Study on indoor comfort of wall type capillary radiant heating system

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Abstract: In this paper, the radiation heat supply and displacement ventilation system for the wall of capillary tube are established. The indoor thermal environment is simulated by the Airpak software, and temperature contours,velocity vector images, PMV nephogram are made respectively. By analysis and comparison, the conclusion is drew: There is temperature gradient in the horizontal direction but minute, and it's also true for the vertical one. When the indoor wind speed is about 0.2m/s, people will be comfortable basically, and the PMV around is about 0.3. Because of the heat source, the temperature as well as PMV value near the computer is higher. Thus, the distribution of PMV value is related to temperature.

Introduction

Nowadays, people advocate energy conservation, environment protection and comfortable life, and thus capillary wall radiation heating and displacement ventilation system came into being. It can improve indoor air quality and indoor comfortable degree which is becoming more and more eminent, and it can also solve the problems the current air-conditioning system is faced with[1-4]. The paper analyses and compares indoor comfort of wall type capillary tube radiant heating system from the following aspects: temperature ,velocity, velocity vector and PMV.

Physical Model

To show the air conditioning system with capillary wall radiation heating and displacement ventilation, Airpark software was used to establish an office room with the size of 5m × 4m ×3m. The size of windows are 3.6m ×1.16m. Air inlet size is 0.2 m × 0.3 m. Air outlet size is 0.2 m × 0.3 m. The human body is replaced by a cuboid whose size is 0.4m ×0.35m × 1.1m. Heat dissipating capacity is 75W. The computer is replaced by a 0.4m ×0.4m × 0.4m cube. Heat dissipating capacity is 108W. The size of lamp is 0.2m ×1.2m ×0.15m whose heat radiation is 34w. the indoor winter temperature is kept at 20 degrees Celsius. Capillary radiation temperature is 28[5].All the information are shown in Figure 1.

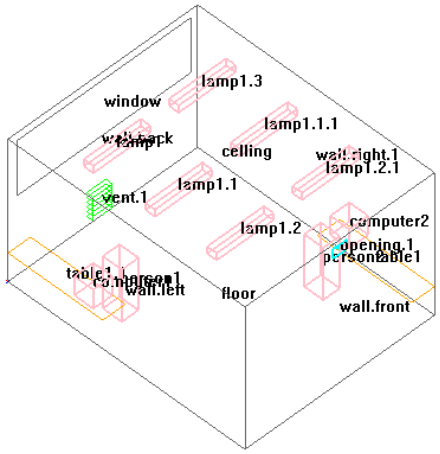


Fig. 1 the model of the office

Wall capillary heat radiation and displacement ventilation CFD simulations:

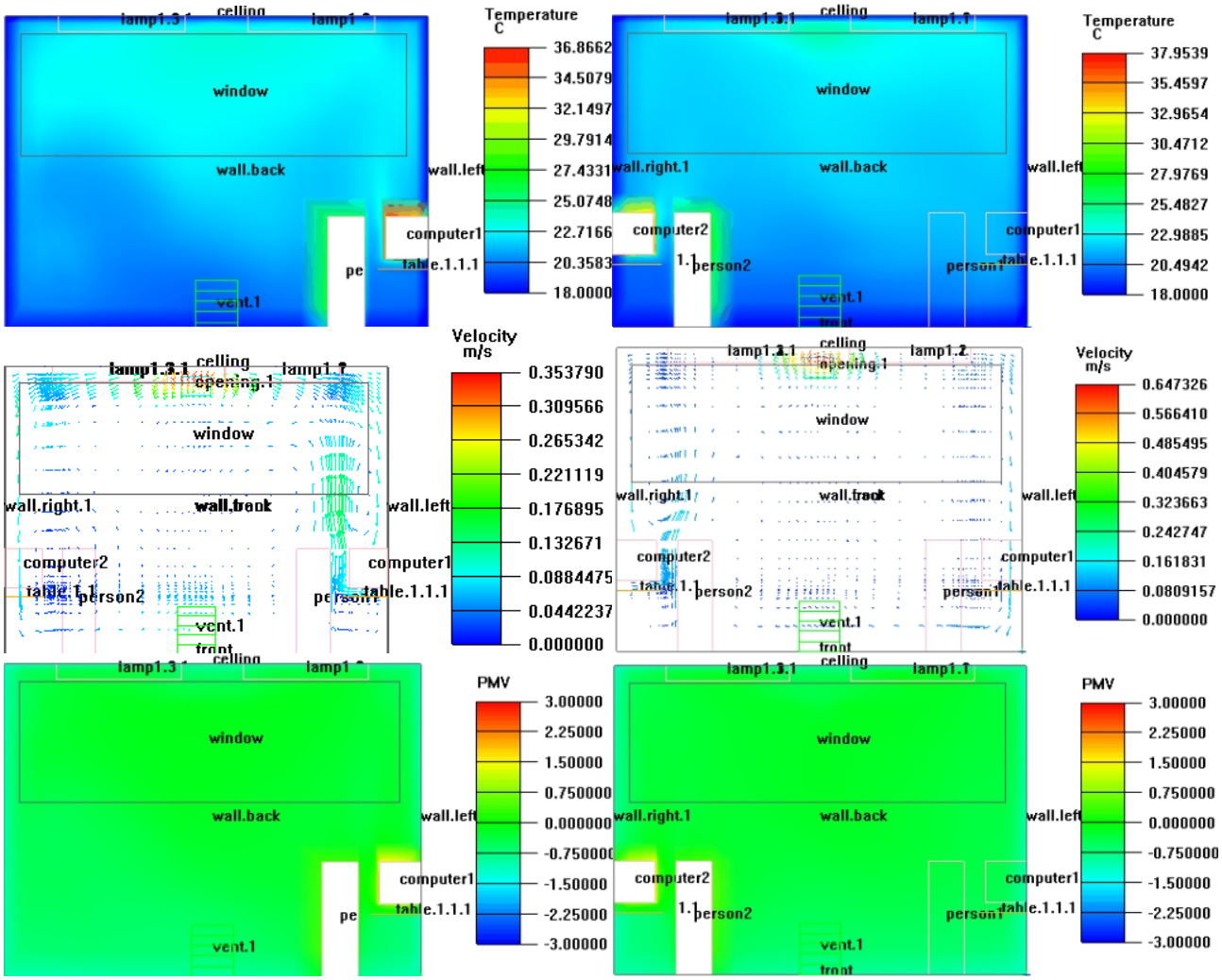
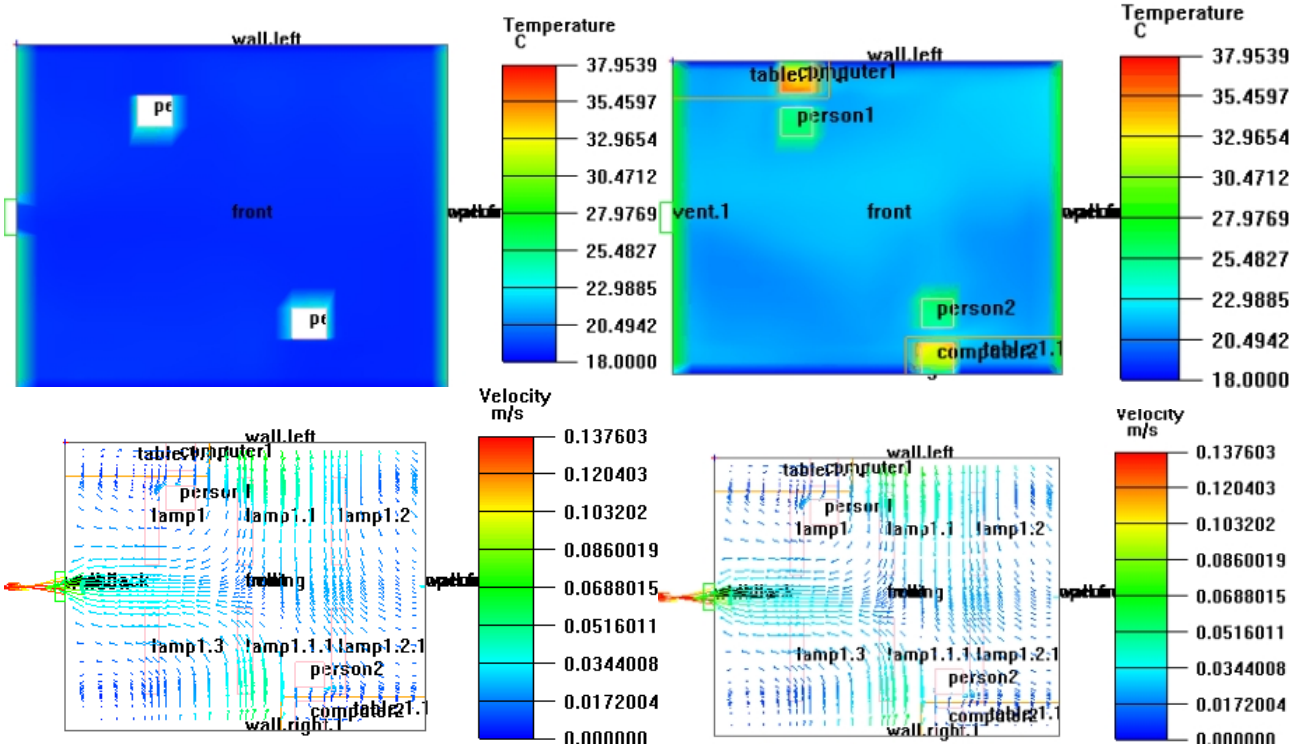


Fig.2 the graph of temperature, velocity, PMV (X=1.5m)

Fig.3 the graph of temperature,velocity, PMV (X=3.5m)



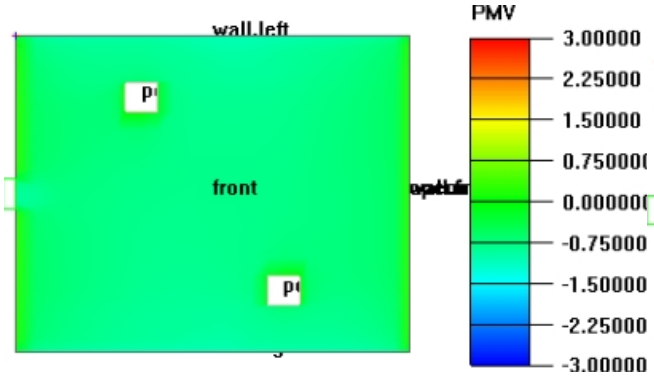


Fig.4 the graph of temperature, velocity, PMV (Y=0.1m)

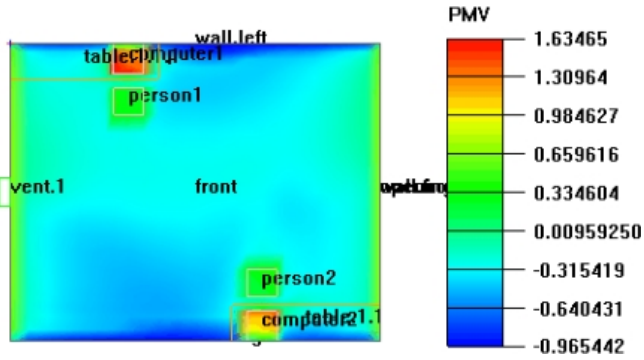


Fig.5 the graph of temperature, velocity, PMV (Y=1.1m)

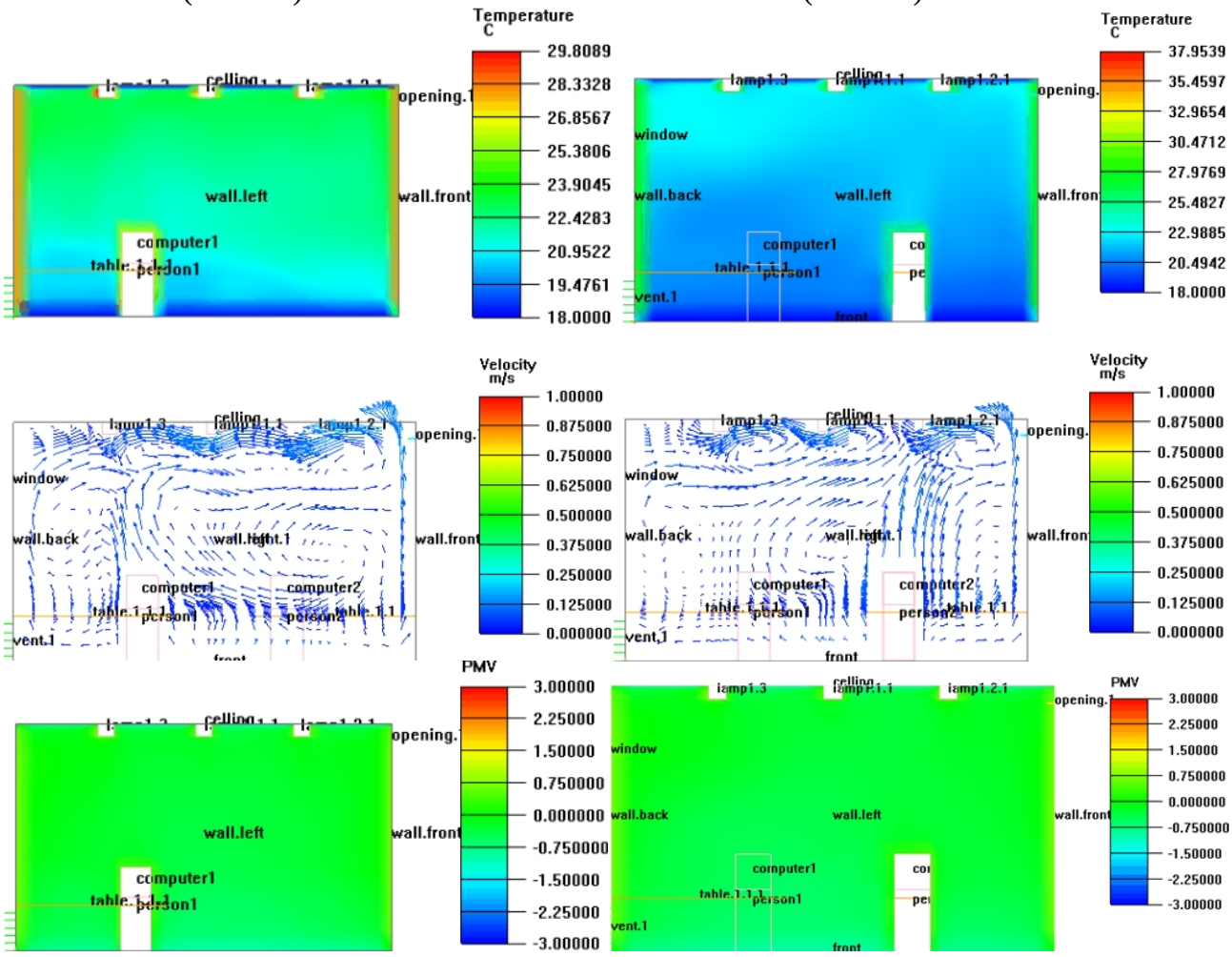


Fig.6 the graph of temperature, velocity, PMV (Z=-0.8m)

Fig.7 the graph of temperature, velocity, PMV (Z=-3.2m)

Note: The temperature of the capillary wall radiation board is 28 degrees Celsius. The temperature of other envelope radiation is the average radiation temperature which is 18 degrees Celsius [6]. Indoor temperature, speed, speed vector diagram, PMV are shown in figures.

As shown in Figure 2 and 3, X=1.5m and x=3.5m are cut off the body, computer plane. In the vertical direction of the two section, there is a phenomenon of stratification. Because the temperature of human body and computer is relatively high, causing the hot air around human body ,the front and back side of computer rising. While the temperature change on the left and right section is not significant. As shown in Figure 4 and 5, the temperature of Y=0.1m is maintained at 18 degrees Celsius. And the temperature of y=1.1m is maintained at 20. Vertical temperature gradient is large. As shown in Figure 6 and 7, the temperature of z=-0.8m is basically maintained at 23 degrees Celsius. And the

temperature of z=-3.2m is basically maintained at 20 degrees Celsius. Due to the south window, the temperature is higher in the south side.

From the velocity vector diagram of x=3.5m, y=0.1m, y=1.1m, z=-3.2m, we can be find that fresh air enters from the air supply and spreads out at the top. When the air flow passes through the left and right cold walls, the air flow drops. When passing by human body and computer, the air current rises and finally reaches the air outlet of the upper part. During the whole process, the working area can get fresh air continuously. From the speed of cloud chamber, we can see can see that the wind speed near the human body is 0.1m/s which can hardly felt, leaving people a comfortable atmosphere. At human working area, PMV is about 0.3 which makes people feel comfortable basically. The temperature near the computer is high, as well as the PMV value, because of the heat source. On the Y=1.1m section, the temperature is high due to hot gas flowing, which is also true for PMV value.

Conclusions

(1) From the chart,conclusions can be drawn. Since the front and rear walls were equipped with the wall type radiation heating system, there is temperature gradient in the horizontal direction. However, the temperature gradient and the vertical temperature gradient is relatively small. Thus, human body can easily feel comfortable.

(2) In the wall radiant heating system, the indoor temperature is easy adjust to the setting temperature and well distributed. Therefore, the heating effect is good. Besides, the PMV around the body is approximately 0.3,which can make people feel comfort in general. Due to the heat source, the temperature around the computer is higher than other area, as well as the PMV value. Given the previous descriptions, the PMV value is related to the temperature.

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