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Carbon Dioxide (CO_2) Monitoring for Indoor Air Quality

Why Monitor CO_2?

Every breath we exhale contains CO_2. Because of this, CO_2 monitoring is an excellent way to measure the level of ventilation, and the rate of fresh air replenishment, in any indoor setting. High CO_2 levels in themselves can cause health problems including headaches, dizziness and fatigue[1]. But when used as a measure of effective ventilation, CO_2 monitoring becomes a key tool in reducing the risk from airborne viruses.

Such viruses, which include Covid-19, are most often spread through tiny, airborne droplets known as aerosols. Improving indoor ventilation reduces the concentration of these aerosols and the risk of infection in an indoor space. Dr Henry Burridge, from Imperial College London, is lead author on a study[2] about using CO_2 monitoring to control the spread of Covid-19:

"In shared spaces such as offices and classrooms, exposure to infectious airborne matter builds up over time, during which room occupancy may vary. By using carbon dioxide levels as a proxy for exhaled breath, our new model can assess the variable exposure risk as people come and go.

"Our work emphasises the importance of good ventilation in workplaces and in schools. The model demonstrates that by managing the ventilation and occupancy levels of shared spaces we can manage the risk of airborne infection by a virus like SARS-CoV-2, which causes COVID-19."

Health and safety laws require employers to ensure an adequate supply of fresh air is available in any enclosed areas of a workplace. Additionally, many local and national governments are mandating the use of CO_2 monitoring in particularly sensitive locations including schools and hospitality venues[3]. The importance of CO_2 monitoring as a tool to improve many health and wellbeing issues is now firmly established.

Effective CO_2 Monitoring

The selected CO_2 monitor should be from a reputable manufacturer, with clearly specified levels of accuracy. The natural background level of CO_2 in the atmosphere is around 400 ppm (parts per million), and indoor readings can exceed 5,000 ppm so as a minimum the monitor must be able to measure across this full range.

The priority is to identify areas that are usually occupied and poorly ventilated. There are some simple ways to identify poorly ventilated areas:

- Look for areas where people spend time and where there is no mechanical ventilation or natural ventilation such as open windows, doors, or vents.
- Check that mechanical systems provide outdoor air, temperature control, or both. If a system only recirculates air and has no outdoor air supply, the area is likely to be poorly ventilated.
- Identify areas that feel stuffy or smell bad.

CO_2 levels vary within an indoor space. It's best to place CO_2 monitors at head height and away from windows, doors, or air supply openings. Monitors should also be positioned at least 50 cm away from people as their exhaled breath contains CO_2. If your monitors are too close they may give a misleadingly high reading.

Instantaneous or 'snapshot' CO_2 readings can be misleading, instead readings should be taken throughout the day frequently enough to represent changes in use of the room or space. A system that allows visual analysis of longer term readings, such as the EasyLog Cloud, makes it easier to understand the true level of ventilation in each space.

You may need to repeat monitoring at different times of the year as outdoor temperatures change and this will affect user behaviour relating to opening windows and doors when your space relies on natural ventilation. Your readings will help you decide if a space is adequately ventilated. The Health and Safety Executive[4] recommends the following guidelines:

- A consistent CO_2 value less than 800 ppm is likely to indicate that a space is well ventilated.
- An average of 1,500 ppm CO_2 concentration over the occupied period in a space is an indicator of poor ventilation. You should take action to improve ventilation where CO_2 readings are consistently higher than 1,500 ppm.
- However, where there is continuous talking or singing, or high levels of physical activity (such as dancing, playing sport or exercising), providing ventilation sufficient to keep CO_2 levels below 800 ppm is recommended.

Using Your Measurements: Taking Action

The results of your monitoring should be discussed with everyone who has responsibility for the way your indoor spaces are used and managed, as well as people who use them on a regular basis.

You can improve natural ventilation by fully or partly opening windows, air vents and doors, but never prop fire doors open. Airing rooms as frequently as you can improves ventilation. Opening all the doors and windows maximises ventilation in a room. It may be better to do this when the room is unoccupied.

Making sure that an area has enough fresh air relies on the people who use it playing their part. You should explain the importance of adequate ventilation to all users so they can help in reducing the risk of Covid-19 transmission.

Mechanical ventilation (including fans and air conditioning) can bring fresh air into a building from outside. Make sure such systems are being used effectively. Don't lower mechanical ventilation rates if the number of people in an area reduces temporarily, you should base ventilation rates on the maximum 'normal' occupancy of an area.

Continue monitoring CO_2 levels to check the effectiveness of your ventilation plan and to measure the effect of changing patterns in the number of people using each space.

How Effective Can CO_2 Monitoring Be?

It is very easy to assume that an indoor space has good levels of ventilation and that CO_2 monitoring is not necessary. However, experience shows that such monitoring is important even in modern buildings.

For example, when Jeremy Chrysler, of Conway, Arkansas, sent a CO_2 monitor into school with his 13-year-old daughter, the CO_2 readings were a sky-high 4,000 ppm. He brought his findings to district officials, who discovered that two components of the school's air conditioning system were not working properly. After the units were fixed, CO_2 levels plummeted.[5] Jeremy concluded:

"*What my measurements showed was, hey, measuring CO_2 can identify problems and sometimes those problems are easy to fix.*"

References

[1] 'Effects of low-level inhalation exposure to carbon dioxide in indoor environments: A short review on human health and psychomotor performance', by Kenichi Azuma, Naoki Kagi, U. Yanagi and Haruki Osawa, 30th August 2018

[2] 'Predictive and retrospective modelling of airborne infection risk using monitored carbon dioxide', by Henry C. Burridge, Shiwei Fan, Roderic L. Jones, Catherine J. Noakes and P. F. Linden, 28th September 2021

[3] 'All schools to receive carbon dioxide monitors', press release from the Department of Education, 21st August 2021

[4] 'Ventilation and air conditioning during the coronavirus (COVID-19) pandemic', Health and Safety Executive online guidance, 31st October 2021

[5] 'The Hot New Back-to-School Accessory? An Air Quality Monitor', by Emily Anthes, New York Times, 10th October 2021