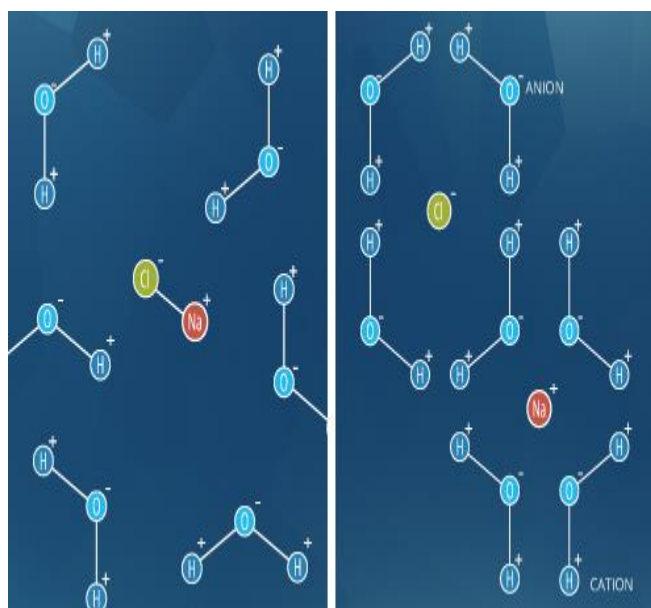


Measurement of Conductivity, Salinity & pH

1. What is Conductivity?

Salts dissolve in water to produce an anion and a cation. These ions make up the basis of conductivity in water.

Conductivity is a measure of water's capability to pass electrical flow. This ability is directly related to the concentration of ions in the water



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These conductive ions come from dissolved salts and inorganic materials such as alkalis, chlorides, sulfides and carbonate compounds.

Compounds that dissolve into ions are also known as electrolytes. The more ions that are present, the higher the conductivity of water. Likewise, the fewer ions that are in the water, the less conductive it is. Distilled or deionized water can act as an insulator due to its very low (if not negligible) conductivity value. Sea water, on the other hand, has a very high conductivity.

Ions conduct electricity due to their positive and negative charges. When electrolytes dissolve in water, they split into positively charged (cation) and negatively charged (anion) particles. As the dissolved substances split in water, the concentrations of each positive and negative

charge remain equal. This means that even though the conductivity of water increases with added ions, it remains electrically neutral.

Conductivity Units

Conductivity is usually measured in micro- or millisiemens per centimeter (uS/cm or mS/cm). It can also be reported in micromhos or millimhos/centimeter (umhos/cm or mmhos/cm), though these units are less common. One siemen is equal to one mho 1. Microsiemens per centimeter is the standard unit for freshwater measurements. Reports on seawater conductivity use micro-, milli- and and sometimes even just siemen/mho per centimeter, depending on the publication.

What is Salinity?

Salinity is an ambiguous term. As a basic definition, salinity is the total concentration of all dissolved salts in water. These electrolytes form ionic particles as they dissolve, each with a positive and negative charge. As such, salinity is a strong contributor to conductivity. While salinity can be measured by a complete chemical analysis, this method is difficult and time consuming. Seawater cannot simply be evaporated to a dry salt mass measurement as chlorides are lost during the process.



The most common ions in sea water

Salinity Units

The units used to measure salinity fluctuate based on application and reporting procedure. Parts per thousand or grams/kilogram (1 ppt = 1 g/kg) used to be the standard 22. In some freshwater sources, this is reported in mg/L 4, 37. Now salinity values are reported based on the unitless Practical Salinity Scale (sometimes denoted in practical salinity units as psu) 22. As of 2010, an Absolute Salinity calculation was developed, but is not used for database archives 24.

Absolute salinity is reported in g/kg and is denoted by the symbol SA. TEOS-10 offers pre-programmed equations to calculate absolute salinity.

$$\text{SALINITY} = 1.80655 * \text{Chlorinity (ppt or g/kg)}$$

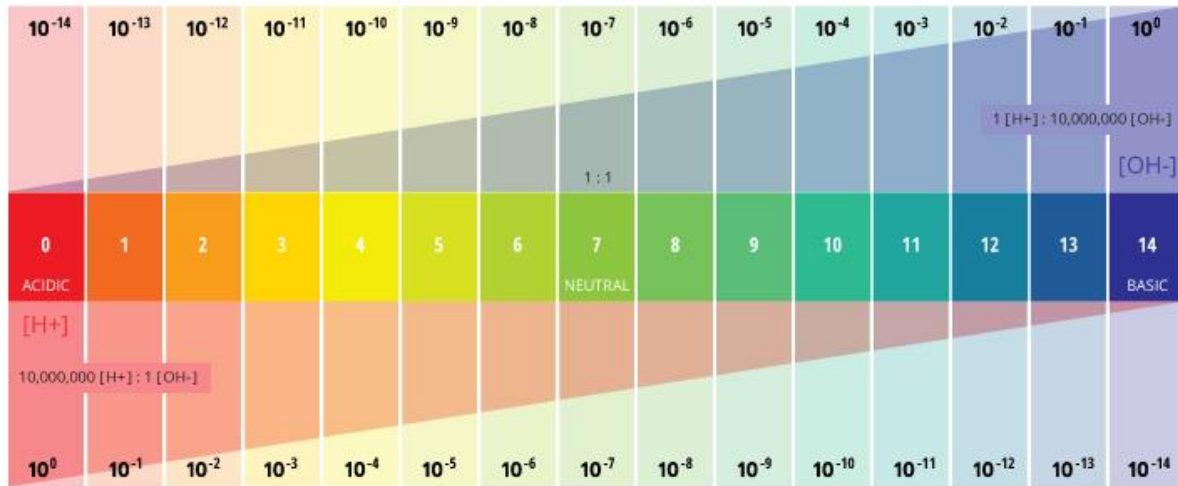
Determining total salinity based on chloride concentrations is only accurate in water sources with a known chloride-salinity ratio, such as seawater.

What is pH?

pH is a determined value based on a defined scale, similar to temperature. This means that pH of water is not a physical parameter that can be measured as a concentration or in a quantity. Instead, it is a figure between 0 and 14 defining how acidic or basic a body of water is along a logarithmic scale. The lower the number, the more acidic the water is. The higher the number, the more basic it is. A pH of 7 is considered neutral. The logarithmic scale means that each number below 7 is 10 times more acidic than the previous number when counting down. Likewise, when counting up above 7, each number is 10 times more basic than the previous number.

pH stands for the “power of hydrogen”. The numerical value of pH is determined by the molar concentration of hydrogen ions (H^+). This is done by taking the negative logarithm of the H^+ concentration ($-\log(\text{H}^+)$). For example, if a solution has a H^+ concentration of 10^{-3} M, the pH of the solution will be $-\log(10^{-3})$, which equals 3.

This determination is due to the effect of hydrogen ions (H^+) and hydroxyl ions (OH^-) on pH. The higher the H^+ concentration, the lower the pH, and the higher the OH^- concentration, the higher the pH. At a neutral pH of 7 (pure water), the concentration of both H^+ ions and OH^- ions is 10^{-7} M. Thus the ions H^+ and OH^- are always paired – as the concentration of one increases, the other will decrease; regardless of pH, the sum of the ions will always equal 10^{-14} M. Due to this influence, H^+ and OH^- are related to the basic definitions of acids and bases.



The logarithmic scale of pH means that as pH increases, the H⁺ concentration will decrease by a power of 10. Thus at a pH of 0, H⁺ has a concentration of 1 M. At a pH of 7, this decreases to 0.0000001 M. At a pH of 14, there is only 0.000000000000001 M H⁺.

pH stands for the “power of hydrogen”³. The numerical value of pH is determined by the molar concentration of hydrogen ions (H⁺)³. This is done by taking the negative logarithm of the H⁺ concentration (-log(H⁺)). For example, if a solution has a H⁺ concentration of 10⁻³ M, the pH of the solution will be -log(10⁻³), which equals 3.

This determination is due to the effect of hydrogen ions (H⁺) and hydroxyl ions (OH⁻) on pH. The higher the H⁺ concentration, the lower the pH, and the higher the OH⁻ concentration, the higher the pH. At a neutral pH of 7 (pure water), the concentration of both H⁺ ions and OH⁻ ions is 10⁻⁷ M. Thus the ions H⁺ and OH⁻ are always paired – as the concentration of one increases, the other will decrease; regardless of pH, the sum of the ions will always equal 10⁻¹⁴ M². Due to this influence, H⁺ and OH⁻ are related to the basic definitions of acids and bases.