Exploration And Correction Of The Temperature In Central Air Conditioning System For Large Space

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Abstract

Based on the analysis of indoor temperature control method in large space central air conditioning system, this paper concludes that the control accuracy is affected by the gradient distribution of indoor temperature. The traditional control method based on indoor air return temperature as the control basis of indoor temperature is irrationality. In this paper, PHOENICS software was used to simulate a central air conditioning system in a control center. According to the simulation results, the air temperature was calibrated by using the temperature correction optimization method, which made the temperature detection value closer to the actual temperature. Central air conditioning system operation energy consumption, energy-saving purposes.

Keywords

Large space, central air conditioning, PHOENICS, correction, energy saving.

1. Introduction

In modern architecture, people are increasingly demanding on the environment comfort, including central air conditioning system plays an irreplaceable role in temperature control, the use of central air conditioning system is becoming more common, but at the same time, the central air conditioning energy consumption accounted for more than 60% of the total energy consumption, reduce building energy consumption of air conditioning system, is an effective measure to reduce building energy consumption, is of great significance for building energy conservation[1]. But for large space indoor environment, regional load present inhomogeneity, easy to appear the phenomenon of uneven and, personnel fluidity big, big load interference, at the same time control the strong coupling between various regions, decoupling is difficult, therefore, the temperature correction for central air conditioning system energy saving and improving comfort plays an important role.

In a large space air conditioning system, terminal device through the return air temperature of the detected parameter values and indoor set temperature deviation adjusting air valve opening, change delivery at the end, to adapt to the changes in the indoor load. However, because of building indoor vertical temperature gradient is bigger, inlet temperature is highly practical human activity needs high temperature, and cannot effectively reflect real indoor temperature, human activity actual demand actual delivery send air volume is greater than demand, terminal operation energy consumption will increase. The control precision of the system is not high. Therefore, it is necessary to rectify the detection value of the indoor air temperature of the large space air-conditioning system and reduce the energy consumption of the air-conditioning system. In this paper, PHOENICS software was used to simulate the air conditioning system in a control center, the indoor temperature distribution was obtained, the vertical temperature gradient was analyzed, and the temperature correction optimization method was used to optimize the return air temperature. The effect has been estimated and analyzed..

2. PHOENICS Model

2.1 PHOENICS Introduction.

PHOENICS is the world's first set of computational fluid and computational heat transfer commercial software researched and developed by the Imperial College of Cambridge, an internationally recognized and authoritative CFD technology research institute. And HVAC FLAIR module is used in this study. The FLAIR module consists of three parts: FLAIR VR-Editor, PHOENICS solver and FLAIR VR-Viewer [2]. FLAIR removes the functionality of the original PHOENICS user interface that is not relevant to HVAC and automatically generates computational grids, while PHOENICS can provide users with a large number of HVAC equipment and components such as fans, showers and more.

2.2 Model Simplification.

In the simulation process, it is considered that the indoor air flow in the air-conditioned room is continuous, the incompressible fluid treatment is performed on the gas in the flow field, and the inner wall is treated as heatless and heat-insulated.

2.3 Model Parameters.

(1) Area

The hall wall of 71.3 meters long axis, 49.4 meters short axis of the ellipse, a height of 10 meters, with a total area of 3976.7 square meters.

(2) Computer and people

A total of 275 scheduling computers are designed in the control center, and each computer with 350 watts. According to 30% of the thermal power of the computer, the thermal power of each computer is 105 watts [3]. The human body load is calculated according to the light labor intensity, Heat dissipation, according to 65W / person calculation, the computer and human work under full load heat dissipation is 46,750 watts.

(3) Wall thermal conductivity

The interior wall is brick wall, the wall thermal conductivity is 0.815w / m^2/ ℃.

2.4 Boundary Conditions.

(1) Entrance

The hall has a total of six air outlets, each outlet 1.5 meters long and 1 meter wide, the layout height of 9 meters, the design of the air temperature is 20 degrees, the air speed of 1m / s.

(2) Exit

Natural exports are distributed in the dispatch hall five doors, each 1.5 meters wide, 2.25 meters high. The return air device are arranged on the wall above a height of 5.5 m.

2.5 Simulation Conditions.

Air inlet 20 degrees, wind speed 1m / s, and simulation for 30 minutes, the model shown in Fig. 1.

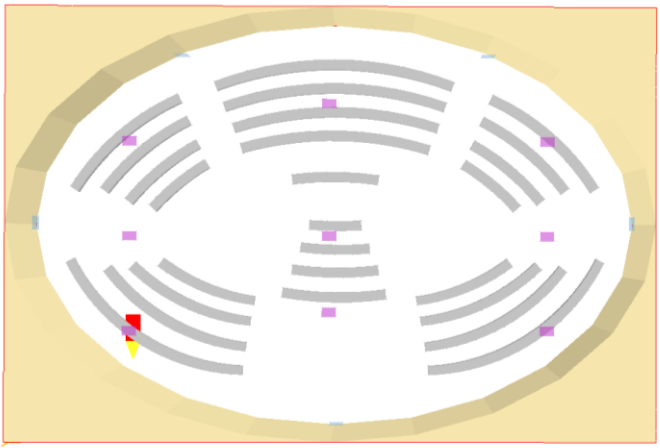

Fig. 1 The control center PHOENICS model

3. Simulation Results And Analysis

3.1 Simulation Results.

The simulation results are analyzed by means of a typical cross-section, and the temperature field simulation results are shown in Fig. 2.

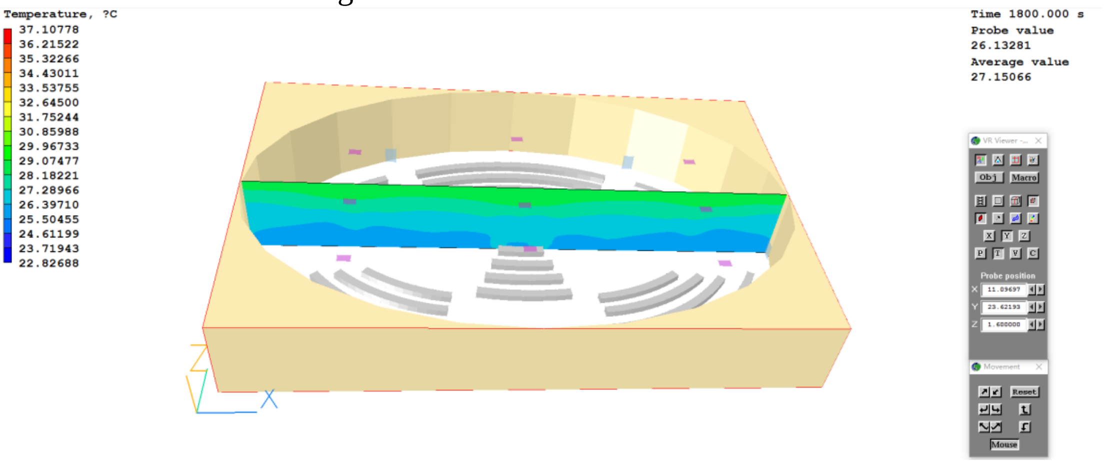

Fig. 2 Temperature distribution map of inlet section

According to the simulation results, taking 2 minutes as a record node, the temperature changes with time at different heights in the air supply section in the first 30 minutes as shown in Table 1 and Fig. 3.

Table 1 1.7 meters height and 5.5 meters height air temperature over time table

Numble	0 min	2 min	4 min	6 min	8 min	10 min	12 min	14 min
1.7m	37℃	34.94℃	32.48℃	31.46℃	30.81℃	30.27℃	29.81℃	29.41℃
5.5m	37℃	35.85℃	35.38℃	34.49℃	33.59℃	32.77℃	31.97℃	31.18℃

Numble	16min	18 min	20 min	22 min	24 min	26 min	28 min	30 min
1.7m	29.03℃	28.63℃	28.21℃	27.79℃	27.38℃	27.01℃	26.65℃	26.33℃
5.5m	30.47℃	29.87℃	29.35℃	28.87℃	28.42℃	27.99℃	27.58℃	27.03℃

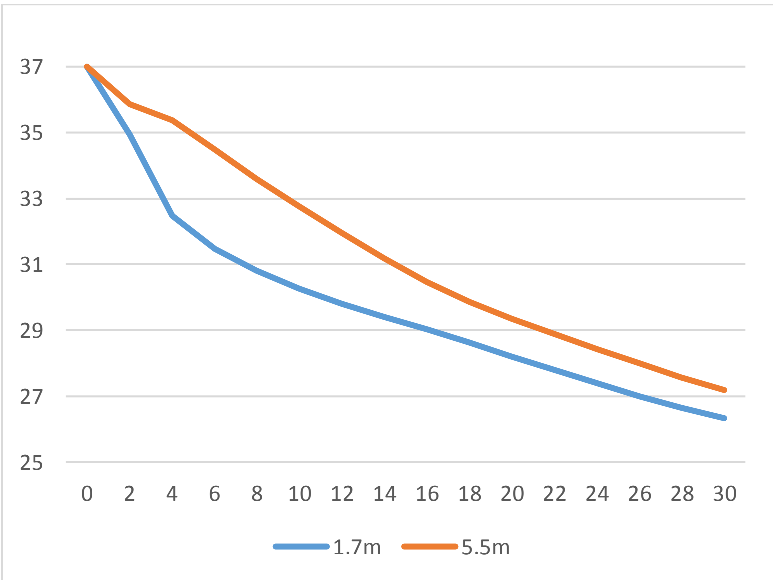

Fig. 3 The temperature varies with time at different altitudes

The design temperature of the control center is 27 ℃. It can be seen from the simulation that the temperature of the human activity area at 1.7m reaches 27.01 ℃ at 26 minutes, as shown in Fig. 4, but the temperature here is 27.99℃, because the sensor is installed at a height of 5.5m ℃, as shown in Fig. 5, when the fan continues to run.

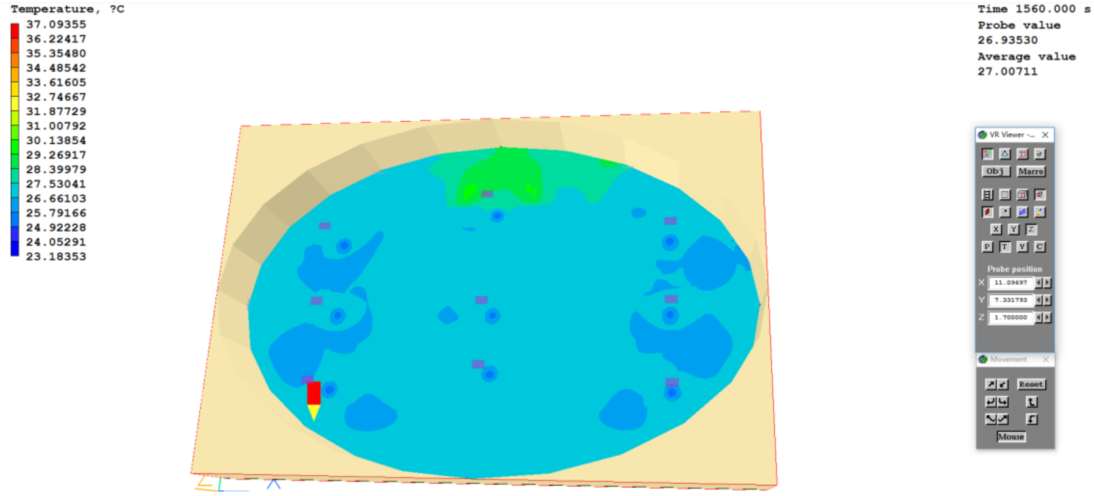

Fig. 4 Temperature at 1.7 m at 26 minutes

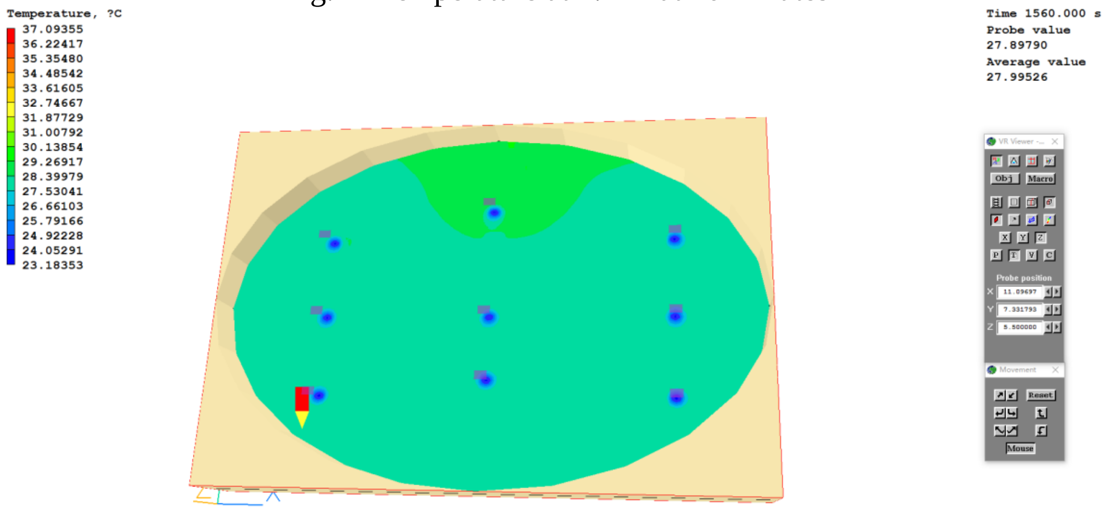

Fig. 5 Temperature at 5.5 meters at 26 minutes

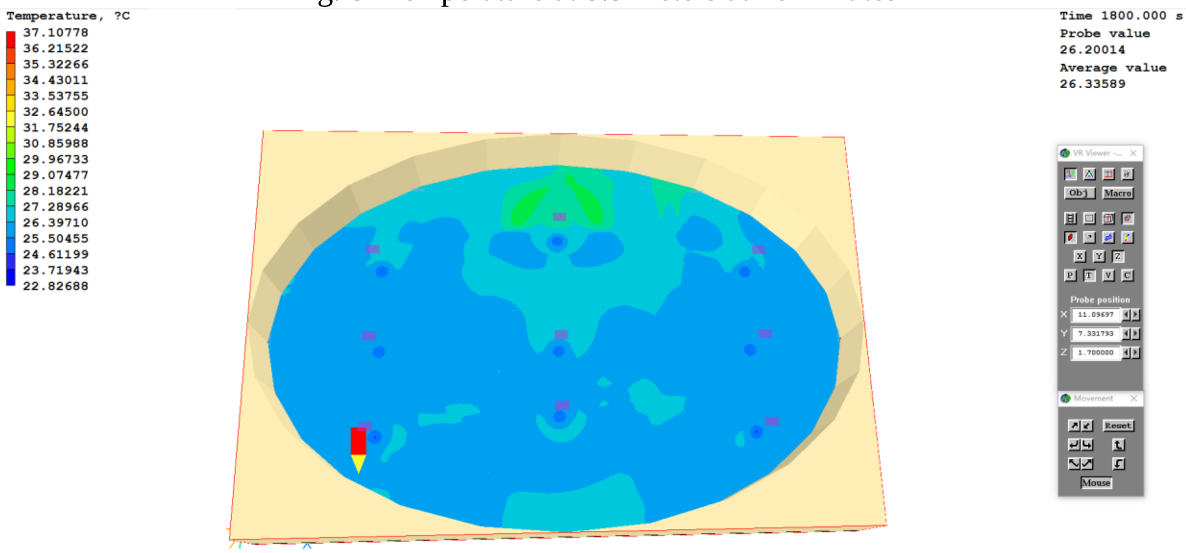

Fig. 6 Temperature at 1.7 m at 30 minutes

As the detection temperature at 5.5 meters, when the temperature here is higher than the set value of 27 ℃, the fan continues to work, when 30 minutes reach 5.5 meters at a temperature of 27.03 ℃, the fan stops, as shown in Fig. 6. At this time 1.7 meters at a temperature of 26.33 ℃, lower than the design temperature, as shown in Fig. 7, the human body will feel cold.

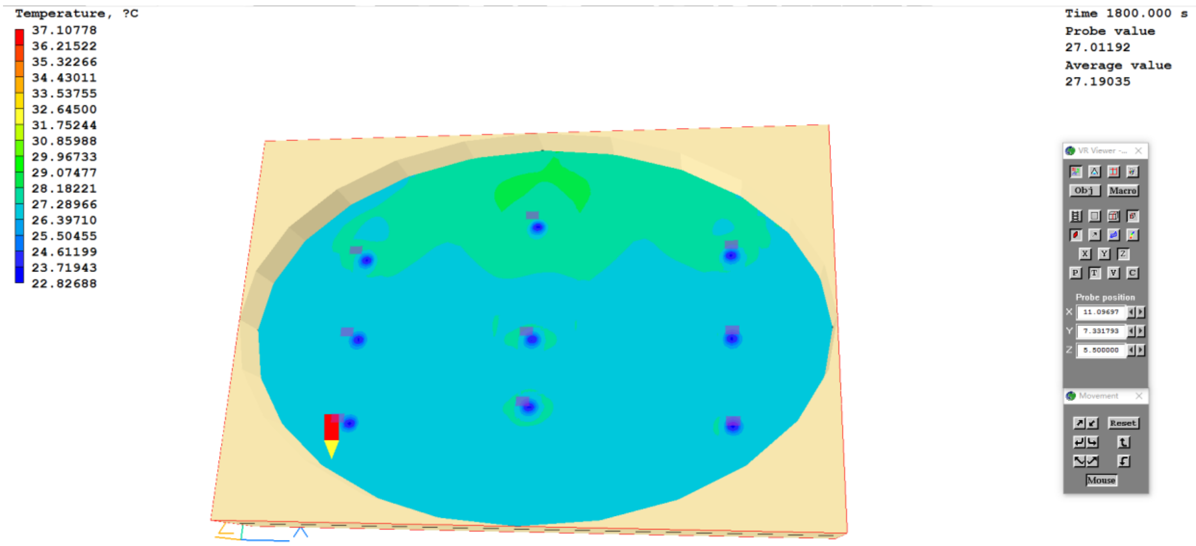

Fig. 6 Temperature at 5.5 m at 30 minutes

From the above analysis, it can be seen that when the fan runs for 26 minutes, the indoor temperature has reached the design requirement, but due to the temperature gradient distribution image, the detected return air temperature is higher than the set temperature, the fan continues to operate, which increases the energy consumption, Lowering the temperature below the design temperature not only reduces environmental comfort but also increases energy consumption.

Temperature Correction.

In the air conditioned environment, it is reasonable to arrange the temperature sensor at a height of 1.7 m in terms of human comfort because the human forehead is one of the parts of the human body that is most sensitive to thermal comfort[4]. However, in practical engineering applications, the temperature sensor is usually installed at the air return port, and the amount of air supply is controlled according to the return air temperature detection value. This control method is somewhat unreasonable. If the air temperature can be detected to some degree of correction to make it closer to the indoor temperature of the actual needs of human activity height, it will be able to effectively reduce the amount of air-conditioning air supply system to achieve energy-saving purposes. Therefore, this article gives the calculation method of temperature gradient:

Vertical temperature gradient:

$$\sigma=\frac{d_t}{d_y} \tag{1}$$

Vertical temperature correction:

$$k_t=\int_{y^1}^{y^2}\sigma \tag{2}$$

In practical engineering, since the temperature distribution in large space is not uniform, we should calculate the average temperature gradient of the temperature detected by each area sensor. The average vertical temperature gradient $\hat{\sigma}$ is:

$$\hat{\sigma}=\frac{\sum_{i=2}^{n}\frac{T_i-T_{i-1}}{y_i-y_{i-1}}i}{n-1} \tag{3}$$

T_i ,T_{i-1}—i test point and i-1 test point detection temperature, ℃.

y_i, y_{i-1} —The height of the i-test point and the i-1 test point in the vertical direction, m.

n —the number of points in the field, a.

3.2 Energy Analysis

In the same case of fan power, fan power is proportional to the time:

$$= P_1 *(\frac{t_2}{t_1}) = P_1 \frac{26}{30} = 0.87 P_1 \quad (4)$$

P_1, P_2—Energy consumption at different times，KW.

t_1, t_2—Different heights to reach the same temperature time，min.

4. Conclusion

In the traditional central air conditioning system, the indoor air outlet temperature monitoring information as the basis for the end temperature regulation has some irrationality, the return air outlet temperature is generally higher than the human activity height of the region, resulting in the actual amount of air supply system than demand The amount of air supply is not conducive to fan energy saving. Based on the simulation software, the distribution of temperature in the vertical direction of the indoor temperature is analyzed by using the simulated data, and the temperature gradient value at the height of 1.7m between the return air passage and the human body activity is calculated. By using the temperature correction method, Wind temperature detection value is amended to make it closer to the design of the indoor temperature, effectively reducing the amount of air supply system, the fan energy consumption can save 13%.

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