

How to Evaluate Ventilation in IAQ Studies

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SUMMARY

Currently, many indoor air quality (IAQ) studies fail to adequately describe ventilation in the space or building being studied. In other cases, ventilation rates are provided with limited or no descriptions of how the measurements were made or no estimates of measurement uncertainty. These situations make it difficult to interpret indoor contaminant concentrations and to compare the results of different studies. This paper explains the importance of properly characterizing ventilation in IAQ studies as well as some important concepts for doing so.

PRACTICAL IMPLICATIONS

It is crucial to characterize building ventilation design and performance when conducting IAQ measurements, but it is not always done properly or at all. This paper presents key considerations when conducting ventilation evaluations and measurements in order to help understand and interpret indoor contaminant levels.

KEYWORDS

Air change rates, experimental design, field studies, measurement, ventilation

1 INTRODUCTION

There are many factors that impact airborne contaminant concentrations in buildings; ventilation is among the most important. However, ventilation is often poorly characterized in many studies of IAQ and occupant health (Persily and Levin 2011; Carrer et al. 2015). This situation may exist due to a lack of appreciation of the importance of ventilation for understanding contaminant levels and a lack of knowledge of how to characterize ventilation in buildings. Evaluating ventilation involves a range of design and performance issues pertaining to ventilation systems and subsystem types, their condition and cleanliness, and ventilation rates and other key airflows. These factors influence airborne contaminants in buildings and therefore the quality of air breathed by occupants.

2 CHARACTERIZING VENTILATION

Some aspects of providing useful information on the ventilation of a building or space are outlined below. Additional detail will be developed by the authors in subsequent publications.

2.1 Building and Ventilation System Design

The first step in understanding and describing building ventilation involves design information including physical dimensions of the building or space being studied (e.g., floor area/volume, number of stories and height). The climate in which the building is located is also important, e.g., outdoor temperatures and wind speeds, heating and cooling degree days, and exposure to wind. This information is important for understanding how climatic forces will drive air leakage through the building envelope and how the heating and cooling systems will operate in response to weather. In addition, information on the building site and outdoor pollutant sources is important as these parameters influence the quality of air delivered.

The approach being used to ventilate the building is another key aspect of design. Options include envelope leakage or infiltration with manual window opening, natural ventilation with automatically-operated windows or other engineered systems including mixed-mode (hybrid) ventilation, and mechanical ventilation. For natural and hybrid ventilation in particular, the following information is needed: location and size of openings through which air is intended to enter and leave the building; how it is intended to flow through the building; the design outdoor airflow rate; and, how the system will respond to weather (e.g., damper modulation and assist fan operation). For mechanical ventilation, important information includes: design outdoor airflow rates; how the rates are modulated by the control system; filter efficiencies; maintenance schedules; and, strategies for moisture management in the system.

2.2 Ventilation Performance Measurement

Ventilation system performance measurement methods have been available for decades and are described elsewhere (e.g., McWilliams 2002). Parameters of interest include outdoor air intake rates, system supply airflow rates, supply airflow rates to individual spaces, and exhaust airflow rates. Rather than review the methods by which these parameters are measured, the more important points are that they be measured, that the measurement methods be well-described and that the measurements be repeated over time to capture temporal and seasonal changes. Without measuring ventilation rates and other performance parameters, it is extremely difficult to interpret indoor contaminant concentrations or to understand variations over time in a single building or differences between buildings. It is also critically important that the measurement method be described, including measurement locations and timing, instrumentation used, and estimates of uncertainty. Given the challenges in making accurate measurements of airflow and other parameters, as well as the fact that many of them vary with time, weather, occupant activities, and system and building operation, it is critical that they are repeated so that the reliability of the results is increased and a more complete characterization of ventilation performance is provided. Additional information that is often of interest includes the uniformity of air distribution (or ventilation efficiency), interzone airflows, and indoor-outdoor pressure differences as well as pressure differences between interior zones. Characterization of these parameters can be quite challenging, but measurement methods exist and should be considered in the context of the study objectives. Note that while carbon dioxide (CO₂) concentrations have been used as a metric of ventilation, they are often unreliable due to uncertainties in occupant CO₂ generation rates, concentration nonuniformities, and other factors (Persily 1997).

3 CONCLUSIONS

IAQ researchers need to do a better job in characterizing ventilation of the buildings and spaces they are studying to understand their measurement results and in reporting them to allow comparability between studies and enable others to interpret and use their results.

4 REFERENCES

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