Indoor Climate in Zero-Emission Buildings

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Present requirements for the indoor environment in spaces and their design are based on the average occupant. It is not possible to provide each occupant with an optimal environment because of the large differences in preferences between people. The individual's preferences may also change during the day depending on their activities. The performed post-occupancy surveys reveal that, typically in commercial buildings, the perceived indoor climate is poor. The percentages of dissatisfaction with thermal comfort and air quality are often over 30% in buildings that are designed to fulfil the targets of A-class indoor climate, in which the dissatisfaction should be less than 5% on thermal environment and 10% on air quality. There are numerous reasons for this, and one of the most significant reasons is inadequate commissioning, i.e. the systems are not tuned to operating as designed.

In tandem with indoor climate, we have to optimize energy usage. Energy-efficient buildings are essential for promoting environmental sustainability, reducing operational costs, improving health and comfort, and complying with evolving regulations. They represent a strategic approach to addressing economic, environmental, and social challenges in a rapidly changing world. The hypothesis that good Indoor Air Quality (IAQ) is challenging to achieve in energy-efficient buildings often stems from certain misconceptions and early experiences with energy efficiency. However, modern designs and technologies have learned from past experiences, incorporating lessons into current best practices that effectively combine energy efficiency with superior IAQ.

The recent technological development provides possibility for development and implementation, in practice better methods for indoor environment design. We have technical solutions that enable the maintenance of IAQ in an energy-efficient manner. New solutions for heating, cooling and clean air supply allow for providing each occupant with local, individually controlled optimal environment. For example, occupant-targeted ventilation and demand-controlled ventilation systems are designed to provide the necessary air exchanges to ensure healthy IAQ and thermal comfort while maintaining energy efficiency in future zero-emission buildings.

Novel ways of measurement, modelling, and supervision can greatly improve the performance of buildings. Recent advances in sensors, wireless sensor networks, cloud services, and data analytics provide new opportunities to enhance the functions of building control and automation. The development of sensor technologies today makes it possible to adjust conditions based on the physiology of people. In addition, user feedback can be used to adjust local conditions. The use of intelligent automation systems helps to optimize energy consumption and maintain comfort. Sensors and control devices can adjust the building's technical systems according to real-time operating and environmental conditions.

To improve the current situation, research on building automation must include the development of indoor air quality measurement systems, the use of user feedback to enhance the meaningfulness of the measurements, and the use of various wireless sensor networks to collect and use cloud-based servers to process and visualize the data. Thus, healthy and sustainable buildings require multidisciplinary advanced research comprising not only automation and building technologies, but also measurement device technologies (including reliability and quality aspects), machine learning for the building automation devices, and optimization for health and comfort. Performance verification and individual control possibility are ways to guarantee user satisfaction for everyone and even to achieve a level of indoor climate satisfaction for everyone. ■