Shaping Tomorrow's Global Built Environment Today

INDOOR CARBON DIOXIDE, VENTILATION AND INDOOR AIR QUALITY

THE ISSUE

Indoor CO_2 has been considered in the context of building ventilation and indoor air quality (IAQ) for centuries. Most of these discussions have focused on how CO_2 concentrations relate to occupant perceptions of IAQ, and the use of CO_2 to evaluate ventilation rates and control of outdoor air intake rates (demand control ventilation). While these topics have been studied for decades, misinterpretation of CO_2 concentration as an indicator of IAQ and ventilation is common in the HVAC industry, the IAQ research community, and the public.

In addition, recent research has studied the impacts of CO_2 on human performance at commonly observed indoor concentrations. Indoor CO_2 monitoring has also been promoted as a ventilation indicator to help manage the risks of airborne disease transmission. Also, concerns have long existed regarding the accuracy of indoor CO_2 concentration measurements, which are now more common due to the availability of less expensive sensors. Given these factors, as well as increasing calls to monitor CO_2 in buildings, ASHRAE is working to clarify the use of indoor CO_2 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 62.1-2022, *Ventilation and Acceptable Indoor Air Quality* and 62.2-2022, *Ventilation and Acceptable Indoor Air Quality in Residential Buildings* 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 CO_2 limits based on human health and comfort. ASHRAE Standard 62.1 contains CO_2 differential concentration setpoints for the application of demand control ventilation, but they are not intended to be and should not be used as indicators of IAQ.

ASHRAE's VIEW

Monitoring indoor CO_2 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. Critically, indoor CO_2 measurements should be understood in the context of the built environment to ensure that they are measured and interpreted in a meaningful way. Claims that ASHRAE Standard 62.1 requires indoor CO_2 concentrations below a certain threshold (typically 1000 ppm) for acceptable indoor air quality are *incorrect*[1]. ASHRAE's IAQ Standards do not use indoor CO_2 values to determine acceptable indoor air quality, as IAQ is impacted by multiple factors (such as temperature, humidity, particulate matter, gas pollutants, etc.).

[1] Persily, A. 2022. *Development and application of an indoor carbon dioxide metric*. Indoor Air. Volume 32, Issue 7.

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Because of ASHRAE's mission to act for the benefit of the public, it encourages building designers, lawmakers, policymakers and others to craft informed recommendations for the measurement of indoor CO_2 concentrations. To that end, ASHRAE stresses that:

- Indoor CO_2 concentrations do not provide an overall indication of IAQ, but they can be useful in IAQ assessments if users understand the limitations in these applications (e.g., number and activity level of occupants compared to the design capacity, length of time a space has been occupied, no combustion or other sources of CO_2 that could impact readings). While CO_2 readings below a threshold value do not assure overall acceptable IAQ, CO_2 readings far above expected ranges likely indicate the ventilation system is not functioning properly.
- Existing evidence for the impacts of CO_2 on health, well-being, learning outcomes and work performance is inconsistent and does not currently justify changes to ventilation and IAQ standards, regulations, and guidelines.[2] However, CO_2 can be used to verify if ventilation system performance meets existing IAQ standards, regulations, and guidelines.
- The use of indoor CO_2 measurements to evaluate the risk of airborne disease transmission must account for the type of space and its occupancy and the differences in CO_2 and infectious aerosols. For example, CO_2 concentration is unaffected by filtration and most other air-cleaning methods that reduce infectious aerosol concentration, so it should not be used as a *direct* indicator of infection risk.
- Sensor accuracy, location, and calibration are all critical for drawing meaningful inferences from measured indoor CO_2 concentrations.
- Programs or requirements to monitor CO_2 in buildings, when conducted with an understanding of their technical basis, can be helpful, but monitoring CO_2 without such understanding can lead to confusion on the part of building occupants and the public.

[2] 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 PM2.5. Activity-based emissions are shown to pose potential acute health hazards for PM2.5, formaldehyde, CO, chloroform, and NO2.