CO2 Monitoring of Ventilation When and How to Use it

People's CDC

Ventilation is critically important for keeping indoor air free of pollutants, including tiny droplets containing COVID-19. Monitoring carbon dioxide (CO2) is helpful in monitoring ventilation.

Why can CO2 be used to monitor ventilation?

Everyone exhales carbon dioxide (CO2) and it's easy to measure. Carbon dioxide is not itself dangerous at normal room levels. But when it rises, it can tell us if other pollutants that are hazardous are also increasing–such as dust, mold, viruses, bacteria or asbestos. These pollutants are much harder to measure than CO2. **High levels of CO2 can tell us there's not enough fresh air provided through natural ventilation (such as open windows) or through the ventilation (HVAC) system to keep levels of all pollutants from increasing.** For an important exception, see the section at the end, When **not** to use a CO2 meter.

Choosing a device to measure CO2

You can buy a hand-held or a desktop CO2 meter for under $100. Most of them also measure other things (usually temperature and humidity, sometimes other chemicals). The best type for measuring room CO2 is called **Non-Dispersive Infrared (NDIR)**. These are generally accurate in the range of CO2 room levels.

Steps in Measuring CO_2

- **Measure the CO2 level *outside* of the building you're monitoring, and consider that a baseline**. It will probably be in the range of 420 to 480 parts per million (PPM). If you are somewhere with a lot of traffic or industrial activity, the baseline readings could be higher. It will be a little lower in rural areas.

- **Decide where to measure CO2 in an occupied room**. This will depend on where the people are in the room, as well as locations of windows, doors and ventilation inlets and outlets.
  - Since CO2 is exhaled by the people in the room, you want to measure in areas where people are, but not extremely close to anyone (which might give too high a reading). Try to stay 4 to 6 feet from anyone's face. To find a good spot, you might walk around the occupied area of the room slowly, watching your meter to see what seems to be a typical level in that area.
  - Hold or place the monitor at about the same height as the nose and mouth of people in the room.
  - Avoid placing the meter close to open windows or doors or where ventilation air comes into the room (called diffusers, grates or grilles) or where ventilation air leaves the room (called return, grates or grilles)

- **Take multiple indoor readings over a period of time**. You want to see if CO2 levels change over time, and how high they get. With adequate fresh air, the CO2 level will rise when people come into a room and then stay the same. That's what you want!
  - If possible, take your first reading before or soon after the room is occupied.
  - Read again at intervals of, say, 30 or 60 minutes.
  - If possible take a reading at the end of the period when the room is occupied.

- **Keep a written record** of time, location, number of people and activities in the room and your CO2 readings. (See the sample chart at the end of this factsheet)

- **Interpret your results**
  - Indoor levels in occupied rooms are almost always higher than outdoor levels.
  - Room CO2 levels will be higher with high occupancy or after strenuous activity.
  - How high is too high? Many experts say the inside level should not exceed 1000 PPM. That is a level most people experience as uncomfortable. Some people will experience the air as "stuffy" at levels as low as 600 PPM. But if you are concerned about dangerous pollutants, then this is just as important than the actual level:
  - **If the CO2 level continues to rise while the space is occupied, that means there is not enough fresh air to keep pollutant levels from rising**. But please note the **exception** in the next section.

Glossary

Carbon Dioxide or CO2 is a natural component of the atmosphere. People exhale carbon dioxide as a normal part of breathing. The amount of CO2 in the air is expressed as parts per million (ppm) – the number of CO2 molecules per million molecules of air.

Dilution, dilute. You can dilute a liquid by adding water, as you would with orange juice concentrate. You can also dilute gases by bringing in clean air to mix with room air. The clean air will lower the concentration of CO2 and any other pollutants in the air.

Filtration means providing a material that can capture pollutants. Room filters are some kind of mesh that can capture particles. They do not filter gases, such as CO2 or fumes from pesticides, cleaning agents or other liquids.

Particulates or **particles** are tiny bits of solid materials, such as asbestos fibers or powders; droplets of liquid are also considered particles. They may contain viruses or bacteria.

When *not* to use a CO2 meter

- **If your only ventilation consists of air purifying units in the room, your CO2 meter cannot tell you anything about the level of viruses or any other particulate present**. Carbon dioxide will continue to increase from the exhalation of the people in the room, even if the HEPA filter is capturing viruses and other particulates. Only if the ventilation includes *dilution*–bringing in outside air through open windows or a ventilation system–will the CO2 meter be useful, telling you whether *all* pollutants are being diluted.
- When a room is *not occupied*, CO2 will not increase, since CO2 is produced by people in the room.

Two helpful resources

- If you are interested in learning how CO2 readings and portable air filters and masking combine to affect the risk of transmitting COVID-19, please check out breathesafe.xyz, a People's CDC project. You can log environmental and behavioral information about a specific location to assess risk. If you have questions about this project, please email info@breathesafe.xyz.

- Find more detailed information on CO2 monitoring, use this National Education Association document, https://www.nea.org/resource-library/how-evaluate-building-ventilation-using-carbon-dioxide-monitors

Sample chart for recording CO2 levels

Building name/location_____ Room number_____
Date sampled_____
Outdoor CO2 reading_____(ppm) Time of reading_____

Time	Number of People in Room	Location in Room	Activities in Room	CO2 reading (ppm)