ASHRAE Indoor Carbon Dioxide Position Document: What’s Next?

Andrew Persily

National Institute of Standards and Technology
100 Bureau Drive
Gaithersburg, Maryland USA
*andyp@nist.gov

SUMMARY

ASHRAE’s 2022 publication of a new position document on indoor carbon dioxide (CO₂) has been a significant contribution to ongoing discussions of how indoor CO₂ can be used to understand ventilation and indoor air quality (IAQ). The position document clarifies what is known about the relationship between CO₂ concentrations and ventilation rates, the effects of CO₂ on building occupants, and how CO₂ concentrations relate to airborne infectious disease transmission. While the position document is a key step to addressing ongoing debate and occasional misunderstanding about indoor CO₂, this summary speaks to additional efforts that are needed to further resolve these matters and advance the application of indoor CO₂ measurements and analyses in understanding and characterizing IAQ. This paper proposes a number of follow-up activities and research topics that should be addressed, which can then be considered in the next version of the position document and help to advance the application of indoor CO₂ measurements and analyses.

KEYWORDS: carbon dioxide, guidance, indoor air quality, research, ventilation

1 BACKGROUND

Indoor CO₂ has been considered in the context of building ventilation and IAQ for centuries. While the relationships between indoor CO₂, ventilation and IAQ have been studied for decades, misinterpretation and misapplication of CO₂ as an indicator of IAQ and ventilation is still too common. Moreover, a variety of organizations and government bodies have issued standards and regulations for indoor CO₂ concentrations in workplaces, and CO₂ sensors have become less expensive and more widely deployed. Indoor CO₂ monitoring has also been promoted as a ventilation indicator to help manage the risks of airborne disease transmission. Finally, many recent research activities have been directed towards examining the impacts of CO₂ on human cognitive performance at commonly observed indoor concentrations that were previously thought not to be of concern.

These factors motivated the development of the ASHRAE Position Document on Indoor Carbon Dioxide, which was approved in early 2022 and is available for free download. The document discusses the following topics: i. the history of indoor CO₂ concentrations in the context of ventilation and IAQ, ii. health and cognitive impacts of exposure to CO₂, iii. existing standards and regulations for indoor CO₂ concentrations, iv. CO₂ as an indicator of IAQ and ventilation, v. use of CO₂ as a tracer gas for estimating ventilation rates, vi. increases in outdoor CO₂ concentrations, vii. air cleaning directed at CO₂ removal alone, and viii. CO₂ as an indicator of the risk of airborne disease transmission.

The Position Document states the following positions, paraphrased for this summary:
• Indoor CO₂ concentrations, although useful, do not provide an overall indication of IAQ.
• Existing evidence for impacts of CO₂ on health, comfort, and performance is inconsistent and does not justify changes to ventilation and IAQ standards.
• Using indoor CO₂ to assess airborne disease transmission must account for the definition of acceptable risk, space type, and differences between CO₂ and infectious aerosols.
• Differences between indoor and outdoor CO₂ concentrations can be used to evaluate ventilation rates and air distribution using established tracer gas measurement methods.
• Sensor accuracy, location, and calibration are critical for interpreting CO₂ concentrations.
• Air cleaning that removes only CO₂ will not necessarily improve overall IAQ.

The Position Document also recommends research in several areas and the development of guidance on indoor CO₂ measurement and application.

2 AREAS MERITING FOLLOW-ON EFFORTS

This section summarizes some key activities to pursue based on the Position Document:

• Detailed and practical guidance is needed on how to measure and interpret indoor CO₂ concentrations. This guidance needs to cover sensor performance and location in a range of building spaces, reflecting differences in how they are ventilated and their occupancy schedules. This guidance also needs to address sensor calibration, data interpretation and the information that needs to be reported in conjunction with measured concentration data, e.g., ventilation system design information, occupant characteristics and schedule, sensor type and accuracy, and measured outdoor concentrations.

• Given the inconsistent results to date and the controversy regarding how CO₂ exposure at typical indoor levels affects humans, research is needed on CO₂ impacts on the health, comfort, work, learning, and sleep quality of building occupants. This research needs to include investigations of physiological mechanisms for any observed effects.

• Many applications of indoor CO₂ require values for the CO₂ generation rates from building occupants. While methods to estimate these generation rates have improved, the uncertainty of these estimations are not known. Also, they require values for the level of physical activity (met), and improved guidance on the selection of met rates for different spaces and activities is needed, which may require additional research and analysis.

• There has been a longstanding desire for reliable and comprehensive IAQ metrics. While there has been progress in the development of such metrics, additional research is needed on metrics that capture the wide range of indoor air pollutants of interest, including CO₂.

• The prominence of indoor CO₂ measurement and analysis in light of the COVID-19 pandemic highlights the need for additional research and guidance on the relationship between indoor CO₂ concentrations and infection risk. These efforts need to distinguish between using CO₂ to judge ventilation adequacy and to quantify infection risk.

3 CONCLUSIONS

The ASHRAE Indoor CO₂ Position Document will be considered for re-approval or revision in 2025. Progress on the identified activities and others will improve the next published version of the document.