Durability and maintenance of smart ventilation components: analysis of the ventilation performance after 15 years of use of Humidity-based DCV systems

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ABSTRACT

Performance 2 project (2020-2024) is a French national research project that aims to evaluate the durability of relative humidity-controlled mechanical extract ventilation (RH-MEV) systems installed in two multi-family social housing buildings (Paris and Villeurbanne) over than 15 years ago. This evaluation includes the analysis of continuous measurements performed on the ventilation system (sensors located close to the air terminal devices) and two additional Indoor Air Quality (IAQ) campaigns including two other monitors placed in the “dry” rooms. IAQ and comfort parameters such as CO2, Relative Humidity (RH), Particulate Matters (PM), and Volatile Organic Compounds (VOC), as well as energy losses and consumption, are being analyzed and compared to tenant usages to assess the performance of the ventilation systems.

Issues relating to the robustness of the technology (durability of the terminals), or its resistance to occupant use (in situ assessment of the state of the ventilation system in terms of cleanliness or misuse) were found during laboratory campaign (Mélois et al., 2023). However, after proper maintenance (inc. cleaning) and without touching the hygroscopic fabric (sensing and actuator part), 100 % of the exhaust units and air inlets not purposely degraded by the occupant still reacted as expected to humidity to control ventilation and guarantee a good IAQ.

RH-MEV system in real conditions show consistent performance 15 years later compared to the commissioning state and performances according to the specifications of fabrication. The system effectively guarantees IAQ by regulating ventilation based on RH levels under over-occupation scenarios.
Deviations from manufacturer tolerance limits occasionally occur due to real-world temperature variations, which impact humidity measurements. However, despite minor deviations, most of the performances remain within acceptable tolerance levels.

The ability of RH-MEV to maintain an acceptable CO2 concentration in bedroom has been questioned over years. Measurement have shown that despite high levels of occupation, CO2 concentrations in most of the cases do not exceed 2000 ppm demonstrating the effectiveness of the ventilation system. Only few cases show that ventilation sometimes is not enough to evacuate the CO2 in the bedrooms, those identified malfunctions are primarily associated with situations of over-occupancy. This highlights the importance of having occupants who respect recommended occupancy limits to ensure an optimal balance between energy consumption and IAQ.

The performance 1 project showed an average gain of 37.6% on heat loss rates, and therefore a reduction in energy use, despite over-occupation - and therefore over-ventilation - compared with the reference used in the calculations that correspond to constant ventilation rates. Similar trends in total extracted airflow are found in Performance 2 and Performance 1 despite differences in occupancy levels or environmental conditions from 15 years ago, meaning that the ventilation systems effectively adapt to varying occupancy and activity levels to maintain appropriate IAQ. This consistency in performance highlights the robustness and effectiveness of RH-MEV in managing IAQ, occupant comfort and energy saving.

Deeper analyses will be performed based on these results and the rest of the collected data, particularly with respect to PM2.5 and VOCs . This project could also be used in new regulations and to explore the feasibility of continuous evaluation of ventilation through cheap but reliable monitoring.

KEYWORDS

Smart ventilation, durability, humidity-based regulation