



Shaping Tomorrow's
Built Environment Today

INDOOR CARBON DIOXIDE, VENTILATION AND INDOOR AIR QUALITY

THE ISSUE

Indoor CO₂ has been considered in the context of building ventilation and indoor air quality (IAQ) for centuries. Most of these discussions have focused on how CO₂ concentrations relate to occupant perceptions of IAQ, and the use of CO₂ to evaluate ventilation rates. While these topics have been studied for decades, misinterpretation of CO₂ concentration as an indicator of IAQ and ventilation is common in the HVAC industry, IAQ research community, and the public. Despite many efforts to address this confusion in standards, guidance documents, technical publications, and conference presentations, significant misunderstanding remains.

In addition, recent research has studied the impacts of CO₂ on human performance at commonly observed indoor concentrations and indoor CO₂ monitoring has also been promoted as a ventilation indicator in the context of managing the risks of airborne disease transmission. Also, concerns have long existed regarding the accuracy of indoor CO₂ concentration measurements, which are now more common due to the availability and more widespread application of less expensive sensors. Given all of these factors, as well as increasing calls to monitor CO₂ in buildings, ASHRAE is working to clarify the use of indoor CO₂ measurements as a tool to help improve IAQ and building ventilation.

ASHRAE's ROLE

ASHRAE has long been active in providing engineering technology, standards and design guidance to support the goal of providing healthy and comfortable indoor environments in an energy-efficient manner. For decades, these efforts have focused on providing effective ventilation in buildings, designing and operating ventilation systems and managing the wide range of air pollutants within buildings. For example, ANSI/ASHRAE Standards 62.1 and 62.2 are standards that specify minimum ventilation rates and other measures to support the health, comfort and productivity of building occupants; these standards do not include CO₂ limits.

ASHRAE's VIEW

Monitoring indoor CO₂ can be a useful tool for understanding building ventilation and IAQ, supporting efforts to provide high quality indoor environments and manage the energy needed to do so. However, using indoor CO₂ measurements requires an understanding of the how these measurements are conducted and interpreted to ensure that they provide useful information. This is not always been the case in the HVAC and industry hygiene communities by the practitioners, building operators and others striving to manage buildings. For example, many practitioners make claims that a building has good IAQ because the indoor CO₂ concentration is below 1000 ppm, and then linking that statement to ASHRAE Standard 62.1. In reality, Standard 62.1 has not had a CO₂ limit since 1989 and achieving good IAQ involves



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managing many more pollutants than just CO₂.¹

Because of ASHRAE's mission to act for the benefit of the public, it encourages building designers, lawmakers, policymakers and others to exercise caution when recommending the measurement of indoor CO₂ concentrations. To that end, ASHRAE stresses that:

- Indoor CO₂ concentrations do not provide an overall indication of IAQ, but they can be a useful tool in IAQ assessments if users understand the limitations in these applications.
- Existing evidence for the impacts of CO₂ on health, well-being, learning outcomes and work performance is inconsistent and does not justify changes to ventilation and IAQ standards, regulations and guidelines.
- The use of indoor CO₂ measurements to evaluate the risk of airborne disease transmission must account for the differences in CO₂ and infectious aerosols.
- Sensor accuracy, location and calibration are all critical for drawing meaningful inferences from measured indoor CO₂ concentrations.
- Programs or requirements to monitor CO₂ in buildings, when conducted with an understanding of their technical basis, can be helpful, but monitoring CO₂ without such understanding can lead to confusion on the part of building occupants and the public.

¹ In a 2010 study by J.M. Logue, T.E. McKone, M.H. Sherman, and B.C. Singer of the Berkeley National Laboratory titled, *Hazard Assessment of Chemical Air Contaminants Measured in Residents*, fifteen pollutants were identified as contaminants of concern for chronic health effects in a large fraction of homes. Nine pollutants were identified as priority hazards: acetaldehyde; acrolein; benzene; 1,3-butadiene; 1,4-dichlorobenzene; formaldehyde; naphthalene; nitrogen dioxide; and PM_{2.5}. Activity-based emissions are shown to pose potential acute health hazards for PM_{2.5}, formaldehyde, CO, chloroform, and NO₂.