Carbon dioxide in the closed environment

Apparatus

Carbon dioxide sensor

Retort stand and clamp

Data recording setup.

Select Start to begin, stop after duration.

Intersample to one sample per minute.

As well as being implicated in global warming and generic pollution Carbon dioxide is an important gas for the regulation of breathing.

Its and odd piece of physiology that considering our dependence upon oxygen for life we have no real oxygen detection mechanism in our body. Instead we use indirect carbon dioxide measurement to work out if we are getting enough oxygen.

In terms of the respiration biochemistry, for each molecule of oxygen used a molecule of carbon dioxide is produced. You only have to measure carbon dioxide to get a measure of oxygen requirements. If carbon dioxide is rising then you are using more oxygen and vice versa

Excess carbon dioxide is normally a measure of increase activity, increased activity tires us. Simplistically stated excess carbon dioxide will create feelings of tiredness and malaise.

In a closed environment (inside a building) a build up of carbon dioxide in the closed environment is an indicator of poor air circulation. You should not get an increase in carbon dioxide if air is free moving.

There has been evidence recently that suggests that a form of sick building syndrome is down to poor ventilation. A measurement of carbon dioxide can be used as a simple model of poor ventilation - in a well ventilated space there should not be a build up of carbon dioxide.

At the time of writing we are struggling with Covid - 19, a virus that caasuses a potentially fatal upper respiratory illness. Covid has (in its current mutation) high transmission, it is understood that your chance of developing the associated illness is a combination of virus presence and duration of exposure. There is also evidence to suggest the virus has relatively short half life in the open environment. Collect this information together and a well ventilated room offers a degree of protection from infection, but how do we know a room is ventilated?

Typical carbon dioxide levels and significance

250-350 ppm: background (normal) outdoor air level

350-1,000 ppm: typical level found in occupied spaces with good air exchange

1,000-2,000 ppm: level associated with complaints of drowsiness and poor air

2,000-5,000 ppm: level associated with headaches, sleepiness, and stagnant, stale, stuffy air; poor concentration, loss of attention, increased heart rate and slight nausea may also be present.

>5,000 ppm: This indicates unusual air conditions where high levels of other gases also could be present. Toxicity or oxygen deprivation could occur. This is the permissible exposure limit for daily workplace exposures.

>40,000 ppm: This level is immediately harmful due to oxygen deprivation

Practical.

The practical is a short term study of the levels of carbon dioxide in a room against ventilation (open windows, open doors, active ventilation on/off). What you need to do is place a carbon dioxide sensor in the room, preferably in the centre of the room and start recording the data to show how levels change. You can then alter the ventilation properties of the room and see how it affects carbon dioxide levels.

It is highly unlikely that carbon dioxide will ever reach dangerous levels in the rooms you use, we are simple using it as a measurable marker, an indirect measure of how well a room is ventilated.

Use a clamp stand to support the sensor, point the “nose” of the sensor downwards (to prevent pooling of the carbon dioxide within the sensor). The sensor also contains humidity and temperature sensors, it can be useful to have theese active for data collection as markers of room occupancy (people give off heat and water vapour).

Method.

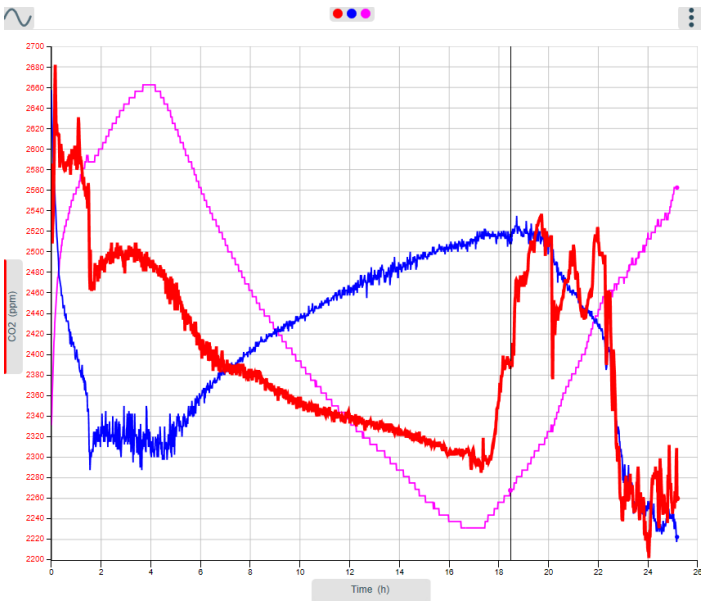
1. Set up the sensor with the nose pointing down in a place away from immediate draughts (not by a window, door or ventilation duct).
2. Connect the sensor to a device to collect the data (we would recommend using a USB connection for long recordings, the carbon dioxide sensors is very power hungry). Select additional sensors if required.
3. Use the setup to change the intersample period to one sample every 30 seconds.
4. Select start to begin data collection, if you are going to test the effect of opening windows etc, record for about 5 minutes to see what is happening and then change the conditions for another 5 minutes.
5. When you have sufficient data to detect any patterns select stop and save the data.

Example data.

A medium term log of 12 hours.

The carbon dioxide data is the red line.

The recording starts towards the end of a working day, carbon dioxide is high (around 2,600 ppm), it falls quickly as the room is emptied, and shows a sudden jump in carbon dioxide when the next working day begins. The large drop in carbon dioxide (at the right of the graph) was when windows to the space were open to see effect of good ventilation - quite dramatic, .



Your collected data over time should a clear image of how carbon dioxide levels change dynamically, and how ventilation can change the levels.

Possible activities / measurements.

1. The daily pattern of carbon dioxide measure over a single day.
2. The effect of a classroom full of Bunsen burners being used.
3. The impact (or not) of working with windows open (does the drop in CO_2 justify the need to wear balaclavas!!
4. Comparison of different rooms.
5. How quickly does a room return to background?

In all cases we are assuming that high carbon dioxide is a sign of poor ventilation.