A Report on the Camp Insulation Performance

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Test Agency: **Zhejiang University of Science and Technology**

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Part-I Basic Information

Date: Mar 12-13, 2018
Location: Binjiang, Hangzhou.
Altitude: 7th floor
Ambient temperature during test: between 16 °C and 19 °C.
Test period:5 hours
Temperature difference: larger than 15 °C
Measurement location: 3 locations, 2 thermocouples at each location (one inside the camp, the other outside the camp)

Camp Parameters:

(1) Outside surface area: 50 m^2 without consideration the carpet area.
(2) Carpet area: 25 m^2 (**two cases:** basic insulation and improved insulation).
(3) Double insulation layers for the outside surface.
(4) mm thickness each, approximate 5 mm thick of air gap.)
(5) Insulation material: eiderdown.
(6) Metals support.

Measurement Instruments:

(1) Agilent DAQ, incorporated with 6 K-type thermocouples
Accuracy: 0.5%.
(2) Dali-T8 Infrared Imager
Resolution: 384×288
Wavelength: 8-14 μm
Accuracy: Max. 2 °C OR 2%.

Measurement Locations:

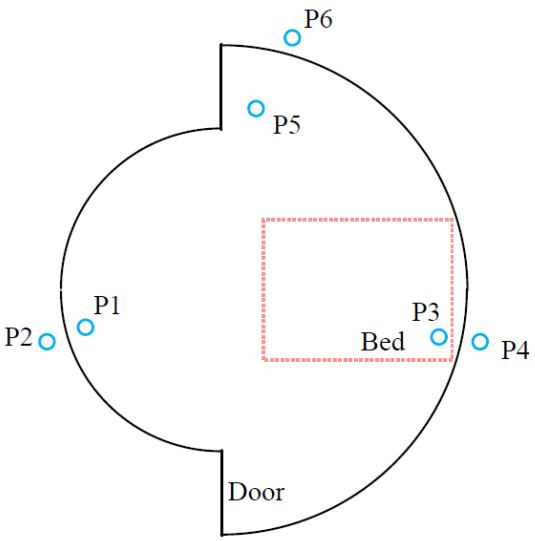


Fig.1 Measurement locations

Part-II Basic insulation performance

The temperature variation curves is shown as Fig.2. Notice that this result is obtained after 2 hours of heating with 2 KW electrical heater inside the camp. Wind velocity: 1.4-1.6 m/s.

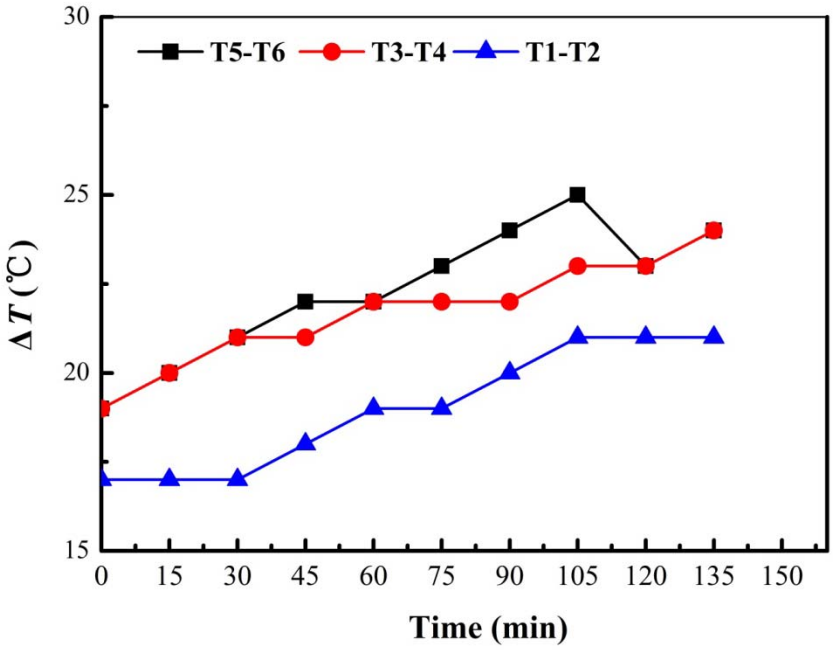


Fig.2 Time evolution of the temperature difference (begins from a semi-steady state)

Analysis:

(1) The average result between 60 minutes to 135 minutes is 22.1 °C.

(2) Maximum temperature difference between 60 minutes to 135 minutes is 2 °C. Therefore, data from this period can be referred as steady-state results.

(3) The overall heat transfer coefficient. The heat dissipation rate from the camp is as follows,

$$Q_{\text{out}} = UA\Delta T$$

where the overall heat transfer coefficient is determined by the five thermal resistances. i.e. the inside convection thermal resistance, the outside convection thermal resistance, the conduction thermal resistances (two insulation layers and one air layer).

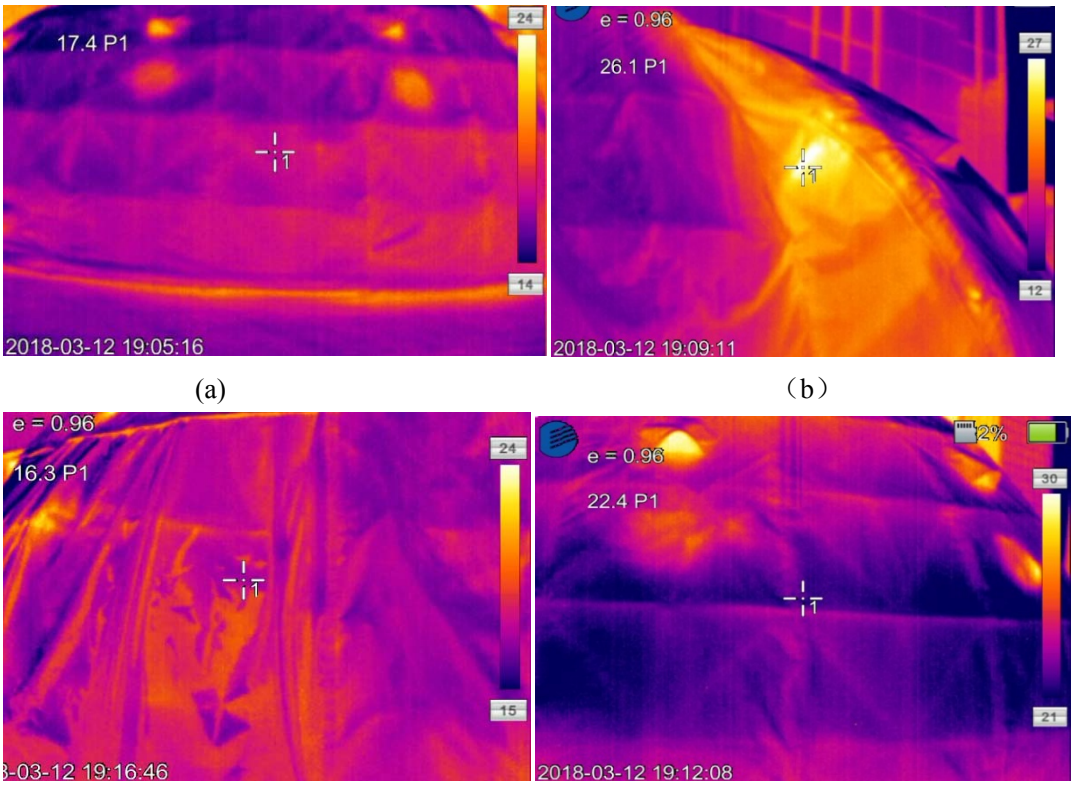
As a result, the overall heat transfer coefficient is 1.21 W/m^2-K.

(4) Heat leak.

(a) The major heat leaks are located at the carpet floor and the upper part of the door.

(b) The heat leaks from the windows should be taken into considerations.

(c) The metal support may contribute to the conduction heat lost.



(a) (b) (c) (d)

Fig.3 Infrared images from difference views

Fig.4 An infrared image of the Sewage treatment equipment (for whom concerns)

Part-III Improved insulation performance

The temperature variation curves is shown as Fig.5. Notice that this result is obtained after 1.5 hours of heating with 2 KW electrical heater inside the camp. Wind velocity: 1.1-1.2 m/s.

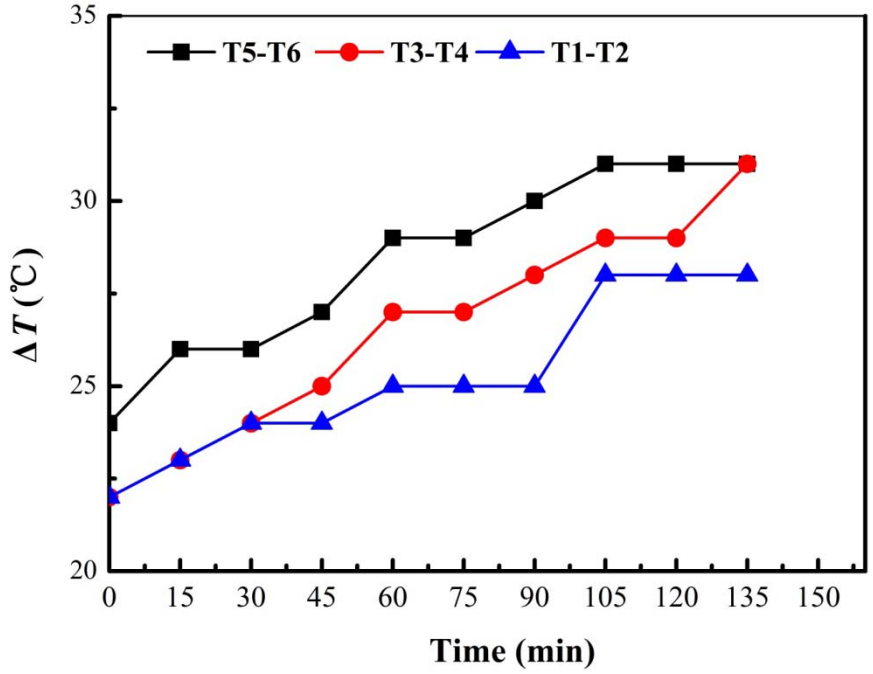


Fig.5 Time evolution of the temperature difference (begins from a semi-steady state)

Analysis:

(1) The average result between 60 minutes to 135 minutes is 28.4°C.

(2) Maximum temperature difference between 60 minutes to 135 minutes is 3°C. Therefore, data from this period can be referred as steady-state results.

(3) The overall heat transfer coefficient. The heat dissipation rate from the camp is as follows,

$$Q_{\text{out}} = UA\Delta T$$

where the overall heat transfer coefficient is determined by the five thermal resistances. i.e. the inside convection thermal resistance, the outside convection thermal resistance, the conduction thermal resistances (two insulation layers and one air layer).

As a result, the overall heat transfer coefficient is 0.94 W/m^2-K.

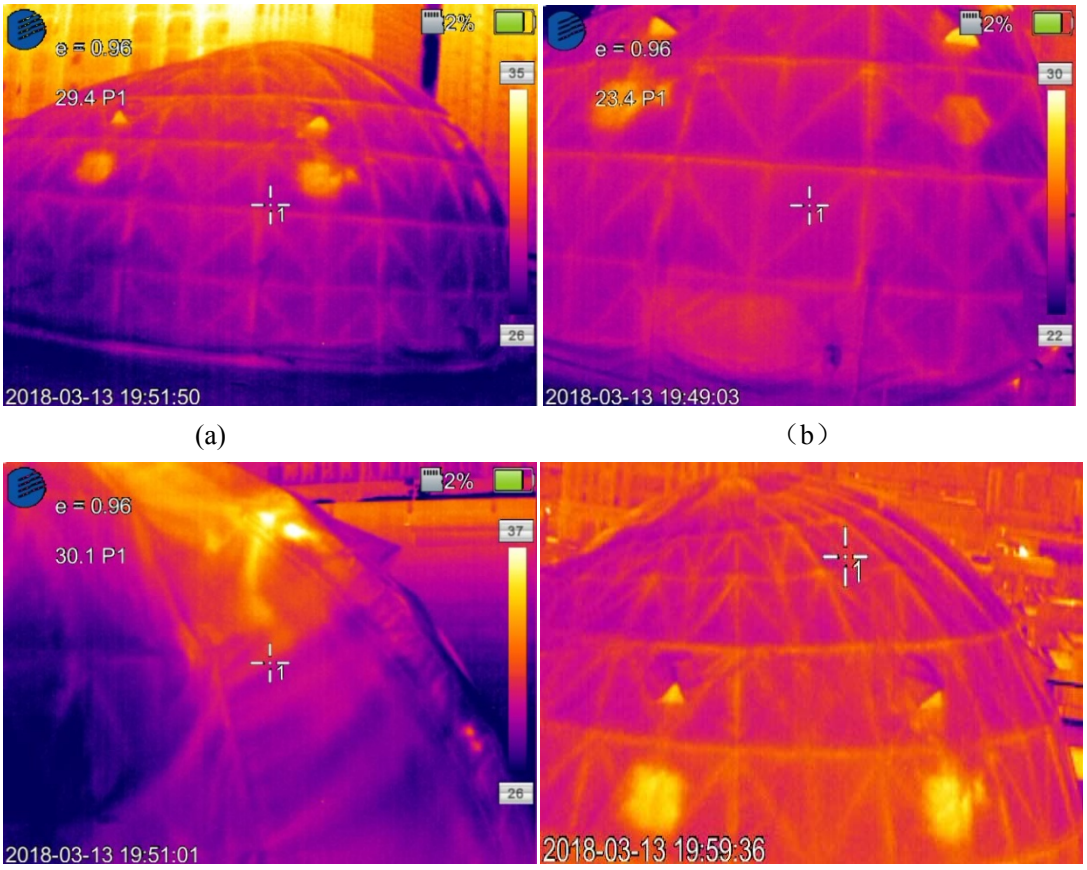
(4) Heat leak.

(a) The heat leak problem from the carpet floor was solved.

(b) The major heat leak is located at the upper part of the door.

(c) The heat leaks from the windows should be taken into considerations.

(d) The metal support may contribute to the conduction heat lost.



(a) （b）

(c) (d)

Fig.6 Infrared images from difference views

Part-IV Conclusions

(1) For the Camp with basic insulation, the overall heat transfer coefficient is 1.21 W/m^2-K.

(2) For the camp with improved insulation, the overall heat transfer coefficient is 0.94 W/m^2-K. Therefore, the insulation of the carpet floor is very important.

(3) The heat leak problem located at the upper part of the door should be noticed.

(4) The heat conduction characteristics of the metal support should be noticed.

(5) The top of the camp was insulated appropriately, minor heat leak was found.

Signature:

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