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# Study on the Thermal Performance of a Wall System Integrated Solar Thermal Collector

Yongga A, Jibo Long *

*College of Civil Engineering and Mechanics, Xiangtan University, Xiangtan, China*

**Abstract**

With the promotion of renewable energy, how to coordinate the efficient use of solar energy and indoor thermal comfort environment has become the key point for applying building integrated solar thermal system broadly. Thus, this paper presents a wall system integrated solar thermal collector. The influences of material and thickness of main layer on thermal performance of the wall system were calculated and analyzed. The results show that thermal performance parameters of the wall differ greatly in heating condition and non-heating condition. Compared with heating condition, heat transfer coefficient of the wall is smaller, and thermal inertia index and attenuation factor are larger in non-heating condition. The delay time of the wall in non-heating condition is 3.5h more than the time in heating condition.


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*Keywords:* Thermal performance; Solar thermal; Building envelop; Integration; Insulation

## 1. Introduction

Solar energy utilization and building integration technology are significant to offer sustainable solution towards environment protection and conservation of conventional energy sources. In recent years, numerous studies have been focused on the solar collector performance. However, the harmony between solar thermal systems and the indoor thermal environment has been rarely taken into consideration, which is an important bottleneck that affects the further efficient development and application of building integrated solar thermal systems technology. Thermal performance of envelope has a great impact on the indoor thermal environment. To give a brief, A.Verhoef found

* Corresponding author. Tel.: +86-0731-58298247; fax: +86-0731-58298247.
*E-mail address:* longjibo2010@126.com

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thermal inertia of traditional building wall was larger and indoor thermal environment was more comfortable [1]. Hui studied the effect of thermal inertia index on the dynamic heat transfer of building envelope [2]. Wang et al. performed attenuation factor was also an important factor in the comprehensive evaluation of wall insulation effect [3]. Bai et al. suggested thermal inertia index and attenuation factor should be taken into account in the thermal insulation performance of building envelope[4].

The efficient application of building integrated solar thermal systems technology should not only consider the efficiency of solar energy utilization, but also the thermal performance of the integrated wall is another important index which needs to be designed. In this paper, a wall system integrated solar thermal collector is proposed, which combines the solar energy utilization and thermal insulation performance. Besides, thermal performance of the wall system under various statuses are calculated and analyzed.

## 2. System description

As shown in Fig. 1, the integrated wall system is mainly composed of glass curtain wall, solar collector plate, heat radiation reflection layer, main layer, etc. There excites air interlayer between glass curtain wall and thermal radiation reflection layer. Solar collector plate installed in the air interlayer can absorb solar radiation to produce hot water. Turning on vents can avoid the problem of overheating in summer, while tuning off vents can ensure the insulation performance in other weather. The physical properties of the integrated wall are shown in Table 1.

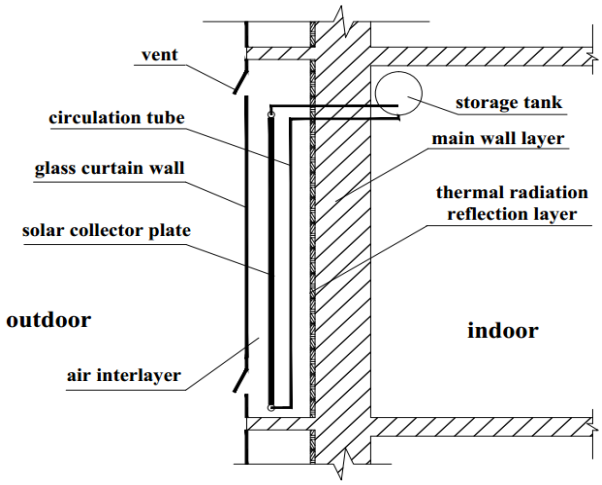


Fig. 1. Schematic diagram of the integrated wall system..

Table 1. Physical parameters of each material layer of the wall system

| Parameter / Material | Density (kg/m³) | Specific heat (J/kg·k) | Thermal conductivity (W/m·k) | Size (mm) |
|---|---|---|---|---|
| Glass curtain wall | 2500 | 840 | 0.76 | 2000×2500×5 |
| Solar collector plate | 2719 | 871 | 202.4 | 2000×2100×2 |
| Thermal radiation reflection layer | 2730 | 900 | 236 | 2000×2500×2 |
| Air interlayer | - | 1006.4 | 0.024 | 2000×2500×500 |

## 3. Methodology

### *3.1. Heat transfer analysis*

Because the vertical dimension of the wall system is far larger than the thickness, thus heat transfer of the wall system is assumed as one-dimensional along the thickness direction. Under the influence of outdoor weather