

Acid - A substance which releases hydrogen ions when dissolved in water. Most acids will dissolve the common metals and will react with a base to form a neutral salt and water. An acid is the opposite of an alkali, has a pH lower than 7.0

Acid Cleaning – removal of adhered deposits by dissolving with an acid solution to solubilize the deposited material, or solubilize the binding portion of the deposited material so that remaining solids can be dislodged and removed via drain.

Admiralty Brass – An alloy of 70% copper 29% zinc and 1% tin. Arsenic or Antimony may be included to minimize dezincification.

Adsorption - The physical process occurring when liquids, gases, or suspended matters adhere to the surfaces of, or in the pores of, an adsorbent media such as activated carbon. Adsorption is a physical process which occurs without chemical reaction.

Aeration - The process in which air is brought into intimate contact with water, often by spraying water through air, or by bubbling air through water. Aeration may be used to add oxygen to the water for the oxidation of matter such as iron, or to cause the release of dissolved gases such as carbon dioxide or hydrogen sulfide from the water.

Aerobic – An action or process conducted in the presence of air, such as aerobic digestion of organic matter by bacteria.

Aggressive Water - A term usually applied to waters containing acid or oxygen which hasten corrosion (rusting).

Algae – Simple forms of aquatic plant life which use sunlight for photosynthesis as a part of their life cycle.

Alkali - substance with a pH greater than 7.0, the opposite of an acid. Highly alkaline waters tend to cause drying of the skin. Alkalis may include the soluble hydroxide, carbonate, and bicarbonate salts of calcium, magnesium, potassium, and sodium. A hydroxide alkali may also be called a base.

Alkalinity - The capacity of water to neutralize an acid; that is, the measure of how much acid can be added to a liquid without causing a significant change in pH. Alkalinity is not the same as pH because water does not have to be strongly basic (high pH) to have high alkalinity.

P Alkalinity (Phenolphthalein) usually not present in a sample with a pH below 8.3

M Alkalinity (Methyl Red or Methyl Orange – also referred to as total alkalinity) usually present in a sample with a pH greater than 4.5

Carbonate (CO_3^{2-}) alkalinity is present when phenolphthalein alkalinity is not zero but is less than total alkalinity.

Hydroxide (OH^-) alkalinity is present if phenolphthalein alkalinity is more than half the total alkalinity.

Bicarbonate (HCO_3^-) alkalinity is present if phenolphthalein alkalinity is less than half the total alkalinity.

Amperometric – An analytical method based on the determination of a flow of current where the current flow is related to the concentration of the material being determined – typically oxidizing biocides such as chlorine, bromine, ozone.

Anaerobic – something that can thrive in the absence of oxygen.

Anion – A negatively charged ion in solution, such as bicarbonate, chloride, or sulfate. An anion [such as chloride (Cl^-)] may result from the dissociation of a salt, acid, or alkali.

Anodic – refers to the area or portion of an electrolytic cell where chemical oxidation takes place and loss of metal occurs.

Anodic Inhibitor – A chemical that prevents or reduces corrosion by a chemical action at the anodic surface of the metal

Anode - The positive pole of an electrolytic system. The metal which goes into solution in a galvanic cell. Anodes of metals such as magnesium and zinc are sometimes installed in water heaters or other tanks to deliberately establish galvanic cells to control corrosion of the tank through the sacrifice of the anode.

ANSI - Abbreviation for American National Standards Institute.

ASME - Abbreviation for American Society of Mechanical Engineers.

Backflow - Flow of water in a pipe or line in a direction opposite to the normal flow; often associated with back siphonage or the flow of possibly contaminated water into a potable water system.

Backflow Preventer - A device or system installed in a water line to stop backflow.

Back Pressure - Pressure which creates resistance against the flow of liquid or gas.

Bacteria - Unicellular microorganisms which typically reproduce by cell division. Although usually classed as plants, bacteria contain no chlorophyll. Some forms of cyst type bacteria have a degree of immunity to biocides due to the cocoon-like shell around the bacteria. Bacteria can form deposits and contribute to corrosion.

BART – An acronym for Biological Activity Reaction Test. The test provides a method for detecting specific bacterial groups and algae in water before excessive growth causes problems.

Base - An alkali that releases hydroxyl ions when dissolved in water. Bases react with acids to form a neutral salt and water.

Basin – The part of the cooling tower that receives that water after it has passed through the tower. Also referred to as a sump.

Bicarbonate Alkalinity - The presence in a solution of hydroxyl (OH⁻) ions resulting from the hydrolysis of carbonates or bicarbonates. It represents carbonic acid with half of the acidity neutralized – Or it can be considered carbonate itself with half the alkalinity neutralized

Biocide – A chemical agent, such as a pesticide, that is capable of destroying living organisms.

Bleed or Blowdown – The periodic removal of mineral saturated water from the cooling tower or boiler, often through the use of a conductivity controller that is set to open a bleed solenoid tower when the conductivity reaches a specific point and close that valve when the conductivity is reduced to a specific point.

Buffer - A substance which causes a solution to resist changes in pH, or to shift the pH to a specific value.

Calcium Carbonate Equivalent - All forms of water hardness and other salts are commonly expressed in terms of calcium carbonate equivalents. This is necessary so that minerals of varying weight can be expressed in chemically equivalent terms.

Carbon Dioxide - Water with a low pH value usually contains free carbon dioxide. Its presence is caused generally by absorption of carbon dioxide (CO₂) from the air as water falls as rain, or by decay of organic matter in the earth. Well water containing substantial quantities of CO₂ has a resultant low pH and corrosive qualities. Carbon dioxide in water forms a weak carbonic acid.

Cation – A positively charged particle or ion.

Caustic Soda - The common name for sodium hydroxide

Chlorine - Widely used in the disinfection of water and as an oxidizing agent for organic matter, iron, hydrogen sulfide, etc. It is available as a gas, as a liquid in sodium hypochlorite, or as a solid in calcium hypochlorite. In water chlorine reacts with organics to form trihalomethanes (THM) which can cause cancer.

Colloid - Very finely divided solid particles larger than molecules but small enough that they will not settle out of a solution; intermediate between a dissolved particle and a suspended solid which will settle out of solution. Typically between 0.1 and 0.001 microns in diameter, it usually requires coagulation prior to filtration.

Condensate - Water which has liquefied from steam.

Conductivity - The quality or power to carry electrical current; in water, the conductivity is related to the concentration of ions capable of carrying electrical current. The unit of measure is the mho, which is the reciprocal of resistivity which is the microhm.

Controller – a monitoring and control device. We use several different makes and models of controllers. Our simplest unit is a conductivity controller that uses an electrical conductivity probe to determine when to actuate the bleed solenoid valve. Our most sophisticated unit uses:

Conductivity probes – capable of governing a relay to actuate a bleed solenoid valve

pH probes – capable of governing a relay to dispense chemical based on pH setpoints

ORP probes- capable of governing a relay to dispense chemical or turn on ozone generators

Timers – capable of dispensing chemical via daily timers, or as a result of other relay actions, and capable of activities like bleeding the system down to a prescribed conductivity point, or for a predetermined number of hours, and capable of locking out other relay activities like blowdown or chemical feed.

Water Meters – to determine the number of gallons taken in the system (makeup) and the number of gallons bled from the system (bleed), newer systems show daily usage values for the meters – older systems require dialing the system up real-time in person to read the meter online.

Digital Indicators – capable of displaying chemical level sensors (wet/dry contacts), or displaying status of other make/break type switches – actuators, pumps, etc....

Logs data at predefined intervals – usually set up for 15 minute intervals – can be as close as 1 minute intervals. Logs the position of every digital input, every relay and the peak, low and average value of each probe sensor for that 15 minute interval. The shortcoming is that if a relay or digital input is on for even a few seconds during the 15 minute interval, the system logs the status as ON for that interval.

Coagulation and Flocculation - the clumping together of finely divided and colloidal impurities in water into masses which will settle rapidly and/or can be filtered out of the water. Colloidal particles have large surface areas which keep them in suspension and in addition the particles have negative electrical charges which cause them to repel each other and resist adhering together. Coagulation, therefore, involves neutralizing the negative charges and providing a nucleus for the suspended particles to adhere to.

Corrosion - Stated simply, general corrosion is the reversion of a metal to its ore form. Iron for example, reverts to iron oxide as the result of corrosion. The process of corrosion is a complex electro chemical reaction and it takes many forms. Corrosion may produce general attacks over a large metal surface or it may result in pinpoint penetration of metal at welded seams or under biofilm/slime deposits.

Corrosion Inhibitor - generally works by forming a thin “inhibitor layer” over the exposed metal protecting it from the natural solvency of flowing water. Corrosion inhibitors are generally one of two types, neutralizing inhibitors and filming inhibitors. Neutralizing inhibitors “passivate” the surface with a substance that can sacrifice itself before the metal is compromised, filming inhibitors are often oily and simply form a film over the metal surface, protecting it from corrosion.

Cycles of Concentration – a ratio of tap water values to sump water values. There are various manners of expressing cycles of concentration. Most common is the ratio of Electrical Conductivity in the raw water to Electrical Conductivity in the sump water. If the raw water has conductivity of 125 and the sump water has conductivity of 375, then your sump is running 3 cycles of concentration. The most common references to “cycles of concentration” include; bleed cycles (gallons of water through the makeup meter/gallons of water through the bleed meter), chloride cycles(ppm chlorides measured in the sump water / ppm measured in the makeup water), hardness cycles (again ppm in the sump/ppm in the makeup), and calcium cycles (again ppm in the sump/ppm in the makeup).

Delta P - The difference in the pressure of water or gas between an inlet and an outlet.

Delta T – The difference in water temperature temperature between the inlet and outlet.

Deposits- Deposits are seldom composed of one constituent alone but are generally a mixture of various types of minerals, corrosion products and other water contaminants. Some common types of deposits are listed below:

Carbonate deposits are usually granular and sometimes of a very porous nature. The crystals of calcium carbonate are large but usually are matted together with finely divided particles of other materials so that the scale looks dense and uniform. A carbonate deposit can be easily identified by dropping it in a solution of acid. Bubbles of carbon dioxide will effervesce from the scale.

Iron deposits, due either to corrosion or iron contamination in the water, are very dark colored. Iron deposits in boilers are most often magnetic. They are soluble in hot acid giving a dark brown colored solution.

Silica deposits are very hard, resembling porcelain. The crystals of silica are extremely small, forming a very dense and impervious scale. This scale is extremely brittle and very difficult to pulverize. It is not soluble in hydrochloric acid and is usually very light colored.

Sulphate deposits are much harder and more dense than a carbonate deposit because the crystals are smaller and cement together tighter. A Sulphate deposit is brittle, does not pulverize easily, and does not effervesce when dropped into acid

Dissolved Oxygen (DO) - Measure of water quality indicating free oxygen dissolved in water. DO is measured in milligrams per liter (mg/l) or percent saturation (based on the temperature of the water sample when it was collected).

Effluent – Discharged water.

Electrolyte - A chemical compound which dissociates or ionizes in water to produce a solution which will conduct an electric current. Could be an acid, base, or salt.

Evaporation Credit – a credit against your sewer bill issued by your utility provider in recognition of the fact that cooling towers evaporate more water than they return to the sewer. Some utility providers provide a flat rate credit. For example, 75% credit against sewer charges for all water that was metered to the cooling tower. If your cooling tower used 200,000 gal in one month, a flat rate evaporation credit of 75% would be a credit for 150,000 gallons of sewer charges. The net effect would be that you paid for 200,000 gallons of water, but for only 50,000 gallons of sewer.

Freeboard - The vertical distance between the surface of the water in a container and the overflow pipe.

Galvanic Corrosion - A form of corrosion which occurs when dissimilar metals in contact with each other and with an electrolyte causes one of the metals to dissolve and go into solution. An example would be the result of connection copper to steel without an insulating (plastic) coupling or union. The anode metal with the higher electrode potential corrodes and the cathode is protected.

Halogens - A family of elements that includes bromine, chlorine, fluorine, astatine, and iodine. They are very active chemically. They are commonly found as the ionic component in compounds with various other elements.

Hardness - A common quality of water which contains dissolved compounds of calcium and magnesium and, sometimes, other divalent and trivalent metallic elements. The term hardness was originally applied to waters that were hard to wash in, referring to the soap wasting properties of hard water. Hardness prevents soap from lathering by causing the development of an insoluble curdy precipitate in the water; hardness typically causes the buildup of hardness scale (such as seen in cooking pans). Silica can also be dissolved in the water but is not reflected as a part of the ppm Hardness.

Hydroxyl - The term used to describe the anionic hydroxide radical (OH⁻) which is responsible for the alkalinity of a solution.

Inhibitors – Two types of inhibitors are generally referred to; corrosion inhibitors and scale inhibitors.

Ion – An atom, or group of atoms in a solution which function as a unit, and has a positive or negative electrical charge, due to the gain or loss of one or more electrons. It is smaller than a colloid.

IRB - Organisms which are capable of utilizing ferrous iron, either from the water or from steel pipe, in their metabolism, and precipitating ferric hydroxide in their sheaths and gelatinous deposits.

Langlier Index - A calculated number that gives an indication of the tendency of water to form a protective film of calcium carbonate scale, to dissolve it or be in equilibrium with it. It does not take into account the quantities of film formed, the effect of velocities, oxygen, carbon dioxide, ammonia, silicon or natural inhibitors in the water. Therefore, it is sometimes erroneously assumed that any water that tends to dissolve calcium carbonate is automatically corrosive.

Lay-Up – Wet layup is a method of storing boilers and chillers so that they are filled with a solution of water and chemicals that will prevent corrosion and deposition during the storage period. Dry layup involves draining, cleaning and drying out the boiler or chiller. A material which absorbs moisture such as hydrated lime or silica gel is placed inside the equipment which is then sealed carefully to prevent leakage of air. Periodic

inspection and replacement of the drying chemical is required during long storage periods.

Legionella - A series of bacteria, including legionella pneumophila, which can cause pneumonia-like illness called Legionnaires disease after the American Legion convention in Philadelphia where the disease first drew attention. These bacteria have been found growing in hard water scale and thrive below 140 degrees Fahrenheit in water heaters, showers, humidifiers, etc. Infection is obtained by inhalation.

Makeup – Freshwater (raw water) added to a system to replenish that lost through leakage, evaporation, condensation or blowdown.

Microhm - One millionth of an ohm. A unit of measurement used to test the electrical resistance of water to determine its purity. The purer the water, the greater its resistance to conducting an electrical current. Water of absolute purity has a resistance of eighteen million ohms across one centimeter at a temperature of twenty-five degrees Celsius.

Micromho - One millionth of a mho. Used to measure the conductivity and the approximate TDS content of water. Absolute pure water has a conductivity of 0.055 micromhos per centimeter at 25 degrees Celsius. Also known as micro Siemens. The specific conductance is the reciprocal of resistance, therefore MHO is OHM spelled backwards.

Micron - A linear measure equal to one millionth of a meter, or .00003937 inch. The symbol for the micron is the Greek letter "μ". The smallest particle visible to the human eye is 40 microns. Most types of bacteria range from 0.05 to 10.0 microns in size.

Microbiologically Induced Corrosion – Corrosion that occurs as a result of various bacteria including sulfate reducing(SRB) and iron related(IRB) that form a protective biofilm barrier making them resistant to microbiocides, and isolating areas of metal that are exposed to high levels of sulfuric acid – a byproduct/waste of the bacteria)

Organic – substances having a carbon-hydrogen structure. Usually derived from plant or animal matter, as opposed to inorganic matter derived from rocks and minerals.

OrganoPhosphonates –are phosphonates (see phosphonates) that contain carbon atoms and are resistant to biodegradation.

ORP – Oxidation Reduction Potential , a measurement of the ability of a solution to oxidize contaminants.

Osmosis - A process of diffusion of a solvent such as water through a semi-permeable membrane which will transmit the solvent but impede most dissolved substances.

Oxidation - A chemical process in which electrons are removed from an atom, ion or compound. The addition of oxygen is a specific form of oxidation. Combustion is an extremely rapid form of oxidation, while the rusting of iron is a slow form. Oxidation never occurs alone but always as a part of the oxidation-reduction (redox) reaction.

Ozone – O₃, Three molecules of pure oxygen. A strong oxidizing agent, ozone is unstable, meaning it seeks to revert to O₂ by giving up a molecule of oxygen. Ozone can be generated by sending a high voltage electrical discharge through air or regular oxygen, it can be produced with ultraviolet light and is produced in nature by lightning, it can also be produced from static electricity – such as that which would be present in many air purifiers without charcoal filters. Ozone has a short half life at room temperature – about 20 minutes, and dissipates more quickly as the temperature approaches 100 degrees. Ozone is not smog – but is a component of a measurement called the Air Quality Index because ozone is an easily measurable byproduct of many processes which produce smog and particulate pollution. High levels of ozone, especially indoors, are irritating to the respiratory systems, generally ozone would have to be at a level high enough to be smelled to be of any risk. Ozone has a pungent odor. Much misinformation exists about ozone, for example the following statement was obtained from the State of Virginia Department of Environmental Quality *“Ground-level ozone is the main ingredient in smog. It is a colorless gas formed by the reaction of sunlight with vehicle emissions, gasoline fumes, solvent vapors, and power plant and industrial emissions. Ozone formation is most likely in hot, dry weather when the air is fairly still.”* Despite Sharper Image’s claims, ozone cannot be produced from smog – ozone is simply three molecules of pure oxygen bound together, that will not stay together for long, especially in warmer environments. Ozone is produced by the Sharper Image Ionic Breeze itself, as cited by Consumer Reports May 2005 issue. The Ozone guard filter is a response to a lawsuit filed against the company for marketing a device that produces unhealthy levels of indoor ozone. In October of 2005 Consumer Reports tested the Ionic Breeze Quadra with Ozone Guard Catalyst and determined that the machine still produces ozone, but slightly less than before.

pH – “potential of Hydrogen” A measure of the degree of the acidity or the alkalinity of a solution as measured on a scale ("pH scale") of 0 to 14. More specifically, pH is the negative of the logarithm of the hydrogen ion concentration of a solution. The hydrogen ion concentration is the weight of hydrogen ions. The neutral point of 7.0 actually indicates the presence of equal concentrations of free hydrogen and hydroxide ions.

Phosphate – a salt of phosphoric acid – a vital component of all living things

Phosphonates – or Phosphonic acids are organic compounds containing one or more C-PO(OH)₂ groups . Scale inhibitors that exhibit excellent temperature and pH stability and prevent the precipitation of mineral salts – primarily calcium.

Polymer - is a long, repeating organic chain, formed through the linkage of many identical smaller molecules called monomers. Polymers in water treatment are generally used as scale inhibitors because they are effective at sequestering calcium.

PolyPhosphates –are phosphate polymers linked between hydroxyl groups and hydrogen atoms. In water treatment these Phosphorus compounds sequester troublesome ions or, if introduced at “threshold” levels, delay their precipitation. Each can stabilize iron and manganese, besides other metals, and each is able to form a protective film on metal surfaces.

Precipitation – a process in which the dissolved minerals react with other minerals and/or chemical components in the water to produce a relatively insoluble reaction product. When precipitation occurs on heat transfer surfaces it inhibits efficient heat transfer. The extent to which heat transfer is affected depends on the makeup of the deposit.

Precipitant (suspended) – the result of precipitation where the precipitation does not accumulate on heat transfer surfaces, rather causing the minerals to precipitate out of solution in a fine powder form. The only negative aspect to suspended precipitant is that the accumulations in the bottom of the sump need to be removed periodically or filtered out. If the deposits are not removed, they can eventually redissolve into solution, and combined with other dirt, debris, sludge can contribute to the occurrence of underdeposit corrosion.

Raw Water - Untreated water from wells or from surface sources or any water before it reaches a water treatment device or process.

Reverse Osmosis - A process for the removal of dissolved ions from water, in which pressure is used to force the water through a semi-permeable membrane, which will transmit the water but reject most other suspended and dissolved materials. It is called reverse osmosis because mechanical pressure is used to force the water to flow in the direction that is the reverse of natural osmosis, namely from the dilute to the concentrated solution.

Scale Inhibitors - Prevent the accumulation of mineral scale on surfaces of the heating or cooling system. Scale inhibitors generally work by interfering with the normal chemical reaction that governs the formation of mineral solids, either by sequestering the minerals or by forming complexes with the minerals and thereby preventing the precipitation.

Softened Water - Any water that is treated to reduce hardness minerals to 1.0 GPG (17.1 mg/L) or less, expressed as calcium carbonate.

Sulfate Reducing Bacteria – (SRB) this is the bacteria that causes that “rotten egg” smell in hot water systems. Sulfate reducing bacteria secrete an acidic byproduct that causes corrosion.

TDS - The abbreviation for "total dissolved solids".

Total Alkalinity - The alkalinity of a water as determined by titration with standard acid solution to the methyl orange endpoint (pH approximately 4.5); sometimes abbreviated as "M alkalinity". Total alkalinity includes many alkalinity components, such as hydroxides, carbonates, and bicarbonates.

Total Dissolved Solids - The weight of solids per unit volume of water which are in true solution, most accurately determined by the evaporation of a measured volume of filtered water, and determination of the residue weight. TDS is expressed as ppm per unit volume of water. An electrical conductivity test provides only an estimate of the TDS since non-conductive substances cannot be measured by electrical means.

Total Hardness - The sum of all hardness components in a water, expressed as their equivalent concentration of calcium carbonate. Primarily due to calcium and magnesium in solution, but may include small amounts of metals such as iron which can act like calcium and magnesium in certain reactions.

Turbidity - A measure of the amount of finely divided suspended matter in water, which causes the scattering and adsorption of light rays. Turbidity is usually reported in arbitrary nephelometric turbidity units (NTU) determined by measurements of light scattering. NTU should not exceed 0.5 in potable water. Turbidity can protect bacteria from sterilization.

Venturi - A tube with a tapered throat which causes an increase in velocity thus a decrease in pressure of the fluid passing through it. It is the common item used to educt or suck a regenerant into a water conditioning system.

Water Analysis - Tests that can be performed in the field or in a lab with specific reagents that reveal information about water quality. The margin for error varies depending on the individual test and the method of dispensing reagent that is chosen. For example, tests that require titration (dispensing an amount of reagent until a reaction occurs) have a greater margin for error when the drop method is used rather than the digital titrator device. Though the digital titrator device is much more accurate, reagent cylinders for the device are much more expensive than bulk reagent designed to be titrated a drop at a time. Generally each drop is equal to 5 or 10 parts per million, whereas the digital titrator can be used to dispense reagent 1 ppm at a time. Drop reagent tests have an acceptable level of accuracy when the user takes adequate time to mix the reagent in the solution as the solution comes closer to the endpoint (usually evidence of a color change starts to develop before the endpoint). Certain procedures for the manner in which the dropper is held, and the manner in which the water sample is measured, the temperature at which the analysis is performed, other chemicals/substances present in the solution and even the type container used for the analysis can also have an effect on the margin for error.

The complete analysis is comprised of several tests, no accurate determination of decisions can be made by the results of a single test by itself.

Analyses performed with an instrument:

Conductivity, TDS (total dissolved solids), ORP (oxidation reduction potential) and pH (pH can be performed with reagents as well).

Analyses performed with chemical reagents:

Calcium ppm, Total Hardness ppm, P Alkalinity (Phenolphthalein), M Alkalinity (Methyl Red or Methyl Orange – also referred to as total alkalinity)

Analyses deduced from other Analyses:

Mg ppm= Total hardness ppm –minus calcium ppm – thus if either of those analyses is in error magnesium will be in error

Water Savings / Reduced Water Consumption – By closely monitoring and controlling water quality, the Flozone Water & Energy Management System is able to reduce the overall volume of water consumed by a cooling tower. It is not uncommon for cooling towers in the Mid-South area to consume 30% more than would be necessary with proper water management practices. While 30% may not sound like much, it is common to find thousands of dollars wasted annually on a single cooling tower. For example, assume your water rate is a modest 2.59 per 100 cubic feet, and assume your cooling tower consumes an average of 500,000 gallons of water per month. The portion of your utility bill pertaining to water consumption alone would reflect a charge of about \$1,730.00. If your water consumption was reduced by 30% due to better water management practices, you would save over \$6,200 annually.