1.2 Concentration, Specifications, and Conversions

Concentrations are given as the content of a substance in a reference substance. For the measurement of contaminants in air, a concentration is used for the amount of the substance compared to the air. An appropriate engineering unit is chosen, to give simple, handy figures for indicating a concentration.

High concentrations are generally given in volume percent (Vol.-%), i.e. 1 part of a substance in 100 parts of air. Air consists of 21 Vol.-% oxygen. (i.e. 100 parts of air contain 21 parts of oxygen).

In smaller concentrations the engineering unit ppm = parts per million (mL/m^3) is used. The concentration ppm means 1 part of a substance in 1 million parts of air, ppb refers to 1 part of a substance in 1 billion parts of air.

The conversion of very small concentration units to Vol.-% is as follows:

1 Vol.-% = 10,000 ppm = 10,000,000 ppb

In addition to gaseous components the air also contains solid particles or liquid droplets, called aerosols. Since an indication in volume percent is not very useful due to the small size of the droplets or particles, the concentration of the aerosols is given in mg/m^3.

		Vol.-%	ppm	ppb
Vol.-% =	$10\ L/m^3$ 1 cL/L	1	10^4	10^7
ppm =	mL/m^3 µL/L	10^{-4}	1	10^3
ppb =	$\mu L/m^3$ nL/L	10^{-7}	10^{-3}	1

		g/L	mg/L	mg/m^3
g/L =	$10\ L/m^3$ 1 cL/L	1	10^3	10^6
mg/L =	mL/m^3 µL/L	10^{-3}	1	10^3
mg/m^3 =	$\mu L/m^3$ nL/L	10^{-6}	10^{-3}	1

Since each volume is related to a corresponding mass, the volume concentrations of gaseous substances can be converted into mass per unit volumes and vice versa. These conversions must be done at a specified temperature and pressure since the gas density is a function of temperature and pressure. For measurements at work places, the reference parameters are 20 °C and 1013 hPa.

Conversion from mg/m^3 to ppm

$$c\ [\text{ppm}] = \frac{\text{mole volume}}{\text{molar mass}} \bullet c$$

The mole volume of any gas is 24.1 L/mole at 20 °C and 1013 hPa, the molar mass (molecular weight) is gas specific.

Example for acetone:

mole volume	24.1	L/mole
molar mass	58	g/mole
assumed concentration	876	mg/m^3

$$c\ [\text{ppm}] = \frac{24.1}{58} \bullet 876$$

Concentration in ppm: c = 364 ppm or mL/m^3.

Conversion from ppm to mg/m^3

$$c\ [\text{mg/m}^3] = \frac{\text{molar mass}}{\text{mole volume}} \bullet c$$

with the assumed concentration of 364 ppm it is:

$$c\ [\text{mg/m}^3] = \frac{58}{24.1} \bullet 364$$

Concentration in mg/m^3 : c = 876 mg/m^3.