An update on the French indoor air quality observatory recent results: focus on ventilation and perspectives

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SUMMARY

The French indoor air quality observatory (OQAI) was set up by the French authorities in 2001 with the objective to collect data on indoor pollutants in various indoor environments to be used for public policies. Funded exclusively by public funding, the OQAI is coordinated by the scientific and technical center for building (CSTB) and involved an extensive network of partners across France in charge of the field campaigns and the laboratory analyses. To date, nationwide surveys were carried out in dwellings (2003-2005), schools (2013-2017), and office buildings (2013-2017). The next survey to be started early 2019 will focus on age care facilities. Moreover, the OQAI has been coordinating since 2012 a permanent data collection on indoor air quality and ventilation in energy-efficient buildings. This topical session summarizes the last OQAI results, with a dedicated focus on ventilation.

KEYWORDS

IAQ, energy-efficient, housing, school, air stuffiness, office building

1 INDOOR AIR QUALITY IN ENERGY-EFFICIENT DWELLINGS

By improving the airtightness of the building envelope, increasing concerns appear about the balance between reducing energy consumption and indoor air quality (IAQ). In this context, the IAQ Observatory coordinates since 2012 the "energy-efficient building program" consisting of a permanent data collection based on standardized survey protocols (Derbez et al., 2018). The measurements include CO_2 concentration, temperature and relative humidity, 19 volatile organic compounds (VOCs), nitrogen dioxide, particulate matter ($PM_{2.5}$), and radon. Moreover, questionnaires are filled in to characterize the building, equipment, household and occupants' habits. Indoor and outdoor measurements are performed at each dwelling during one week in both the heating and non-heating season.

To date, data were collected in 72 newly built or retrofitted dwellings and were compared with data from other energy-efficient European dwellings and the French housing stock. Statistically higher concentrations of alpha-pinene, limonene and hexaldehyde were observed. The sources and factors explaining these higher concentrations were looked for through a statistical analysis and were wood or wooden-based products, storage of cleaning products inside the dwelling, as well as air exchange during night or duration of bedroom window opening during day-time.

Moreover, while the visible dampness, water infiltration and visible mould were less frequent in the energy-efficient dwellings (2% *versus* 15% in the national housing stock), the hidden fungal contamination was found to be more important: 47% *versus* 37%. Some associations with the building characteristics such as water damages were found.

2 NATIONWIDE SCHOOL SURVEY (2013-2017)

From 2013 to 2017, the French IAQ Observatory performed a nationwide survey in 301 randomly selected schools. This survey had three specific objectives: i) description of the buildings, equipment and systems (i.e., heating, ventilation, lighting) and use (window opening, occupancy rate, activities, cleaning frequency, etc.); ii) assessment of comfort parameters (CO_2, temperature, relative humidity, noise, light); iii) measurement of indoor air concentrations (volatile and semi-volatile organic compounds (VOCs and SVOCs), aldehydes, NO_2, $PM_{2.5}$) and settled dust concentrations (metals and SVOCs), as well as lead concentrations in paint and electromagnetic field levels.

The first results highlight four issues regarding particles, semi-volatile organic compounds (SVOCs), lead in paint and indoor air stuffiness. Particulate pollution with $PM_{2.5}$ was omnipresent, with concentrations higher than the guideline value recommended by the World Health Organization (WHO) in 2005 in almost all of the classrooms (93%). Numerous SVOCs were measured in the air, including some phthalates, PAHs (polycyclic aromatic hydrocarbons) and lindane, which were ubiquitous. The presence of lead in damaged paint at concentrations higher than the regulatory threshold was observed in 10% of the schools. Lastly, 41% of the schools had at least one classroom that was very stuffy, i.e., indoor air stuffiness index, ICONE, equal to 4 or 5.

3 NATIONWIDE OFFICE BUILDING SURVEY (2013-2017)

From 2013 to 2017, the French IAQ Observatory carried out a nationwide survey to assess IAQ and comfort in office buildings across mainland France. One hundred and twenty-nine office buildings (66% randomly selected and 34% volunteers) were investigated for one day, corresponding to 645 rooms where IAQ measurements (VOCs, aldehydes, ultrafine particles, CO_2) were performed.

Overall the indoor concentrations were low. The highest median concentration was observed for 2-ethylhexanol (4.3 $\mu g/m^3$) and the highest 95^{th} percentile for limonene (91 $\mu g/m^3$). The CO_2 concentration never exceeded 1000 ppm in 40% and 51% of the offices, in winter and summer respectively. Through a statistical analysis, three different IAQ profiles were identified among the offices: 78% with indoor concentrations below the median values of the whole sample, 14% with concentrations around the median values, and 8% with indoor concentrations far over the medians, particularly for toluene, xylenes, limonene, 2-butoxyethanol and 2-ethylhexanol. The factors explaining these high concentrations in some offices are currently being looked for.

4 ACKNOWLEDGEMENTS

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5 REFERENCE

Derbez, M., Wyart, G., Le Ponner, E., Ramalho, O., Ribéron, J., Mandin, C. (2018) Indoor air quality in energy-efficient dwellings: levels and sources of pollutants. *Indoor Air*, 28, 318-338.