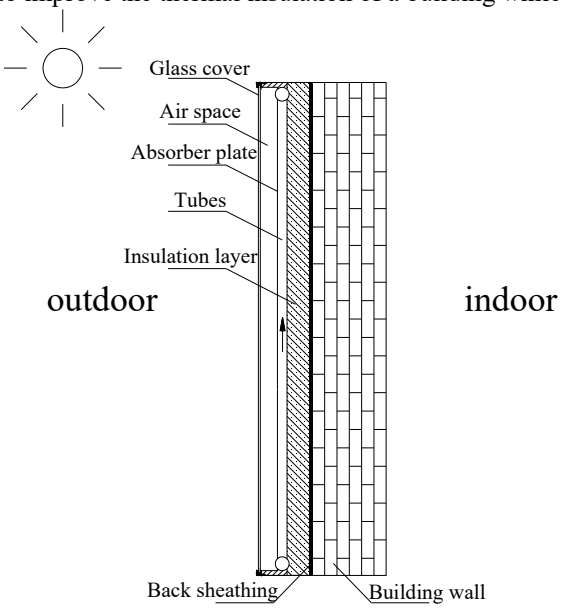

Fig. 1.Schematic of the active solar wall.

The specifications of the flat-plate solar collector and the wall are shown in Table 1 and Table 2 respectively.

Table 1. Specifications of the solar collector.

Item	Properties and Dimensions	
Collector	Tilt angle	90°
	Area	1.5m^2
Glass cover	Emissivity	0.88
	Thickness	4mm
Air space	Spacing between the absorber plate and the glass cover	20mm
Absorber plate	Absorptivity	0.92
	Emissivity	0.10
	Thickness	0.5mm
Tubes	Spacing	120mm

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