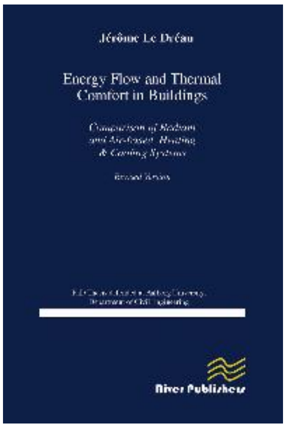
River Publishers



Energy Flow and Thermal Comfort in Buildings

Author: Jérôme Le Dréau, Department of Civil Engineering, The Faculty of Engineering and Science, Aalborg University, Aalborg, Denmark

e-ISBN: 9788793237230
Available From: November 2014
Price: € 0.00

Description:

Heating and cooling terminals can be classified in two main categories: convective terminals (e.g air conditioning, active chilled beam, fan coil) and radiant terminals. The two terminals have different modes of heat transfer: the first one is mainly based on convection, whereas the second one is based on both radiation and convection. This thesis focuses on characterizing the heat transfer from the terminal towards the space and on the parameters influencing the effectiveness of terminals. Therefore the comfort conditions and energy consumption of four types of terminals (active chilled beam, radiant floor, wall and ceiling) have been compared for a typical office room, both numerically and experimentally.

From the steady-state numerical analysis and the full-scale experiments, it has been observed that the difference between the two types of terminals is mainly due to changes in the ventilation losses (or gains). At low air-change rates (below 0.5 ACH), radiant and air-based terminals have similar energy needs. For higher air change rate, the energy consumption of radiant terminals is lower than that of air-based terminals due to the higher air temperature. At 2 ACH, the energy savings of a radiant wall can be estimated to around 10% compared to the active chilled beam (in terms of delivered energy). The asymmetry between air and radiant temperature, the air temperature gradient and the possible short-circuit between inlet and outlet all play a role equally important in decreasing the cooling need of the radiant wall compared to the active chilled beam. These conclusions are valid for multi-storey and/or highly insulated buildings (R > 5 m2.K/W). In case of single-storey building with a low level of insulation, the effectiveness of radiant terminals is lower due to the larger back losses, and an air-based terminal might be more energy-efficient than a radiant terminal (in terms of delivered energy).

Regarding comfort, a similar global level has been observed for the radiant and air-based terminals in both numerical and experimental investigations. But the different terminals did not achieve the same uniformity in space. The active chilled beam theoretically achieves the most uniform comfort conditions (when disregarding the risk of draught), followed by the radiant ceiling. The least uniform conditions were obtained with the cooled floor due to large differences between the sitting and standing positions.

Besides this comparative study of different terminals, the relation between cooling system and internal convective flow has also been investigated experimentally. The comparison with existing models pointed out the specificity of existing correlations and the limitation of their range of application. Because of differences in the air jet trajectory, existing correlations tend to overestimate the convective flow, especially at the ceiling. Two approaches have thus been tested to better account for the air flow pattern in the definition of convective heat transfer coefficients (CHTC). In a first method, local values of air velocity have been used to evaluate convection at the ceiling. An alternative approach consists of including a modified Archimedes number in the definition of CHTC. Both methods improved the modelling of CHTC with an error around ± 15-17%.

Keywords: Energy flow, Thermal comfort, Convective terminals, Radiant heating, Air-based heating, Cooling systems, Experimental methods, Numerical methods

Keywords: > Energy flow, Thermal comfort, Convective terminals, Radiant heating, Air-based heating, Cooling systems, Experimental methods, Numerical methods

Denmark Head Office
Alsbjergvej 10
9260 Gistrup
Denmark
www.riverpublishers.com
Email: info@riverpublishers.com

USA Office
Indianapolis, IN
USA
Tel.: +1-3176899634
Email: rajeev.prasad@riverpublishers.com

UK Office
River Publishers
Email: philippa.jefferies@riverpublishers.com