Carbon dioxide in the closed environment

Technician and teacher sheet

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 a build up of carbon dioxide in the environment creates an increase in carbon dioxide within us, it also 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.

While it is known that carbon dioxide will create a bad atmosphere most sensor technology centres around carbon monoxide. Carbon monoxide is deadly, it is not a natural environment gas and we have not evolved the ability to detect it, hence it is known as the silent killer. Carbon dioxide is a natural environment gas and we can detect changes and react to them. The level of carbon dioxide is very low in the atmosphere but that does not tell us the truth about how it reacts and the damage it can do. The low value of carbon dioxide in the air and the small differences that create change means we measure it in a very low level unit ppm (parts per million). 1 ppm is equal to 0.0001%. Until recently atmospheric carbon dioxide levels were at 300pp or 0.003%.

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

Note that the workplace exposure limit is 5,000ppm average over an 8 hour work period, but it is already above the point where our body has started to react to its increased presence.40,000 ppm is considered an immediate danger to life and requires some method of isolating the user from the gas (oxygen supported breathing apparatus, for example)

The practical, if it can be called a practical is a matter of placing a detector in a location and recording the data over several hours - with a classroom a single lesson's data will be instructive.

Practical notes.

The data Harvest Carbon Dioxide sensor can measure over the range 0 to 100,000 with a 1ppm resolution. The sensor can also measure temperature, humidity and pressure t the same time. It is an ideal sensor for monitoring the room atmosphere.

The wireless connectivity to any device (android, iOS, chrome) also means you can quickly link to the sensor and take "spot" readings.

To use the sensor It is best operated with the end cap pointing down, carbon dioxide is heavier than air and potentially can pool in the sensing element if used with the end cap upwards.

The software has the ability to click to start and continue until stopped making it ideal for long open ended recordings. However we would not recommend using the default intersample period for too long, the amount of data collected will be a strain on the software. Set the period between samples to once every 10 seconds, you will see trends in the data perfectly well on a longer recording.

Example data.

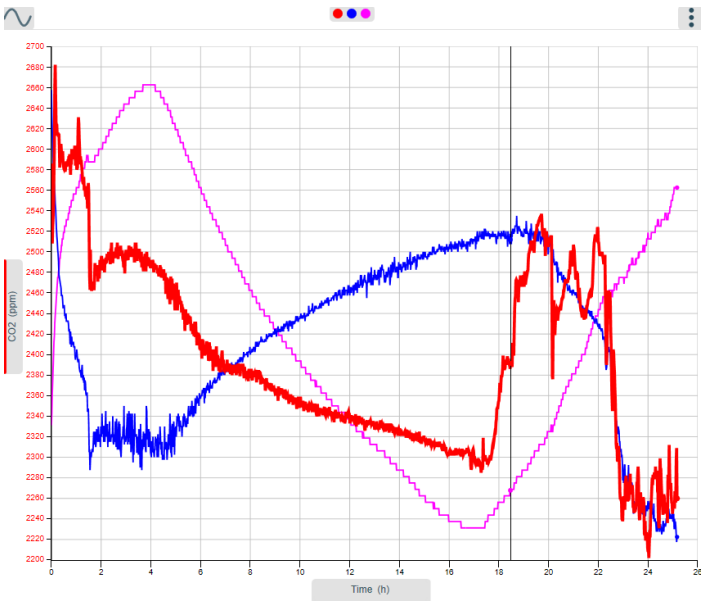
A medium term log of 12 hours in the Data Harvest development lab.

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 but remains at 2,500 while the building is occupied, falling rapidly and then more slowly overnight down to a value of 2,300 pm.

The start of the next working day is seen by a sudden jump in carbon dioxide. The large drop in carbon dioxide was when windows to the space were open to see effect of good ventilation - quite dramatic, a fall from an average of 2,400ppm to 2000 ppm.

All office values are really above "good air" values.



This example is for an overnight into the beginning of the working day.

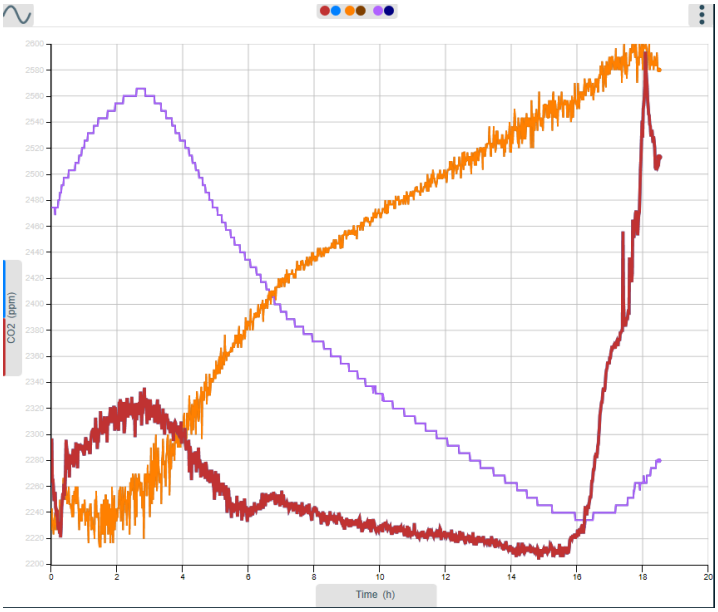
Red = Co2

Purple = Temperature

Orange = humidity.

Note how humidity and temperature are “mirror images” of each other, relative humidity is temperature dependent.

The sudden peak in CO2 matches the occupancy of the room for the new days work.



The recording of the data over time gives a clear image of how carbon dioxide levels change dynamically, it also (in our case) showed how stubborn they were to change. Even full window opening and forced ventilation by fans only halved the recorded 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 CO2 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.

Software knowledge required.

- Connect sensors to the software.
- Change intersample period.
- Select and deselect ranges on sensors.
- Scale data.
- Change axis from unified to separate for each data type.