Advanced Materials Research
ISSN: 1662-8985, Vols. 594-597, pp 2086-2089
doi:10.4028/www.scientific.net/AMR.594-597.2086

Online: 2012-11-29

Simulation Study on the Radiant Tube Transferring Characteristics for the Gas-infrared Heated System

Daying Zhang[1,a], Weidong Zhuang[1,b] and Keqin Gong[2,c]

[1]College of Engineering, Heilongjiang Bayi Agricultural University, Daqing 163319, China

2Civil Engineering College, Northeast Petroleum University, Daqing 163318, China

[a]zdy004@163.com, [b]81nd@163.com, [c]gkqdqpi@126.com

Keywords: Gas-fired radiant heating, Numerical simulation, Temperature distribution

Abstract. The numerical simulation for radiant tube heat transferring process of the gas-infrared heated room was finished. By means of numerical calculation, the influences of radiant tube emittance to the indoor temperature and workspace air temperature as well as the heat radiation flux were studied. The results show: The greater of radiant tube surface emittance, The higher of the total heat flux, meanwhile, workspace average temperature and average radiation temperature are rise.

Introduction

Gas-infrared heating is a kind of low-intensity far-infrared radiation heating method, This system is particularly applicable in the places of a lot of heat loss, a large number of ventilated spaces and open space etc. Gas infrared heating system with energy-saving and environmentally friendly features is widely used.

Physics Model of Building

A numerical simulation on a gas heating plant was processed. The room width is 8000mm and the room height is 5200mm; the room length direction is unit length. There are two gas radiant tubes in the room and they are installed on the height of 4.2m. Suppose the surfaces of room are gray and not consider the infiltration from doors or windows, the convection heat transfer coefficient of exterior surface of palisade structure is constant.

Boundary Conditions

The Conditions of Thermal Boundary. Outdoor calculated temperature in winter is 247.15K;The heat transfer of exterior wall and roof adopt the typeⅢwall boundary conditions, the heat transfer coefficient is 23.26 W/ (m^2•K); The surface of radiant tube adopts type wall boundary conditions and the wall temperature is 420K; The emittance of exterior is 0.9.

The Materials of Palisade Structure. Exterior wall: 20mm cement mortar, 370mm ordinary brick and 20mm cement mortar;Roof: color plate 100mm polystyrene foam plastics.

Influence of Radiant Tube Emittance to the Wall Heat Transfer and Indoor Thermal Environment. CFD software is adopted to simulate the indoor temperature field, and the indoor temperature distribution of this plant are shown in Fig.1~ Fig.6.

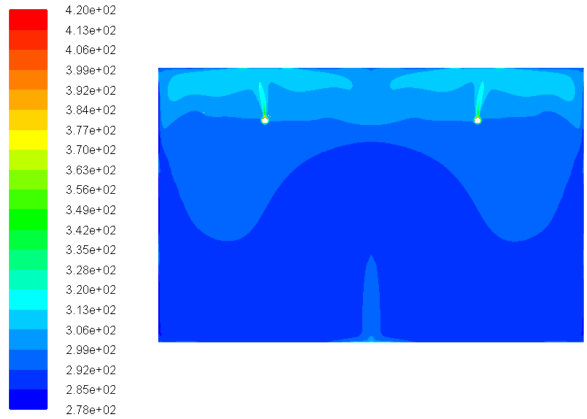

Fig.1 The temperature contours with radiant tube emittance of 1.0

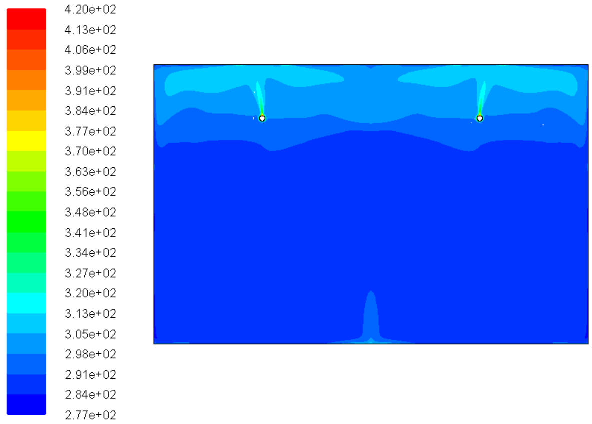

Fig.2 The temperature contours with radiant tube emittance of 0.95

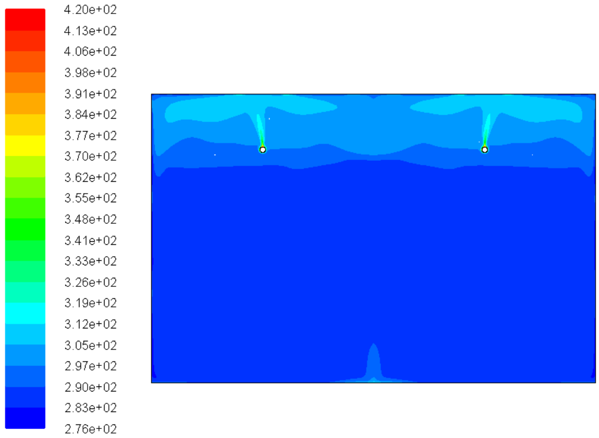

Fig.3 The temperature contours with radiant tube emittance of 0.9

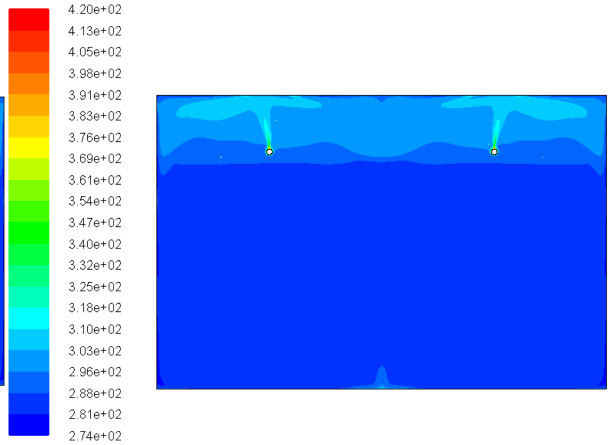

Fig.4 The temperature contours with radiant tube emittance of 0.8

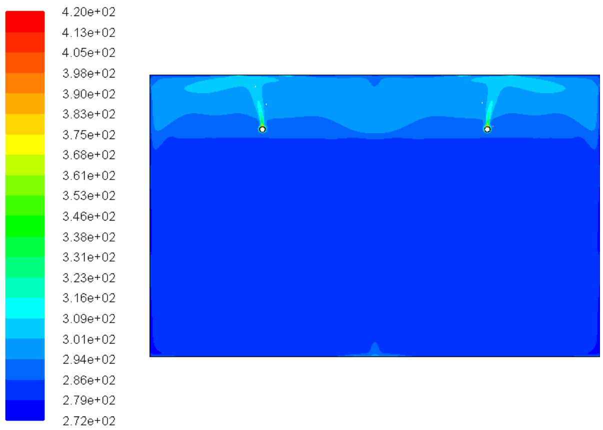

Fig.5 The temperature contours with radiant tube emittance of 0.7

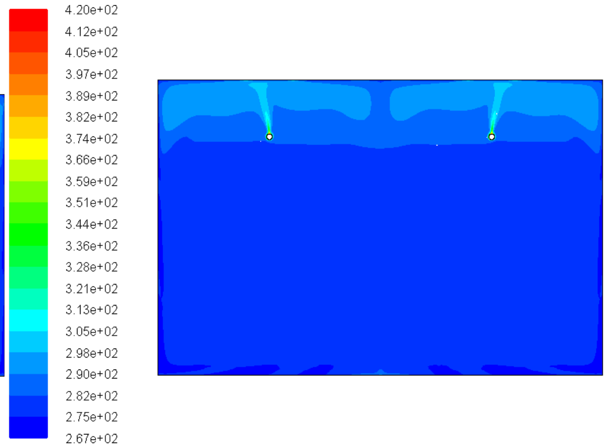

Fig.6 The temperature contours with radiant tube emittance of 0.5

From Fig.1~ Fig.6, it is concluded that indoor temperature is affected by radiant tube emittance. The greater the emittance of radiant tube, the higher air temperature indoor. However, The higher the radiation tube emittance, indoor temperature distribution more uneven.

The Influence of Radiant Tube Emittance to the Inside Surface Temperature of Exterior Wall. Influence of the radiant tube emittance to the inside surface temperature of exterior wall is shown in Fig.7.

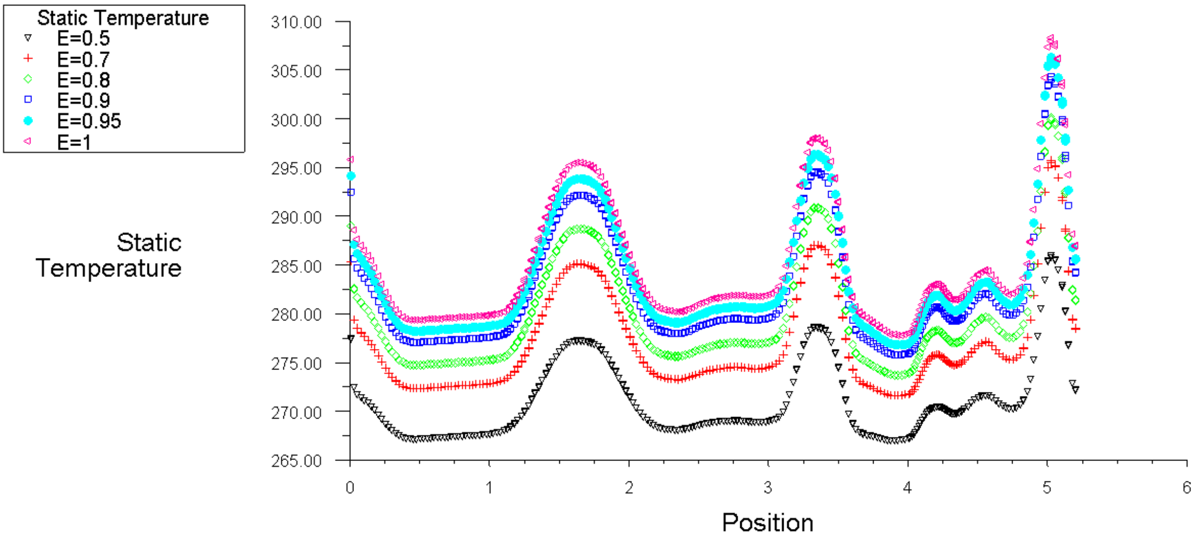

Fig.7: Influence of radiant tube emittance to the inside surface temperature of exterior wall

The calculation shows that rising radiant tube emittance can increase the exteriorl wall surface temperature. The reason is that radiant tube heat flux is related to the surface emittance. The higher the emittance, the greater the heat radiation. The walls absorb more incident radiation, the higher wall surface temperature.

The influence of radiant tube emittance to the average temperature of exterior wall is shown in table1.

Table1. Radiant tube emittance and average temperature of exterior wall relations

radiant tube emittance	1.0	0.95	0.9	0.8	0.7	0.5
Average temperature of exterior wall [K]	285.0	283.7	282.4	279.7	277.0	271.1

The Influence of Radiant Tube Emittance to the Workspace Temperature. When the radiant tube emittance is respectively 1.0, 0.95 0.9, 0.8, 0.7 and 0.5, the distribution of workspace air temperature in the height of 1.5m is shown in Fig.8.

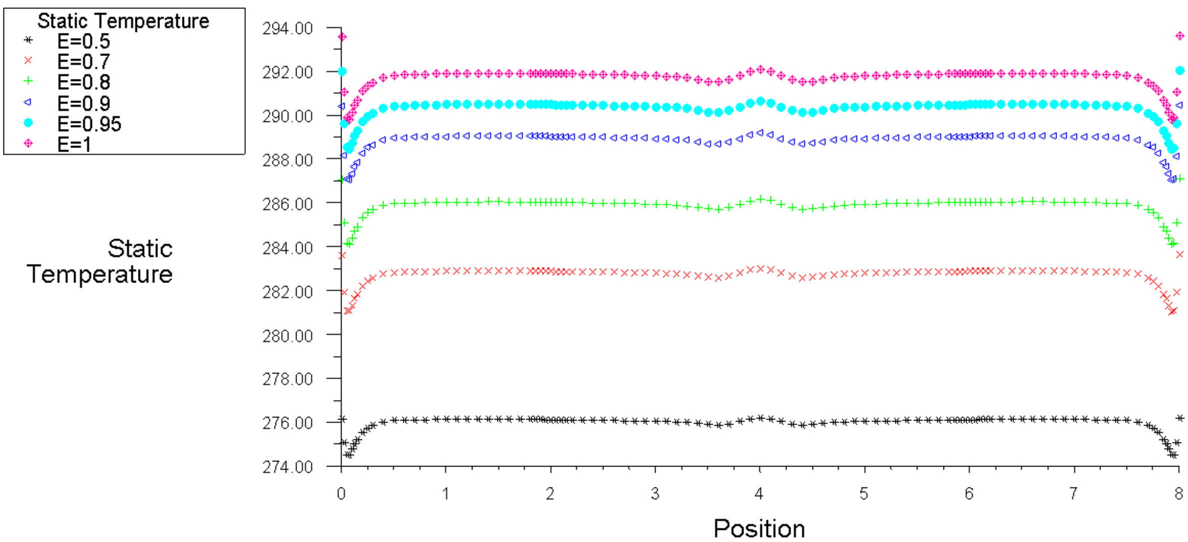

Fig.8: Influence of radiant tube emittance to the workspace temperature.

From Fig.8, It is concluded that when the radiant tube emittance is rising from 0.5 to 1.0, the work space average temperature is rising from 275.43K to 291.02K. Mainly due to the air and the building envelope surface take place convective transfer. The higher the surface temperature within the building envelope, the greater the convection transfer, the higher the air temperature.

The influence of radiant tube emittance to the radiant tube heat flux is shown in table2.

Table2. Radiant tube emittance to the radiant tube heat flux relations

radiant tube emittance	1.0	0.95	0.9	0.8	0.7	0.5
radiant tube radiation heat flux [W]	796.7	763.8	730.4	661.3	589.4	436.8
radiant tube total heat flux [W]	926.9	895.7	863.9	798.2	729.8	584.8
Radiation heat flux ratio of the total heat flux	85.9%	85.3%	84.5%	82.9%	80.8%	74.7%

Figure9 shows the relationship between radiant tube emittance and radiant tube total heat flux.

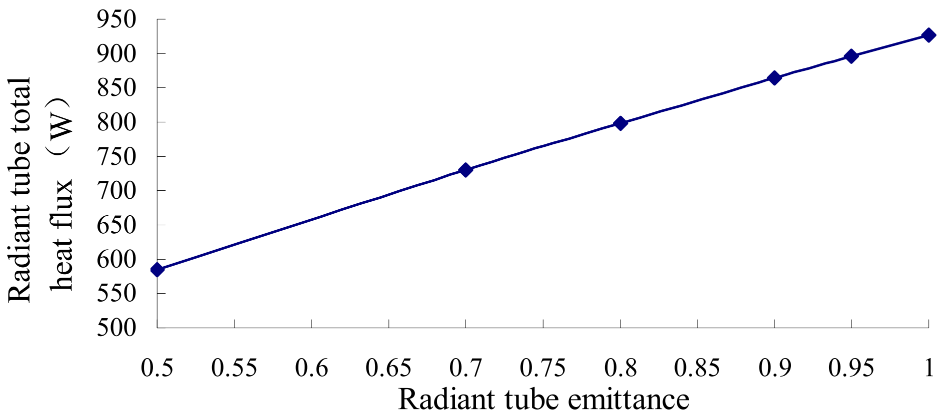

Figure 9: Radiant tube emittance and radiant tube heat flux relations.

As can be seen in Figure 8and Figure9, That increasing the radiator surface emittance can improve the work area air temperature. Emittance per 0.1 rise, work area air temperature increase of about 3K.The higher of radiator surface emittance the greater of radiator total heat flux.

Conclutions

(1) The greater the emittance of radiant tube, the higher air temperature indoor. However, indoor temperature distribution more uneven.

(2) Rising radiant tube emittance can increase the exteriorl wall surface temperature and workspace temperature.

(3)When the radiator surface emittance rising, the radiator radiation heat flux and the total heat flux are higher.

References

[1]ASHRAE, ASHRAE handbook-HVAC systems and applications, 1987.

[2]People's Republic of China Ministry of construction.2003. *Code for design of heating ventilation and air conditioning.*

[3]Ling M D F and Deffenbaugh J M. 1990. Design strategies for low temperature radiant heating systems based on thermal comfort criteria.*ASHRAE Trans*, Vol 96 pp 1296-1305.

[4]Yost P A,Barbour E C, Watson R. An evaluation of thermal comfort and energy consumption for a surface mounted ceiling radiant panel heating system.1995.*ASHRAE Trans*,Vol,101 pp 1221-1235