



A Glossary of 50 Basic Aquarium Technical Terms

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Every group that shares a special interest develops its own terminology that its members use to discuss and explain their experiences and problems. Tropical fish hobbyists are no different and over the years as the hobby technology has increased, so has the technical vocabulary of the hobby. Most of the technical terms hobbyists and writers use are borrowed from biology and chemistry. But in some cases, the definitions or meanings of the terms have been changed by the hobby or incorrect definitions have been allowed to spread through the hobby, much like computer viruses.

Miscommunication is an everyday problem, even in the fishkeeping hobby, and the incorrect usage of technical terms is one reason. By learning a bit of the technical side of the hobby, you will be in a better position to understand and apply the biological and chemical principles that are part of fishkeeping. The purpose of this article is to present a compendium of some of the most common terms used in the hobby and a short definition of the term. Use this list when reading articles which contain unfamiliar words so you can better understand the author's point.

The terms are presented in alphabetical order.

Absorption: the process of retaining one substance within another without any chemical or physical interaction (bonding)--in contrast to adsorption. A sponge absorbs water as the water does not bind to the sponge and is easily reclaimed by squeezing the sponge.

Acidity: a measure of the ability of water to accept bases without the pH increasing. Acidity is rarely important to aquarists as few fish and invertebrates normally kept in the hobby must live in the low pH water normally associated with high acidity. Acidity is a type of buffering and is the opposite of alkalinity.

In most natural waters, acidity is caused by humic and fulvic acids. These organic acids are formed by the decay of organic material such as leaves and other forest litter. Some South American and Asian waters have such high humic acid content that they are

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colored tea brown. A number of popular tropical fish come from these waters commonly called blackwaters.

Water with high acidity is not readily available to the hobbyist, so it is generally made using commercial preparations. Peat is also used to generate soft (see hardness definition) water with relatively high organic acid content and some acidity.

Activated Carbon: a highly adsorptive carbon based material used as a chemical filter media. Activated carbon adsorbs dissolved organics such as tannins and phenols from the water. Activated carbon does not remove ammonia, nitrite or hardness causing compounds. It is made from a variety of materials such as bituminous and lignite coal, coconut shells, peat and wood. Bituminous coal based carbons are the best choice for aquarium water filtration as they are hard, have a large internal surface area and the widest range of pore sizes.

Adsorption: the chemical or physically bonding (interaction) between two different phases of matter (in the case of aquarium filtration, the water and the chemical filtration media). Activated carbon, for example, adsorbs organics from water.

Aerobic: two uses in the hobby. When referring to bacteria (as in aerobic bacteria), it means bacteria which can live or grow only where free oxygen is present. In a more general usage (an aerobic environment), it means an area where free oxygen is present. The opposite of anaerobic.

Alkalinity: a measure of the acid-neutralizing capacity (ANC) of water. Acid-neutralizing capacity means the ability to accept acid without a subsequent drop in pH. The more acid that can be added to water before the pH starts to drop, the higher the alkalinity.

Alkalinity is a measure of the buffering ability of water. It is not the measurement of just one substance or ion. It is the combined property of many anions (negative charged ions). To a great extent, the alkalinity of most waters is determined by the amount of bicarbonate and carbonate present in the water. But other substances such as hydroxide, phosphates, silicates and borates also contribute to the alkalinity.

Ammonia (NH₃): the major excretory product of fish and many other aquatic organisms. Ammonia is formed during the utilization of proteins which the organism

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receives through its diet. In fish, the majority of ammonia is excreted through the gills.

Ammonia exists in two forms in water, the gaseous or un-ionized form (NH₃) and the ionic form (NH₄⁺) which is called ammonium. While the sum of the two forms (called total ammonia) always equals 100%, the percentage present in the water of either form depends mostly on the pH of the water and, to a lesser extent, the water temperature and salinity. For example, assuming a total ammonia concentration of 1 mg/L at a pH of 7.5 and a temperature of 75°F (24°C), the gaseous fraction (NH₃) will be 0.0165 mg/L, while the ammonium concentration is 0.9835 mg/L, with the sum of total ammonia equaling 1.0 mg/L. If everything is kept the same except the pH is increased to 8.5, the NH₃ value becomes 0.144 mg/L while NH₄⁺ will equal 0.856 mg/L (the sum still equaling 1.0 mg/L).

Ammonia is acutely toxic to fish at concentrations near 1 mg/L of NH₃. Chronic low values of ammonia (e.g., 0.1 mg/L NH₃) result in stunted fish growth and increased stress which can lead to secondary bacterial infections. The ammonia level in an aquarium should be maintained as close to 0.0 mg/L as possible.

Anaerobic: two uses in the hobby. When referring to bacteria (as in anaerobic bacteria), it means bacteria which can live or grow where free oxygen is not present. In a more general usage (an anaerobic environment), it means an area where free oxygen is not present. The opposite of aerobic.

Anions: elements or compounds (groups of elements) that have a negative charge. The negative charge is a result of having gained one or more electrons. Orthophosphate (PO₄³⁻), nitrite (NO₂⁻), nitrate (NO₃⁻), chloride (Cl⁻) and sulfate (SO₄²⁻) are common anions in aquarium water.

Autotrophic Bacteria: bacteria whose carbon needs for growth and reproduction are fulfilled by carbon dioxide. Autotrophy refers to the carbon source, not the energy source for growth. Autotrophic bacteria are in contrast to heterotrophic bacteria. The nitrifying bacteria, Nitrosomonas and Nitrobacter are autotrophic bacteria. They obtain energy by oxidizing inorganic compounds, ammonia or nitrite, respectively (see lithotrophic), while reducing carbon dioxide.

Biological Filtration: same as nitrification. A biological filter is a physical structure or device designed to promote nitrification. Biological filtration is the most important of the

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three types of aquarium filtration (the others being mechanical and chemical filtration). Types of biological filters include trickle filters, wet/dry filters, Bio-Wheels, and undergravel filters.

Buffer: a substance that can neutralize a base or an acid so that the original pH of the liquid is maintained or changes much more slowly than if the buffer were not present. Acidity and alkalinity are two measurement of buffering capacity.

Carbon dioxide (CO₂): a colorless, odorless gas which readily dissolves in water to form carbonic acid. Carbon dioxide is respired by animals, absorbed by plants during photosynthesis, and produced by heterotrophic bacteria during mineralization of organic material.

Cations: elements or compounds (groups of elements) that have a positive charge. A significant portion of the ammonia in water is in the cation form called ammonium (written NH₄⁺). Calcium (Ca²⁺), magnesium (Mg²⁺), sodium (Na⁺), and potassium (K⁺) are other common cations in aquarium water.

Chemical Filtration: the removal of dissolved substances by chemically or physically binding them to filter media such as activated carbon. Other types of chemical filtration media are ion exchange resins and clinoptilolite.

Chemolithoautotrophic Bacteria: bacteria which live (-trophic) by obtaining their energy from chemical reactions (chemo-), their carbon from carbon dioxide (auto-), and their electron donor chemically (litho-). The nitrifying bacteria, Nitrosomonas and Nitrobacter, are chemolithoautotrophic bacteria.

Clinoptilolite: a type of zeolite which has a demonstrated affinity for certain cations such as ammonia. Used as a chemical filtration media in the aquarium hobby. Most common use is as cat litter.

Compound: a substance combining two or more elements from the periodic table of elements.

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Deionization (DI): a process that purifies water using ion exchange resins. DI systems will remove 100% of the inorganic chemicals in water and when combined with activated carbon and a bacterial filter, can produce pure water.

Denitrification: a chemical reduction process in which nitrate is converted (reduced) to dinitrogen gas by bacterial processes. Denitrification is an anaerobic process which can eliminate nitrate from water. There are a number of intermediate steps which form compounds such as nitrous oxide (N₂O). Denitrification is carried out by bacteria such as *Pseudomonas*, *Alcaligenes* and *Rhodopseudomonas*.

Dissolved Organic Carbon (DOC): includes a variety of carbon based (thus organic) compounds that are dissolved in water. They are in contrast to particulate material. Tannins and phenols are two common DOCs in aquarium water. Studies have shown that increased levels of DOC inhibit nitrification. DOC is produced by several processes including biodegradation.

Detritus: dead organic material (either plant, animal or bacterial) that can be degraded or mineralized by bacterial processes.

Heterotrophic Bacteria: bacteria which utilize organic compounds for their carbon and energy needs. Heterotrophic bacteria are responsible for the mineralization, or degradation of uneaten food, plant material, dead organisms and the other organic based matter that accumulates in an aquarium. Their processes are responsible for recycling nutrients and minerals.

Ions: elements or compounds (groups of elements) that have a negative or positive charge because of having gained or lost one or more electrons. See also anions and cations.

Ion Exchange: a type of filtration whereby one ionized compound (or element) changes places with another on the surface of a media. The media can be a natural occurring (e.g. clinoptilolite) or man-made such as ion exchange resins. Common uses for ion exchange media include: removing hardness from water (the calcium and magnesium in the water are exchanged for sodium on the media) and ammonia removal by exchange

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also with sodium. Deionization (DI) water systems use ion exchange media to purify water by removing cations and anions by exchanging them with hydrogen and hydroxyl ions, respectively.

Lithotrophic Bacteria: bacteria which get their energy for growth from inorganic compounds such as ammonia, nitrite or nitrate.

Mechanical Filtration: the trapping of particulate material from aquarium water by straining the water through a pad, sponge, or similar media, and the subsequent removal and cleaning of that media. This process reduces water turbidity and removes particulate organic material from the system. Mechanical filtration should be placed before chemical and biological filtration as it helps prevent the clogging of the media of these two types of filtration processes.

Mineralization: is the breakdown of organic matter by bacteria into inorganic compounds such as ammonia and carbon dioxide.

Molecular: the smallest form of an element or compound that can exist in the free state (without a charge). NH_3 is the molecular form of ammonia.

Nitrification: the oxidation of ammonia to nitrite, and nitrite to nitrate by bacteria belonging to the family Nitrobacteraceae. The most well-known nitrifying bacteria are *Nitrosomonas europaea* which oxidize ammonia to nitrite, and *Nitrobacter winogradskyi* which oxidizes nitrite to nitrate. But there are other members of both groups such as the ammonia oxidizers *Nitrosococcus mobilis*, *Nitrosolobus multiformis* and *Nitrosococcus oceanus*, and the nitrite oxidizers including *Nitrobacter hamburgensis*, *Nitrospira marina* and *Nitrococcus mobilis*.

Nitrification is the most important process in an aquarium as it forestalls the build-up of ammonia which would otherwise increase to toxic levels. Nitrification takes 30 to 45 days to become established in a new aquarium during which time ammonia and nitrite may reach toxic levels (called new tank syndrome).

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Nitrite (NO₂-): a form of nitrogen that is produced during nitrification and denitrification by bacteria. Generally nitrite is very transient being quickly utilized by bacteria. Nitrite can accumulate to toxic levels during the break-in or cycling of a newly established aquarium.

Nitrate (NO₃-): a form of nitrogen that is the end-product of nitrification which is produced by *Nitrobacter* spp. Nitrate is also the initial substrate for denitrification. Nitrate is not considered very toxic to aquatic organisms. The nitrate concentration in an aquarium will continue to increase unless steps are taken to remove it from the water. The most common way is through regular water changes. Other methods are to use live plants which utilize nitrate for growth or by installing a denitrifying filter.

Nitrobacter: the genus name for aerobic, chemolithoautotrophic bacteria that convert nitrite to nitrate via oxidation. Rod shaped, often pear shaped (0.6-0.8 to 1-2 microns in length).

Nitrosomonas: the genus name for aerobic, chemolithoautotrophic bacteria that convert ammonia to nitrite via oxidation. Shaped as short rods to ellipsoidal cells (0.8-1.0 to 1-2 microns in length).

Oxidation: the process of removing one or more electrons from a compound or ion. When ammonia is oxidized to nitrite, or nitrite then oxidized to nitrate, electrons are removed from the substance being oxidized.

pH: a measure of the hydrogen ion concentration. For aquarium hobby purposes a good working definition of pH is the hydrogen ion intensity or activity. The "p" stands for power while the "H" stands for the hydrogen ion (always capitalized because it is a chemical element); together they mean the power of the hydrogen ion. pH is the negative logarithm of the hydrogen ion concentration (written $-\log [H^+]$) and is measured on a scale from 0 to 14. Since pH is logarithmic, it is important to remember that a change of one pH unit represents a tenfold change in hydrogen ion concentration. For example a pH of 6 has 10 times the hydrogen ions of pH 7, and a pH of 5 has 100 times the hydrogen ions of pH 7.

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Since higher levels of hydrogen ion activity mean an increased acidic level, it should also be apparent from the above discussion why a "lower" pH is more acidic than a "higher" pH. A solution with a low pH, such as 3, has a hydrogen ion activity of 0.001 mol/L while a solution with a higher pH, such as 8, has only 0.00000001 mol/L of hydrogen ions. Since 0.001 is a larger number than 0.00000001, the solution with a pH of 3 has a much greater hydrogen activity, making it more acidic.

If there are equal numbers of hydrogen and hydroxide ions then, by definition, the pH is neutral and its value is 7 (the concentration of both hydrogen and hydroxide ions is 10^{-7} mol/L). The pH of most natural waters fall in the range of 4 to 9 and much more often in the range of 6 to 8. In water, deviation from the neutral pH 7 is primarily the result of the hydrolysis of salts of strong bases and weak acids or of weak bases and strong acids. However, dissolved gases also have a significant effect. The majority of natural waters have a somewhat alkaline pH due to the presence of carbonate and bicarbonate.

Phenols: a group of low molecular weight organic compounds that are responsible for smells, such as the "fishy smell" sometimes associated with aquariums.

Phosphorus (P): occurs in water as phosphate (PO_4) in two general forms: ortho- and organic. The orthophosphate form which is utilized by plants and algae for growth is also called soluble reactive phosphate (SRP). The chemical formula is PO_4^{3-} . This is also the form of phosphorus that test kits can measure.

The second category, the organically bound phosphates, is also called particulate phosphates. This group contains phosphate in a number of different forms that are bound to organic particles, or incorporated in freshly dead tissue, or chemically bound to elements such as calcium. In general, particulate phosphate must be converted to orthophosphate before it can be utilized by algae and plants for growth. To measure particulate phosphate, it must first be liberated from whatever it is bonded to by a chemical procedure called digestion using strong acids or chemicals. Either method breaks the bond on the phosphate converting it all to orthophosphate which is measured with a conventional test kit. Digestions generate some hazardous waste and are not something the hobbyist can do easily or safely at home.

The importance of the particulate phosphate is that it serves as a reservoir which is constantly producing SRP which can be utilized by algae and plants. Over 98% of the total phosphorus in lake water is in the particulate form cycling back and forth to the SRP fraction. Bacteria are responsible for cycling the phosphorus in the aquarium.

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While the test kit for SRP is easy to use, there are a few things to keep in mind when doing a phosphate test. Phosphate is very "sticky" and the sampling tube and water is easily contaminated. Oils from your hands, phosphate from soaps, and phosphate left over in the vial from the last test all can contaminate the sample leading to mistakenly high results.

Pure Water: water which contains nothing but a few dissociated hydrogen and hydroxyl ions. Pure water contains no salts, gases, bacteria or other such substances. The chemical name is hydrogen oxide with a molecular weight of 18.016. It contains 11.19% hydrogen and 88.81% oxygen. There is no such liquid as "pure seawater," nor can fish or other organisms live in absolutely pure water as it has no dissolved gases such as oxygen. Further, one cannot measure the pH of pure water because it is too weak ionically.

Redox Potential (ORP): measures whether a solution would tend to accept or give electrons. The name, redox, comes from the common terms of reducing (giving electrons) or oxidizing (accepting electrons). A high redox value means the water will accept electrons. Water which is aerobic is an oxidizing environment and thus has a high redox potential. Conversely, anaerobic waters are reducing environments with low redox values.

A low redox reading can be an indication of heavy organic loading. As the level of organic matter increases, there is more heterotrophic bacteria activity which consumes oxygen. This reduces the redox potential. There is no one correct redox number for an aquarium. Redox will change over the course of a day. It will be lower in the dark than in the light because photosynthesis adds oxygen to the water which increases the redox potential.

Reduction: the process whereby a chemical substance gains electrons. For example, when nitrate is reduced to dinitrogen (see denitrification) electrons are added to the substance being reduced. Reduction is the opposite of oxidation.

Respiration: the production of energy using either organic or inorganic compounds, which are oxidized, and inorganic compounds which are reduced.

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Reverse Osmosis (RO): a water purification process using selective membranes and high pressure. RO systems will remove 100% of the bacteria in water and 85 to 95% of the inorganic chemicals. They can waste 4 to 10 gallons of water for every gallon of purer water produced.

Salinity: a measurement of the mass of all the dissolved salts in a given mass of solution. It is usually expressed as parts per thousand (ppt) and used to determine the salt level in a seawater aquarium. The normal range for aquariums is 30 to 34 ppt.

Tannins: a group of high molecular weight organic compounds that are responsible for the discoloration of aquarium water.

Total Dissolved Solids (TDS): a measurement of the total amount of dissolved ions in water.

Trace Elements: refers to the elements which occur in seawater at a concentration between 0.000001 and 0.01 mg/L. They include cesium, chromium, cadmium, selenium, silver, cobalt, lead and tin. In general usage, the term refers to elements or compounds which are originally present in very small quantities and are important for physiological processes.

Water Quality: a term that encompasses the entire range of physical, chemical and biological environmental factors in an aquarium. It is subjective in that what would be considered good water quality for one set of fish may be poor water quality for another group.

Zeolite: a group of naturally-occurring clay compounds which have an affinity for certain chemicals and, thus, are capable of ion exchange. Clinoptilolite is a type of zeolite. Zeolites are a type of ion exchange media which are utilized for removing ammonia from water.

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