

Vaisala CARBOCAP® Carbon Dioxide Sensors:

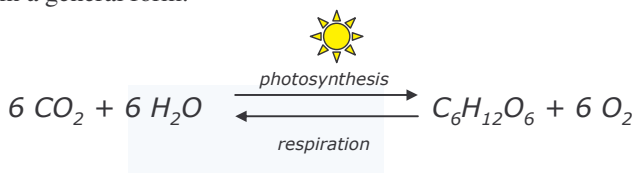
What is CO₂?

This document describes the properties of carbon dioxide (CO₂) and presents ideal gas law, unit conversion and gas dilution theory to support gas sampling issues in CO₂ measurements.

What is CO₂?

Carbon dioxide (CO₂) is a colorless gas consisting of one carbon and two oxygen atoms. CO₂ exists in gas state above -78.5°C and in solid state (dry ice) below -78.5°C. CO₂ changes from solid to gas by sublimation.

In nature, plants use CO₂ in photosynthesis, where CO₂ and water are combined using sun light as energy to produce sugars (and oxygen). The reaction can be written in a general form:



In fact, CO₂ is introduced in the greenhouse air to maintain plant growth, since plants grow up to 50% faster in elevated CO₂ concentrations. The opposite reaction to photosynthesis, respiration, takes place in all living organisms.

In addition to its vital role in photosynthesis, respiration and carbon cycle, CO₂ has many industrial applications. Solid and liquid CO₂ are used in refrigeration and cooling. In beverage industry, CO₂ gives the fizz to the drinks and prevents bacterial and fungal growth in soft drinks, beer and wine. CO₂ is an environmentally friendly propellant in aerosols and due to its unreactive nature it is used as an inert gas in various processes, packaging and fire extinguishers, to mention some applications. CO₂ is produced in combustion processes of carbon containing material.

Effects of CO₂

Typical atmospheric CO₂ concentration is 350-450 ppm. CO₂ is a non-toxic and non-flammable gas. However, it doesn't support life and exposure to elevated CO₂ concentrations can induce a risk to life. The effects of CO₂ concentrations on people are summarized in Table 1.

Table 1. Effect of CO₂ concentrations on people.

Concentration	Effect
350-450 ppm	Typical atmospheric
600-800 ppm	Acceptable indoor air quality
1000 ppm	Tolerable indoor air quality
5000 ppm	Average exposure limit over 8 hours
600-30 000 ppm	Concern, short exposure only
3-8%	Increased respiration and headache
above 10%	Nausea, vomiting, unconsciousness
above 20%	Rapid unconsciousness, death

To ensure the safety of the people in facilities having a potential risk for CO₂ leakage, CO₂ transmitters should be installed as close to the potential leakage points as possible. CO₂ is heavier than air, therefore it sinks and pools low to the ground, displacing the oxygen. The CO₂ transmitter installations should always be based on risk assessment.

Physical properties of CO₂

CO₂ absorbs light in the infrared (IR) region, see Figure 1. This absorption can be utilized to measure volumetric concentration of CO₂. Vaisala CARBOCAP® is utilizing this absorption in the silicon-based non-dispersive infrared CO₂ sensors.

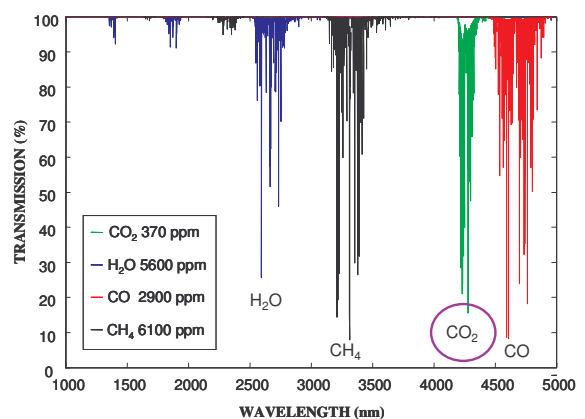


Figure 1. IR absorption of some gases.



[Click here to find out more about Vaisala CO2 measurement products](#)

VAISALA