

Numerical Simulation of a Combined Impact of Cooling and Ventilation on the Indoor Environmental Quality

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Abstract : Impact of three different combinations of cooling and ventilation systems on the indoor environmental quality (IEQ) has been studied. Comparison of chilled ceiling cooling in combination with displacement ventilation, cooling with fan coil unit and cooling with flat wall displacement outlets was performed. All three combinations were evaluated from the standpoint of whole-body and local thermal comfort criteria as well as from the standpoint of ventilation effectiveness. The comparison was made on the basis of numerical simulation with DesignBuilder and Fluent. Numerical simulations were carried out in two steps. Firstly the DesignBuilder software environment was used to model the buildings thermal performance and evaluation of the interaction between the environment and the building. Heat gains of the building and of the individual space, as well as the heat loss on the boundary surfaces in the room, were calculated. In the second step Fluent software environment was used to simulate the response of the indoor environment, evaluating the interaction between building and human, using the simulation results obtained in the first step. Among the systems presented, the ceiling cooling system in combination with displacement ventilation was found to be the most suitable as it offers a high level of thermal comfort with adequate ventilation efficiency. Fan coil cooling has proved inadequate from the standpoint of thermal comfort whereas flat wall displacement outlets were inadequate from the standpoint of ventilation effectiveness. The study showed the need in evaluating indoor environment not solely from the energy use point of view, but from the point of view of indoor environmental quality as well.

Keywords : cooling, ventilation, thermal comfort, ventilation effectiveness, indoor environmental quality, IEQ, computational fluid dynamics

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