Research on Cool Storage Time of a Phase Change Wallboard Room in the Summer[1]

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Abstract： Through testing and analysis of the parameters of the indoor thermal property in a phase change wallboard room and an ordinary room, the effects of using phase change wallboards on indoor temperature in summer and with air conditioning are analyzed. The combination of construct enclosure and phase change materials can stabilize indoor temperature, improve indoor thermal comfort, reduce the frequency of the operation of air conditioning facility, cut the initial investment and operation expense, and meanwhile play an practical role in “the power balancing between the peak period and the valley period” policy.

Key words: phase change wallboard room; indoor temperature; cool-storage air-conditioning; energy conservation

With the rising of people’s living standards, people now attach more attention to the indoor thermal comfort, which results in the popularity of air conditioner application, higher demand of the electric power and more consumption of construction energy. But the application of phase change materials to the construction enclose can improve indoor thermal comfort effectively, relieve the stress of the electric power supply, reduce energy consumption and alleviate the negative effect on the atmospheric environment [1–5].The enclosure of phase change wall room is constructed by bricks combined with phase change wallboards. Because PCM can increase thermal inertia of the enclosure, the phase change wall room can improve the thermal comfort of indoor environment notably, reduce the fluctuation range of indoor temperature and better the indoor thermal environment [6–10].

Through the experiment and test of the parameters of the indoor thermal property in phase change wallboard room and ordinary room which are the same construct in summer and with the experimental research and its related conclusions made by the author and other members of the work team before, the author analyzed the improved effects on indoor thermal environment and the reduction of construction energy by the application of phase change wallboards [11-15].

1. EXPERIMENTAL PLACE AND CONDITIONS

The experimental place is Shenyang, and the testing room is established in the Artificial Environment and Energy Conservation Lab. Pieces of the equipment applied are listed as follows: PT100 thermocouple, plate-type heat flowmeter, SWP-LCD-SSR-M intelligentizes 64circuit polling instrument residential air conditioning, and Luban testing software.

2. EXPERIMENT

By establishing the phase change wallboard room and the ordinary room, the comparative

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analysis of the thermal properties of the two type rooms was made in the condition of cooling storage with the night air-conditioning in summer. The working period of phase change wallboard room was set: 24hours. The temperature of interior and exterior surface of the wall of the phase change wallboard room and the ordinary room and the heat flow from the outside were tested during the working period, and the effects exerted by phase change wallboard on cutting down the load during the peak period and reducing the capacity of air-conditioning facility was also analysized.

2.1 The Effects Analysis without Residential Air-conditioning

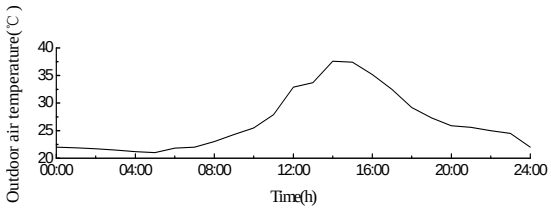

Fig.2.1 Outdoor air temperature

In Fig.2.1 it was showed that in the working period, the lowest temperature was 20.9 and the highest temperature was 36.5 at night.

The comparative analysis of the indoor thermal properties between two rooms during the working periods of air-conditioning-3 hours, 5 hours and 7 hours-at night was made respectively as follows:

the comparison of the temperature difference of the interior and exterior surfaces of the walls of the phase change e wallboard room and the ordinary room in the next day.

Because the range of the melting point of the phase change materials was 19-24 , it was supposed that the indoor temperature in the period of cool-storage was 20 , and kept the temperature of the walls of the two type rooms in the next day. In this experiment, only the south wallboard of the test room was exterior wallboard and could absorb the solar radiation.

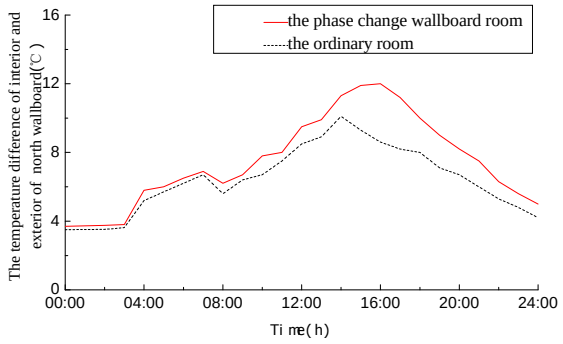

Fig.2.2 Temperature difference of interior and exterior surface of south wall in phase change wallboard room and ordinary room (3 hours)

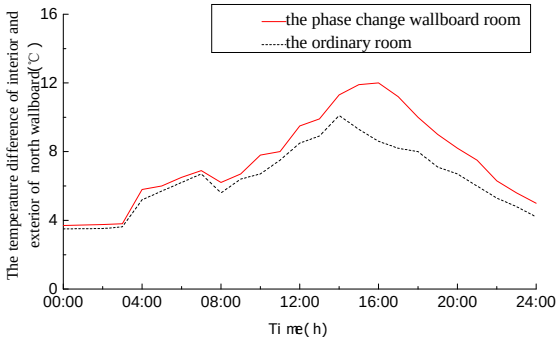

Fig.2.3 Temperature difference of interior and exterior surface of south wall in phase change wallboard room and ordinary room (5 hours)

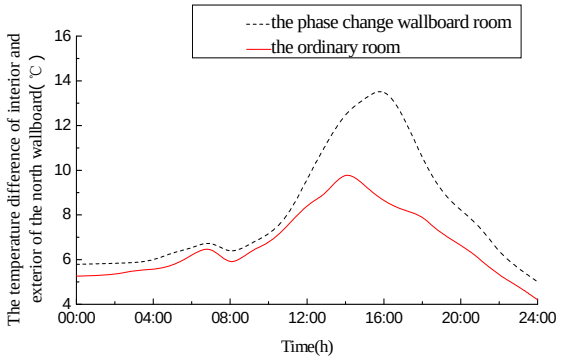

Fig.2.4 Temperature difference of interior and exterior surface of south wall in phase change wallboard room and ordinary room (7 hours)

In Fig.2.2, Fig2.3 and Fig2.4, it was found that due to the solar radiation, the surface temperature of the north wall rose quickly, and then the change of the temperature difference between interior and exterior surface of wall was great. The temperature

difference of interior and exterior surface of wall of the phase change wallboard room was larger than the one of the ordinary room, which indicated that the change of interior and exterior surface of wall of the phase change wallboard room was smaller than the one of the ordinary room. The effects of Cool-storing for 3 hours and cool-storing for 5 hours were similar, but the temperature difference of interior and exterior surface became larger. However, comparing cool-storing for 3 hours and cool-storing for 5 hours, the condition of temperature did not rise obviously. In a word, the phase change wallboard had better cool-storage properties.

⑵The comparison of the changes of the heat flow of the phase change wallboard room and the ordinary room in the next day.

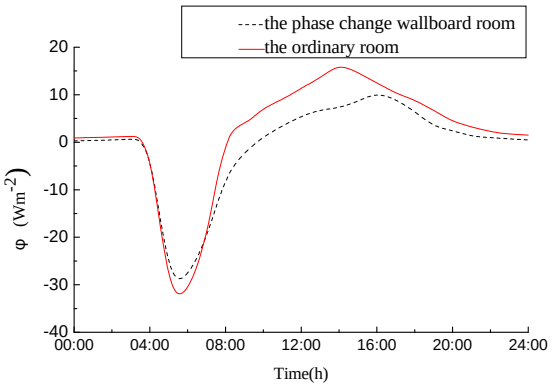

Fig.2.5 The heat flow of south wall of the phase change wallboard room and ordinary room (3 hours)

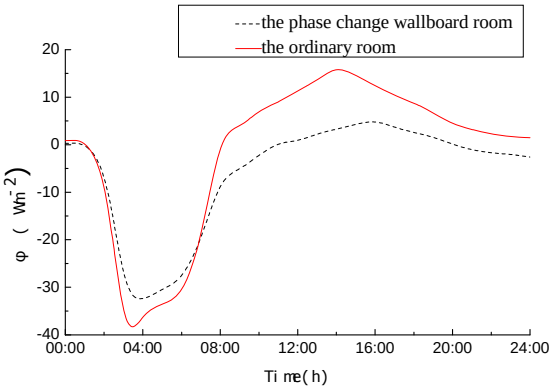

Fig.2.6 The heat flow of south wall of the phase change wallboard room and ordinary room (5 hours)

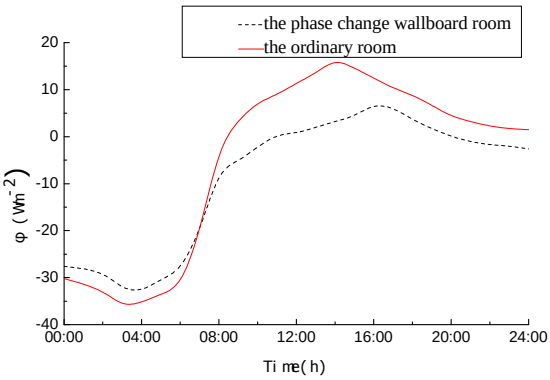

Fig.2.7 The heat flow of south wall of the phase change wallboard room and ordinary room (7 hours)

In Fig.2.5 it was found that the heat flow of the phase change wallboard room was lower than the one of the ordinary room, but the effect was not obvious. And in Fig.2.6 and Fig.2.7, it was indicated that the effect of cool-storing for 5 hours was obvious, but the difference of heat flow of the two type walls in cool-storing for 5 hours and 7 hours was smaller.

In summary, through testing the thermal properties of the two rooms in the different cool-storing periods, it was showed that cool-storing for 5 hours could have the better effect. However, the effect could not improve obviously with prolonging the operating period, which indicated that cool-storing for 5 hours could make the function of phase change wallboard better.

2.2 The Effects Analysis of The Combination Of Residential Air-conditioning And Phase Change Wallboard In The Daytime (With Sunlight)

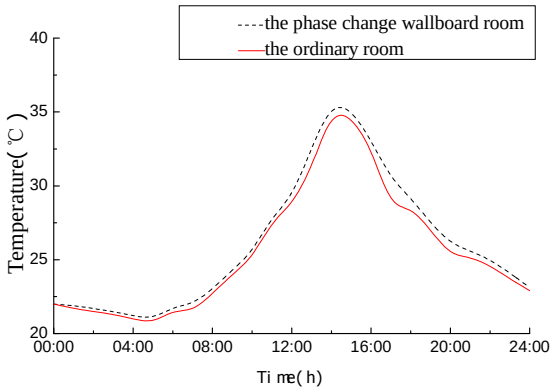

Fig.2.8 The changes of outdoor air temperature

The changes of outdoor air temperature of the phase change wallboard room and ordinary room during 24 hours were tested respectively. In Fig.2.8, it was obtained that the temperature difference was very small, which could exert little impact on the comparative testing in this research.

During the testing period, the minimum outdoor temperature was 20 and lasted from 2-3 hours; the maximum outdoor temperature was about 35 , which appeared at round 2:00PM.Because of the different constructs between two rooms, the changes of indoor cool load in different rooms were different. In the process of this test, the operation changes of the air conditioner were all kept in details.

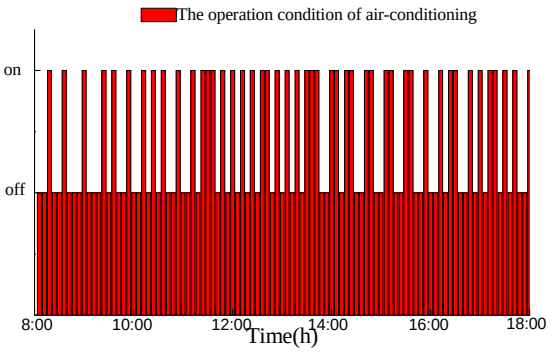

Fig.2.9 On-and-off changes of the air conditioner in the ordinary room

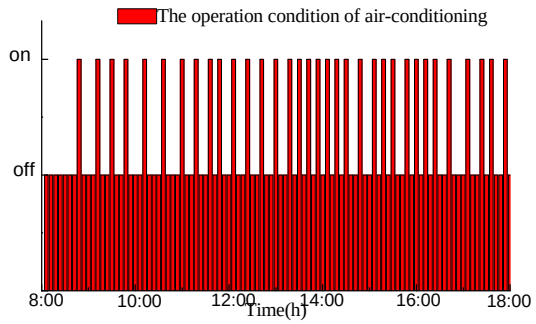

Fig.2.10 On-and-off changes of the air conditioner in the phase change wallboard room

In Fig.2.9 and Fig.2.10, it was obtained that the operation of air-conditioning in the ordinary room took the means -"now needed, and then supply", which meant that how much was needed in the construction equals how much the air-conditioning facility could supply. But there lacked the cushion and adjustment mechanism between demand and supply. By contrast, the application of phase change wallboard could fix the matters mentioned above, reduce the frequency of the operation of air conditioning facility, prolong the lifetime of the facility and play an important role in reducing the indoor temperature.(to see Fig.2.10)

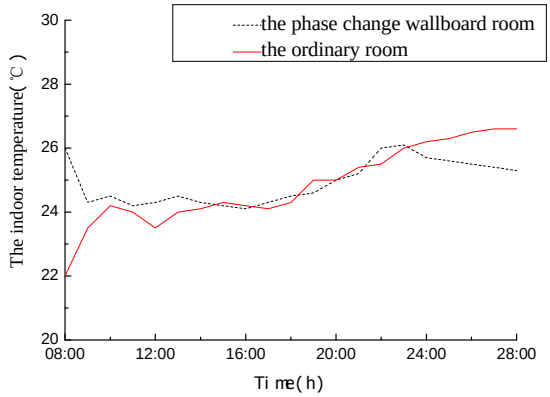

Fig.2.11 The indoor temperature changes in different rooms

When the indoor temperature was set at 24 , there was little difference between the indoor temperature changes in different rooms. Compared with the temperature fluctuation in phase change wallboard room, the one of the ordinary room was larger, for the reason of its higher frequency of the operation of air-conditioning facility. Comparatively

speaking, the phase change wallboard could reduce the heat flow from the outside, release the heat stored in the daytime into the room in the night, and maintain the indoor temperature without any declining.

2.3 Impact on the capacity of the air-conditioning facility

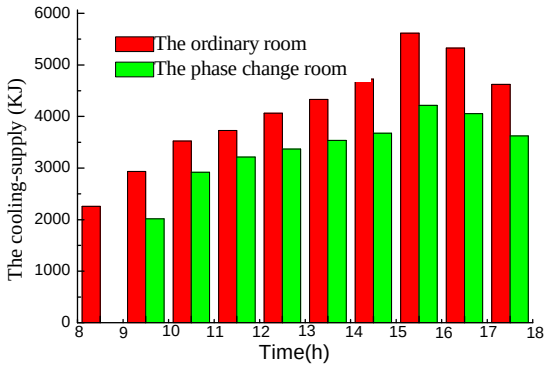

Fig.2.12 The relation between the cooling-supply from the air conditioner and time

The change of cooling-supply from the air conditioner during 8:00-18:00 in daytime is showed in Fig.2.12. Meanwhile, it is obtained that the phase change wallboard could serve as the assisting facility for the cooling facility in the daytime, and also played an active role in reducing the capacity of the air-conditioning facility

3. CONCLUSIONS

Through the experiment and the test of the effects exerted by phase change wallboard room and ordinary room on the indoor thermal environment, it is obtained that the phase change wallboard can reduce the fluctuation range of indoor temperature and the heat flow from the outside into indoor environment in summer.

Through the analysis of the phase change wallboard without air conditioning in daytime, it is obtained that the frequency of the operation of air conditioning in phase change wallboard room is smaller than that in the ordinary room, which can prolong the lifetime of the facility and reduce operation expense.

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