

Glossary

WATER TERMS

Anion – A negatively charged ion.

Anion Exchange Resin – An ion exchange material that removes anions from solution by exchanging them with hydroxyl ions.

ASTM – The American Society of Testing and Materials

Bed – Column of carbon, sand or ion exchange resins through which the water passes during treatment.

Biopure Water – Water that is sterile, pyrogen free and has a total solids content of less than 1ppm.

Boiler – The vessel used in distillation systems (or power plants) to convert water into steam.

Buffer – A solution that is capable of opposing small changes in chemical composition; particularly in pH.

Calcium – A metallic element often found in water, usually as dissolved calcium carbonate (CaCO_3). Soluble in water, it causes hardness and subsequent scaling.

Carbon – A nonmetallic element that occurs in many inorganic and in all organic compounds. Is capable of chemical self-bonding to form an enormous number of important molecules.

Cation – A positively charged ion.

Cation Exchange Resin – Ion exchange resins capable of removing cations by exchanging them for hydrogen ions.

Chlorine – An element used to kill micro-organisms in water. At room temperature and atmospheric pressure it is a greenish yellow gas.

Condensate – Distillate just after it has been cooled from steam into the liquid state.

Conductivity – The reciprocal of resistivity, it is a measure of the ability to conduct an electric current. Since ionized impurities increase the conductivity of water, it is also an accurate measure of ionic purity. To measure it, current is passed between two electrodes a fixed distance apart. Conductivity is normally expressed as microsiemens/cm, identical to micromhos/cm.

Deionization – Removing dissolved ions from solution by passing it through a bed of ion exchange resins, consisting of polymer beads that exchange hydrogen ions for cations and hydroxyl ions for anions in solution. The ionic impurities remain bound to the resins, and the hydrogen and hydroxyl ions combine with each other to form water.

Glossary

WATER TERMS

Demineralization – Sometimes used interchangeably with deionization, it refers to the removal of minerals and mineral salts using ion exchange.

Desalination – The removal of dissolved salts from brine to produce potable water.

Dilution – Lowering the concentration of a solution by adding more solvent.

Disinfection – To destroy (but not necessarily all) of the harmful or objectionable microorganisms by means of chemicals, heat, ultraviolet light, etc. Also referred to as sanitization.

Dissolved Solids – Also referred to as Total Dissolved Solids (TDS), it is the amount of nonvolatile matter dissolved in a water sample, and is usually expressed in parts-per-million by weight.

Distillation – The process of separating water from impurities by heating until it changes into vapor and then cooling the vapor to condense it into purified water.

Effluent – The output or discharge from a water treatment process.

Electrolyte – A chemical compound which, when dissolved or ionized in water, allows it to conduct electric current.

Endotoxin – A poisonous substance present in bacteria that is released when the cell disintegrates. In water treatment, it most often refers to pyrogens.

Exhaustion – When absorbents, such as activated carbon or ion exchange resins, have depleted their capacity by using up all active sites. Ion exchange resins may be regenerated to reverse the process.

Feedwater – Water entering a treatment process.

Filtration – Removal of suspended matter by passing it through a porous matrix that prevents particles from getting through, usually by entrapment on or in the filter matrix.

Fouling – When gelatinous coatings, colloidal masses or dense bacterial growth form a compacted crust on membrane or filter surfaces which blocks further flow.

Gel – A continuous mass formed when colloids congeal.

Grains per Gallon – Concentration of dissolved ions in water, generally as calcium carbonate. 7,000 grains is equal to a pound. One grain per gallon is equivalent to 17.1 ppm of Dissolved Solids.

Glossary

WATER TERMS

Hardness – Concentration of calcium and magnesium salts in water. Hardness is a term originally referring to the soap-consuming power of water. As such it is sometimes also taken to include iron and manganese. High hardness can cause boiler or pipe scale and failure of reverse osmosis membranes.

Inert – Does not dissolve in water, nor react chemically with other substances.

In-Line – An integral part of the flow path. In a fluid stream, something is said to be in-line if the entire fluid stream flows directly through it.

Inorganic – Commonly referred to as mineral, it includes all matter that is not animal or vegetable. Inorganic substances normally dissociate in water to form ions.

Ion – An atom or group of atoms with an electrical charge that is positive (cation) or negative (anion) as a result of having lost or gained electrons.

Ion Exchange – Also called deionization. A process in which harmless ions attached to the resin beads are exchanged for undesirable ions in solution. Typically, hydrogen ions are exchanged for any cations and hydroxyl ions for any anions. The hydrogen and hydroxyl ions combine to form pure water.

Leach – To dissolve by the action of a moving liquid. For example, high purity water leaches trace impurities from glass vessels.

Megohm-cm – A measure of ionic purity in water. Resistivity (the reciprocal of conductivity) is a measure of specific resistance to electrical flow. The fewer dissolved ions in water the higher its resistivity. One megohm-cm is equivalent to one million ohms of resistance measured between two electrodes one centimeter apart. The theoretical maximum ionic purity for water is 18.3 megohm-cm at 25°C.

Membrane – Filtration membranes are thin polymer films that are permeable to water and other fluids. Microporous membrane filters have measurable pore structures which physically remove particles or microorganisms larger than pore size. Ultrafiltration membranes, (sometimes called molecular sieves), also remove molecules larger than a specified molecular weight. Reverse osmosis membranes are permeable to water molecules, and very little else, rejecting even dissolved ions in water.

Mho – Unit of measurement for conductance; the reciprocal of ohm (resistance). Also see “Megohm-cm”.

Micro – Prefix meaning one millionth, as in microgram, micrometer.

Micrometer – One millionth of a meter. Still widely referred to as a micron in the U.S., although micrometer is now the internationally accepted standard.

Glossary

WATER TERMS

Micromho – A measure of conductance equal to one millionth of conductance equal to one millionth of a mho.

Micron – See “Micrometer”.

Milli – Prefix meaning thousandths, as in milliliter, milligram.

Mixed-Bed Ion Exchange – Mixing both anion and cation resins in the same deionizer results in higher efficiency, but lower capacity than separate-bed deionizers.

Nano – A prefix meaning billionths, as in nanogram, nanosecond. One nanogram per liter is equal to one par-per-trillion (ppt is used only in the U.S.)

Ohm – The practical unit of electrical resistance in a circuit, where a potential difference of one volt produces a current of one ampere.

Organic – Organic matter is a broad category that includes both natural and man-made molecules containing carbon and hydrogen. All living matter in water is made up of organic molecules. The most common are by-products of vegetative decay, such as tannins, lignins and humic acid.

Osmosis – The diffusion of a solvent through a semipermeable membrane from a less concentrated solution to a more concentrated solution.

Percent Recovery – In reverse osmosis or ultrafiltration, the ratio of pure water output to feedwater input.

Percent Rejection – In reverse osmosis or ultrafiltration, the ratio of impurities removed to total impurities in the incoming feedwater. For example, RO membranes typically remove (reject) 90% of the dissolved inorganic contaminants in water.

Permeate – In reverse osmosis, the water that diffuses through the membrane, thereby becoming purified water.

pH – The negative log of the hydrogen-ion concentration. A solution with a pH lower than 7 is acidic. If its pH is higher than 7 it is alkaline.

Pico – A prefix meaning one trillionth, as in picogram.

Polished Water – High purity water after it has undergone a second treatment step. Ultrapure water usually undergoes two or more treatment steps; more economical pretreatment processes (e.g., reverse osmosis) are used to remove all but a very small fraction of the impurities, and highly efficient polishing processes (e.g., mixed-bed deionization) are used to remove the impurities that remain.

Glossary

WATER TERMS

PPB – Parts per billion, or micrograms per liter. Abbreviated ppb only in the U.S. One part per billion is like seeing a bottle cap on the earth's equator from an orbiting satellite.

PPM – Parts per million. The most common measure of dissolved ionized impurities in water. The same as milligrams per liter.

Pretreatment – Initial water treatment steps performed prior to final processing to prolong the life of cartridges and filters and to protect downstream elements from premature failure.

Product Water – The purified water produced as a result of treatment.

Psig – Pounds per square inch of gauge pressure, or pressure above atmospheric pressure.

Purification – Removal of impurities of concern. It has one meaning when applied to the preparation of drinking water, another when applied to reagent grade water for the laboratory, and still another when applied to water used to rinse integrated circuit devices.

Recirculation – Continuous recirculation may be necessary to maintain uniformly high purity in larger water systems. Water is continuously recirculated and reprocessed to prevent stagnation and to rinse out residual impurities in the system. Bacteria flourish in stagnant water.

Regenerate – Restore ion exchange capacity of resins by reversing the process. An acid rinse is used to restore cation resin capacity and a sodium hydroxide rinse is used to restore anion resin capacity.

Reject – In reverse osmosis and ultrafiltration, those impurities not able to permeate the membrane are said to be rejected (removed). They are flushed away in the reject (waste) stream.

Resin – Ion exchange resins are usually bead-like spherical materials with an affinity for particular ions. Cation exchange resins, made of styrene and divinylbenzene containing sulfonic acid groups, will exchange hydrogen ions for any cations they encounter. Similarly, anion exchange resins, made of styrene and divinylbenzene containing quaternary ammonium groups, will exchange a hydroxyl ion for any anions.

Resistivity – A measure of specific resistance to the flow of electricity. In water, it is an accurate measure of ionic purity. See "Megohm-cm".

Reverse Osmosis – The reversal of osmosis to purify water. In osmosis, water diffuses through a semipermeable membrane from a less concentrated solution to a more concentrated solution. The flow of water can be reversed with an opposing pressure that exceeds osmotic pressure. With Reverse Osmosis, water is forced out of a concentrated solution, leaving the solute (impurities) behind.

Glossary

WATER TERMS

Salinity – The concentration of soluble mineral (mainly salts of the alkali metals or of magnesium) in water.

Salt – Any of numerous compounds that result from replacement of part or all of the acid hydrogen of an acid by a metal or a radical acting like a metal; an ionic or electrovalent crystalline compound.

Salt Rejection – In reverse osmosis, the ratio of salts removed (rejected) to the original salt concentration. See “Percent Rejection”.

Scale – The mineral deposits that can coat the insides of boiler or the surfaces of RO membranes. It consists mainly of calcium carbonate, which precipitates out of solution under certain conditions of pH, alkalinity and hardness.

Semipermeable – Membranes that do not have measurable pores, but through which smaller molecules can pass.

Solution – A liquid that contains dissolved solute.

Specific Conductance – The reciprocal of specific resistance, usually expressed in microsiemens/cm, identical to micromhos/cm.

Specific Resistance – Resistance of a one-centimeter cube of water to the passage of electricity under standard conditions, expressed in ohms-cm. It is a measure of the Total Ionized Solids concentration.

Sterilization – Destruction or removal of all viable organisms.

Suspended Solids – Undissolved solids that can be removed by filtration. Determined by a filter paper before and after filtration of a water sample.

Total Ionized Solids – Concentration of dissolved ions in solution, expressed in concentration units of NaCl (sodium chloride). It determines the operating life of ion exchange resins, and is calculated from measurements of Specific Resistance.

Total Organic Carbon – A measure of the level of organic impurities in water, which determines the operating life of activated carbon beds.

Total Solids – Total solids in water include both dissolved and suspended solids. Determined by weighing sample before and after evaporation.

Treatment – Water treatment, also referred to as water conditioning, can consist of adding, as well as removing, chemicals to change the properties of water. In water softening, for example, sodium ions are substituted for ions which cause “hardness”, thus reducing the scale-forming tendencies of water. Water purification, on the other hand, always consists of removing undesirable impurities.

Glossary

WATER TERMS

Turbidity – A suspension of fine particles that obscures light rays but requires many days for sedimentation because of small particle size.

Two-Bed – Separate beds or layers of cation and anion exchange resins. Results in lower purity than mixed-bed deionization, but provides higher capacity in terms of throughput.

Ultrafiltration – Molecular sieves; membranes with pores small enough to remove large molecules. Rated in terms of nominal molecular weight cutoff. A 10,000 Dalton (molecular weight) UF membrane, for example, will remove bacterial pyrogens, which are typically in the range of 20,000 Daltons.

Ultrapure Water – Water with a specific resistance higher than 1 megohm-cm. In the laboratory, it usually refers to ASTM D1193 Type 1 reagent grade water. Anything in laboratory water that is not H₂O is an impurity. Although chemically pure water is not attainable, ultrapure water systems are now capable of reducing impurities down to the limits of detection.

USP – United States Pharmacopoeia.

UV Oxidation – Ultraviolet radiation is employed in water purification for the photochemical oxidation of organic impurities, resulting in HPLC grade water with organic impurity levels below 5 ppb.

Viscosity – The tendency of a fluid to resist flowing as a result of molecular attraction (cohesion).

Glossary

UNITS OF MEASURE

amp – Unit of electrical current.

cm – Unit of length. Abbreviation for centimeter. 1 centimeter = 1/100 meter.

°C – Unit of temperature. Abbreviation for degree Centigrade. $^{\circ}\text{C} = 5/9 (^{\circ}\text{F} - 32)$.

°F – Unit of temperature. Abbreviation for degree Fahrenheit. $^{\circ}\text{F} = 9/5 (^{\circ}\text{C} + 32)$.

gpm – Unit of water flow. Abbreviation for U.S. gallons per minute.

grain – Unit of ion-exchange capacity. Also, unit of weight.

Hz – Unit of frequency. Abbreviation for Hertz. 1 Hertz = 1 cycle per second.

megohm-cm – Unit of specific resistance of water. 1 megohm-cm = 1,000,000 ohm-cm.

mho/cm – Unit of specific conductance of water.

mmho/cm – Unit of specific conductance of water. Abbreviation for micromho/cm. 1 micromho/cm = 1/1,000,000 ohm-cm.

ms/cm – Unit of specific conductance of water. Abbreviation of microsiemens/cm. 1 microsiemens/cm = 1/1,000,000 mho/cm.

mg – Unit of weight. Abbreviation for milligram. 1 milligram = 1/1,000 gram.

mL – Unit of volume. Abbreviation for milliliter. 1 milliliter = 1/1,000 liter.

NPT – Abbreviation for National Pipe Thread.

ohm-cm – Unit of specific resistance of water.

ppb – Unit of concentration. Abbreviation for parts per billion. 1 part per billion = 1 micro-gram per liter.

ppm – Unit of concentration. Abbreviation for parts per million. 1 part per million = 1 milligram per liter.

psi – Unit of pressure. Abbreviation for pounds per square inch.

S/cm – Unit of specific conductance of water. Abbreviation for seimens per centimeter. 1 siemens/cm = 1 mho/cm.

TDS – Abbreviation for total dissolved solids.