Observation of vertical temperature gradient in Finnish nZEB industrial buildings and importance of occupancy schedules for energy simulation.

Kaiser Ahmed, Aalto University (2016 – 2017)

1. Occupancy schedules for energy simulation in new prEN16798-1 and ISO/FDIS 17772-1 standards.

Hourly schedules of occupancy, lighting, and appliances are reported. The developed schedule apply for 10 different building categories with accounting different space categories as well as weekdays and weekend variations. The obtained schedule can be used in building simulation tools to estimate the heating and cooling need more precisely. The study found that the cooling load in an office room was increased by factor of 1.1–1.3 compared to the use of constant average value. In addition, the developed hourly schedule for single office room increased the cooling energy of 8% compared to the open plan office schedule. Furthermore, peak heating and cooling power also showed significant variations while using the proposed schedule in energy simulation tools. For instance, 16.5% of higher peak cooling power (kW) for simulated office floor with Office single schedule was reported compared to Office main schedule.

2. Radiant panel and air heating performance in large industrial buildings.

This study compared the performance of radiant panel and air heating system in large industrial halls. The onsite indoor temperatures along the building height were measured during heavy winter period, which were used as an input data in energy simulation tools to estimate the heating and ventilation energy differences. The results showed about 0.2 K/m vertical temperature gradients in both halls. Temperature gradients kept reasonably constant at all measured outdoor temperatures. In the case of air heating, room temperature control was less accurate and the set point was not always achieved. With similar outdoor air flow rate during occupied hours, i.e. 1.0 l/(s m^2) and measured gradient values of 0.2 K/m along building height, this study resulted in 15% to 41% higher primary energy for air heating compared to radiant panel heating. In addition, 23% lower primary energy use was reported for radiant heating compared to air heating when it considered minimum outdoor air flow rate during occupied hours, i.e. 0.5 l/(s m^2).

3. Data for occupancy internal heat gain calculation in main building categories.

This study has reported the heat losses from occupant body by means of convection, radiation, vapor, and sweat. This data are essential for indoor climate and energy simulations. Higher variations of body surface area of occupants are found in different building categories such as day care centers, kinder gardens, and schools. Higher body surface area, metabolic rate, activity level are responsible for different heat losses and these variations need to be accounted for estimation heat production, CO_2, and humidity generation, otherwise the heat gains are over estimated. The study also reported typical dry and total heat losses from occupant during summer and winter period.