TECHNICAL NOTES
Units of Measure

Units of Measure

Understanding certain units of measure used in your applications for concentration allows visualization of the scale of measurement of concentrations and is necessary for your functioning in a monitoring or treatment project. This Tech Note is an introduction to the subject matter and not a definitive guide for all elements of the subject.

PPM

PPM, or parts per million, is the number of parts of a substance in a million parts of a solution or mixture.

mg/L

mg/L, or milligrams per liter relates how many milligrams of a substance can be found in a liter of a solution or mixture.

We assume 1 PPM = 1 mg/L if the density of the substance we dissolved in water is more or less equal to 1,000 kg/m³, i.e., to the density of water. This is only an approximation, and its validity depends on the temperature, the purity of water, etc.

PPM is the same as mg/L?

Answer: N**o**. Note that mg/L is a measure of concentration as a ratio of mass to volume, while PPM is the ratio of the number of particles of a substance to the number of particles of a solution. You need to know the solute density to convert one to the other.

(solute is the medium in which a material(s) is contained or in this case dissolved and water is the solute)

Does 75 PPM = mg/L?

This is contingent on the solute density as we're basically comparing two substances densities. If it's 1,000 kg/m³ (water), then 75 PPM is 75 mg/L. But if the density is 880 kg/m³ (oil), then 75 PPM is 66 mg/L. In general, 75 PPM is 75 × density / 1,000 mg/L.

Convert PPM to mg/L

Converting PPM to mg/L perform these steps:

1. Divide PPM by the solute density expressed in kg/m³.
2. Multiply the result from Step 1 by 1,000.
3. The result is mg/L.

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Examples
Formula: ppm X density (kg/m3) / 1,000 = mg/L

1) Cubic meter (m3 water) weighs 1,000 kg

Assumption: material (water) density is 1,000 kg/m3 (the density of water @ 40°F)
Result depends on the density of the material (solute).
- 75 ppm X 1,000 / 1,000 = 75 mg/L

Assumption: material (oil) density is 880 kg/m3
- 75 ppm X 880 / 1,000 = 66 mg/L

Common units of concentrations being used in air/water and other fluids-based monitoring and treatment:

mg/L =	milligram (million)	
ug/L =	microgram (billion)	1 ug/L = 0.000001 mg/L
ng/L =	nanogram (trillion)	1 ng/L = 0.00000001 mg/L
pg/L =	picogram (quadrillion)	1 pg/L = 0.000000001 mg/L

Understanding Units of Measurement
For use in technical environmental reports or equipment used in soil, water, or air contamination often report numerical values in units unfamiliar to people who don't routinely read these types of reports. The different units of measurement

Mass
28 grams = about 1 ounce
1 kilogram (kg) = 1,000 grams
1 milligram (mg) = 1/1,000 gram = 0.001 gram
1 microgram (ug) = 1/1,000,000 gram = 0.000001 gram
1 nanogram (ng) = 1/1,000,000,000 gram = 0.000000001 gram
1 picogram (pg) = 1/1,000,000,000,000 gram = 0.000000000001 gram

Parts per million and parts per billion may be converted from one to the other using this relationship:
1 part per million = 1,000 parts per billion. For soil, 1 ppm = 1 mg/kg of contaminant in soil, and 1 ppb = 1 ug/kg. A measurement of 6 mg/kg is the same as 6 ppm or 6,000 ppb, which is equal to 6,000 ug/kg.

Concentrations in Water
Concentrations of chemicals in water are typically measured in units of the mass of chemical (milligrams, mg or micrograms, ug) per volume of water (liter, L, l) can be confusing.

Numbers
Million = 1,000,000
Billion = 1,000,000,000
Trillion = 1,000,000,000,000
One millionth = 0.000001
One billionth = 0.000000001
One trillionth = 0.000000000001

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Volume

One liter (L) = 1.06 quarts

One cubic meter (m3) = 35.31 cubic feet (ft3)

One cubic meter (m3) = 1,000 liters (L)

One liter (L) = 1,000 milliliter (ml) = 1,000 cubic centimeters

Concentrations in water can also be expressed as parts per million (ppm) or parts per billion (ppb). Parts per million and parts per billion may be converted from one to the other using this relationship: 1 part per million = 1,000 parts per billion.

For water, 1 ppm = approximately 1 mg/L of contaminant in water, and 1 ppb = 1 ug/L (also written as ug/l). A measurement of 6 mg/L is the same as 6 ppm or 6,000 ppb, which is equal to 6,000 ug/L. A way to visualize one part per billion (ppb) in water is to think of it as one drop in one billion drops of water or about one drop of water in a swimming pool. One part per million is about 1 cup of water in a swimming pool.

Also, concentrations of chemicals in water may be written as grams per cubic meter (g/m3) as grams per 1,000 liters, which may be converted to milligrams per liter (mg/L). Therefore, 1 g/m3 = 1 mg/L = 1 ppm. And so, one milligram per cubic meter (mg/m3) is the same concentration in water as one microgram per liter (ug/L), which is about 1 ppb.

Concentrations in Air

Concentrations of chemicals in air are typically measured in units of the mass of chemical (milligrams, micrograms, nanograms, or picograms) per volume of air (cubic meter or cubic feet). However, concentrations may also be expressed as parts per million (ppm) or parts per billion (ppb) by using a conversion factor. The conversion factor is based on the molecular weight of the chemical and is different for each chemical. Also, atmospheric temperature and pressure affect the calculation.

Typically, conversions for chemicals in air are made assuming a pressure of 1 atmosphere and a temperature of 25 degrees Celsius. For these conditions, the equation to convert from concentration in parts per million to concentration in milligrams per cubic meter (mg/m3) is as follows:

Concentration (mg/m3) = 0.0409 x concentration (ppm) x molecular weight

To convert from mg/m3 to ppm, the equation is as follows:

Concentration (ppm) = 24.45 x concentration (mg/m3) ÷ molecular weight

The same equations may be used to convert micrograms per cubic meter (ug/m3) to parts per billion (ppb) and vice versa:

Concentration (ug/m3) = 0.0409 x concentration (ppb) x molecular weight

Or, concentration (ppb) = 24.45 x concentration (ug/m3) ÷ molecular weight

As an example. The molecular weight of benzene is 78. If the concentration of benzene in air is 10 mg/m3, convert to the units of ppm by multiplying 24.45 x 10 mg/m3 ÷ 78 = 3.13 ppm.

Note: Sometimes you will see chemical concentrations in air given in concentration per cubic feet (ft3) instead of concentration per cubic meter (m3). The conversion from cubic feet to cubic meter and vice versa is as follows: 1 ft3 = 0.02832 m3 and 1 m3 = 35.31 ft3.

Conclusion

There are many units of measure and acronyms used in monitoring and treatment. Knowing and understanding why they are important and what they mean can be key to a successful water monitoring or treatment program.

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