# CO2 Gas Concentration Defined

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When measuring gases like carbon dioxide, oxygen, or methane, the term concentration is used to describe the amount of gas by volume in the air. The two most common units of measurement are **parts-per-million**, and **percent concentration.**

## What is the formula for parts per million?

**Parts-per-million** (abbreviated ppm) is the ratio of one gas to another. For example, 1,000 ppm of CO2 means that if you could count a million gas molecules, 1,000 of them would be of carbon dioxide and 999,000 molecules would be some other gases.

Parts per million calculations are often used when measuring concentrations in gases and the basic formula for PPM is as follows:

**parts per million: mass of solute / mass of solution x 1,000,000**

## What is acceptable CO2 ppm gas concentration?

Because carbon dioxide (CO2) is exhaled by individuals, the content of carbon dioxide in indoor air can be used as a significant indication of air quality.

Normal vs. Hazardous CO2 ppm levels can be shown as the following:

- normal outdoor level: *350 - 450 ppm*
- acceptable levels: *< 600 ppm*
- complaints of lack of focus or stuffiness: *600 - 1000 ppm*
- **ASHRAE and OSHA standards**: *1000 ppm*
- general drowsiness: *1000 - 2500 ppm*
- adverse health effects may be expected: *2500 - 5000 ppm*
- maximum allowed concentration within a 8 hour working period: *5000 - 10000 ppm*
- maximum allowed concentration within a *15 minute* working period: *30000 ppm*

- slightly intoxicating, breathing and pulse rate increase, nausea: *30000 - 40000 ppm*
- above plus headaches and sight impairment: *50000 ppm*
- unconscious, further exposure death: *100000 ppm*

# How to convert ppm to percent concentration?

When you start counting over 10,000 ppm, most scientists and manufacturers change from ppm to **percent concentration**. So instead of describing a 10,000 ppm CO2 sensor, we talk about a 1% CO2 sensor instead. (10,000/1,000,000 = 0.01) – the terms are synonymous.

In other words, 1 ppm = 0.0001% gas.

For reference, here's an easy to follow table that shows how to convert percentages to ppm:

- 1,000,000/1,000,000 = 100%
- 100,000/1,000,000 = 10%
- 10,000/1,000,000 = 1% or 10,000ppm
- 1,000/1,000,000 = 0.1% or 1,000ppm
- 400/1,000,000 = 0.04 or 400ppm

The advantage of ppm and % concentration is that, under typical operating conditions, temperature and pressure are not important when comparing two different sensors specifications.

Keep in mind that while ppm and % concentration tell you the ratio of one gas to another, they don't tell you the weight of the target gas. This is why you will occasionally see the molecular weight ($mg/m^3$, or milligrams per cubic meter) of a gas in a specification.

For further resource, there are easy ppm gas calculators or ppm to percent conversion calculators on the web that you can use. However, if you are looking to make a quick, approximate conversion, (assuming 77 degrees F and sea level) **for CO2 only** you can multiply the ppm by 1.8 to get $mg/m^3$, or divide $mg/m^3$ by 1.8 to get ppm.

# What percentage of CO2 do you need?

In order to know what percentage of carbon dioxide (CO2) you need to accurately monitor, it is important to understand your use case and industry. To date, many carbon dioxide sensors or carbon dioxide detectors are used across the field to provide instant indication of gas concentrations and indicate should hazardous levels be present.

Here is a quick reference guide to assist you:

- Indoor and outdoor air has between 400 ppm and 2,000 ppm CO2 by volume. This means that for projects measuring indoor air quality to measuring atmospheric CO2, a 0-1% (0-10,000ppm) CO2 sensor is your best solution.
- For applications like CO2 safety monitoring for restaurants, breweries, indoor agriculture or industrial settings, a 5% CO2 sensor is used. This is because OSHA requires safety monitoring sensor devices to be present at 1.5% and 3% CO2.
- Other applications like modified atmosphere packaging, laboratory, cryogenics, or fire suppression require sensors between 5 and 100% CO2.

**Learn More: CO2 Safety Devices**

Once you have the proper resources and formulas to measure carbon dioxide, it is not a difficult task. And, while carbon dioxide monitoring is required in many different scenarios and industries our team is always available to help provide any additional information you may need on carbon dioxide measurement.

For more information, speak to a CO2Meter specialist at Sales@CO2Meter.com or (877) 678-4259

Sources: Wikipedia, Lenntech.com, Engineering ToolBox, The Guardian,

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