SC/Tetra

Cradle
MSC Software Company

Research and Development of Personal Air-Conditioning System with Radiant Cooling

Case Study for Takenaka Corporation and Waseda University

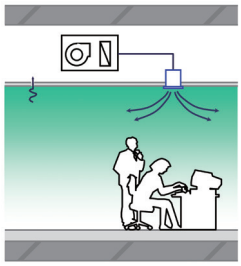
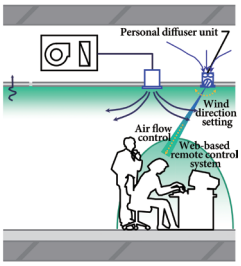
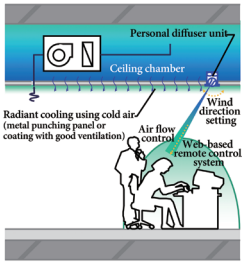
Predict the thermal environment of an office using thermoregulation model (JOS) of SC/Tetra

Main Purpose

In recent years, tenants are increasingly demanding a higher-quality office working environment. Use of personal diffuser unit to control their thermal environment improves environmental quality or thermal conditions in the office. And this localized air-conditioning system could improve worker's satisfaction with thermal environment.
In the process of developing air-conditioning system, thermal environment of an office and cooling effect on a human body are analyzed using thermoregulation model of SC/Tetra.

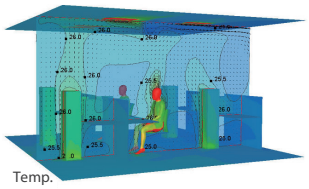
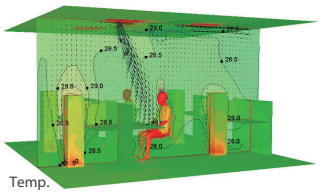
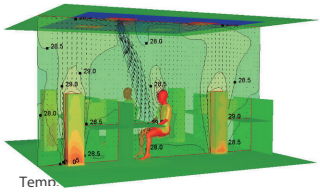
Personal diffuser unit

Air-conditioning system with radiant cooling

1. Convective air-conditioning system for the whole room	2. Convection-driven personal air-conditioning system	3. Personal air-conditioning system with radiant cooling
		
• General air-conditioning system for the whole room • High level of thermal comfort system control for occupant space • Low level of thermal comfort system control for individuals	• Use of personal air-conditioning unit on the ceiling and the desk together • Individual airflow preference or range of ventilation options available	• Use of radiant cooling with cold air in addition to #2 functions • Sensible temperature is lower because of the radiation from the cooling surface • Temperature control and the energy saving are expected

Comparative analysis using SC/Tetra

Analysis model / conditions: An office is simulated in a hot climate, and it is ventilated by an air-conditioning system. Heat source conditions are applied to lighting, equipment, and human bodies to account for heat generation in the office. The flow rate and supply air temperature is set to bring the indoor average temperature to the desired temperature. In the following system 3, a material with good aeration property is used for the ceiling to provide fresh air into the room.

1. Convective air-conditioning system for the whole room	2. Convection-driven personal air-conditioning system	3. Personal air-conditioning system with radiant cooling
 Temperature: 25 °C Man in business suits	 Temperature: 20.4 °C Man in light-duty garment	 Temperature: 28 °C Man in light-duty garment
Anemostat air outlet Outlet air temperature: 17.4 [°C] Anemostat outlet air flow rate: 370 [m^3/h]	**Anemostat and personal air outlet** Outlet air temperature: 20.4 [°C] Anemostat outlet air flow rate: 310 [m^3/h] Personal air-conditioning system Outlet air flow rate: 30 [m^3/(h•unit)]	**Personal air outlet** Outlet air temperature: 20.4 [°C] Personal air-conditioning system Outlet air flow rate: 30 [m^3/(h•unit)] **[Ceiling used for radiant cooling]** Outlet air temperature: 22.8 [°C] Outlet air flow rate: 310 [m^3/h] Surface temperature: 23.5 [°C]
• Air velocity around a man is slow • The temperature of entire room is low	• Because air is blowing from personal diffuser unit to a man's chest, the air velocity around the man's chest is fast	• In addition to the cooling effects of radiant cooling on the ceiling, air temperature near the ceiling is lower • Human body can be efficiently cooled because the temperature of flow, which reaches to a body, is lower than #2

Experiment and conclusions

As a result of measuring the amount of sensible heat loss using thermal mannequin, cooling effect on the human body is greater in the system 3, and the air from personal diffuser unit tends to be cooler, which is consistent with the simulation using SC/Tetra.

Experiment using thermal mannequin

[Reference]

"Task Ambient KOOL System with Ceiling Radiation Membrance (Part1-5)", Summaries of Technical Papers of Annual Meeting of Architectural Institute of Japan, Hokuriku, Sept.2010 (in Japanese)

Customer Comments

In the conduct of our research and development of the radiant cooling or the personal air-conditioning system, a key question is how to cool a human body efficiently with certain amount of energy. Since SC/Tetra enables the users to simulate an office with air-conditioning system by coupling with thermoregulation model (JOS), effective analysis can be performed on what part of body gets cool by radiant cooling or on which air-conditioning system has a higher sensible heat loss on human body. Personal air-conditioning system will remain one of the important topics, and SC/Tetra is powerful and indispensable simulation software for its development.