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name

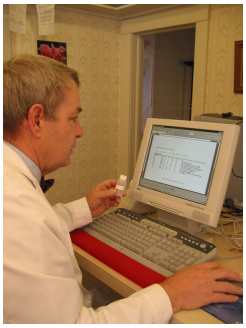
Where is one to turn for value and objectivity?

Sales

Salesmen strive to maximize profit by selling their product at the highest price by creating the PERCEPTION of value.

You, the customer, on the other hand, wish to select the best product at the lowest price.
You and any salesman have conflicting goals.

Science and Engineering



Research - discovering and describing facts about matter and energy.
Engineering - developing useful, inexpensive, materials and technologies.
Communicating - the fruits of science & engineering (e.g., via a seminar).

Buildings are networks of engineered systems. During design and construction, soils, building structures and electrical systems are engineered, installed and commissioned. After start-up, HVAC water system corrosion, scaling and fouling are determined solely by the chemistry of the wetted interface between circulating water and system metal. We protect all interfaces by controlling the water chemistry with chemical tools. This seminar describes three types of HVAC water systems and how chemical tools are used to protect them.

2 years service: *protected* *unprotected*

Since 1970, we have engineered and managed such programs for facilities managers.

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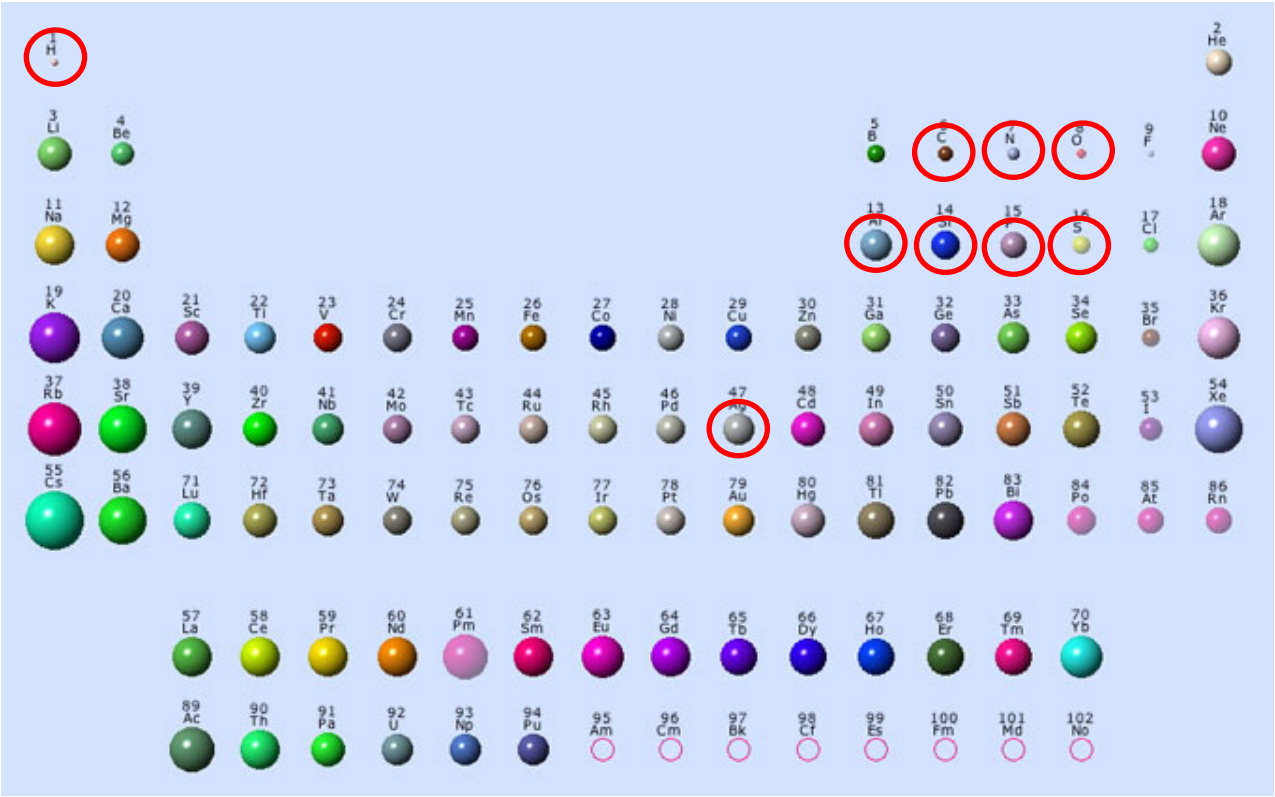
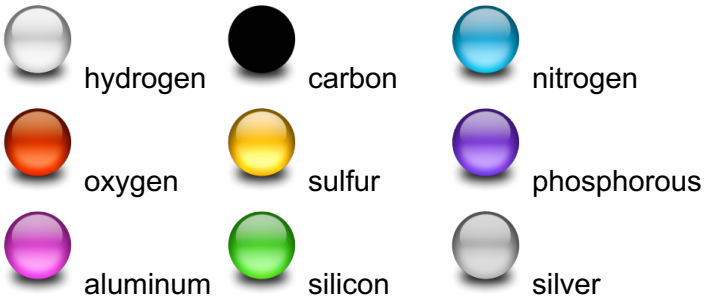
Components



Everything in the universe, <u>all matter</u> - animal, vegetable, mineral –
is composed of 102 elements and their combinations.



<u>The above 9 are incorporated in protective treatment molecules.</u>

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The Temptation to Dilute

100% 40% 20%

Active Ingredient Content

Active Useful Molecules Inactive Useless Molecules

The value of a chemical treatment lies in the number of active, useful molecules one receives for his dollar. Some expensive dry mixtures and solutions contain only 5% to 20% active ingredients. Not much bang for the buck!

Judging value from appearance is impossible because chemical treatment venders add colorants, thickeners and odorants to disguise the extent of dilution.

As Chemists, as part of the program, we supply our clients HVAC Protective Treatment molecules in the highest concentrations available, labeled by their true scientific names. This translates to handling approximately 1-pound quantities of treatment instead barrels of mostly water.

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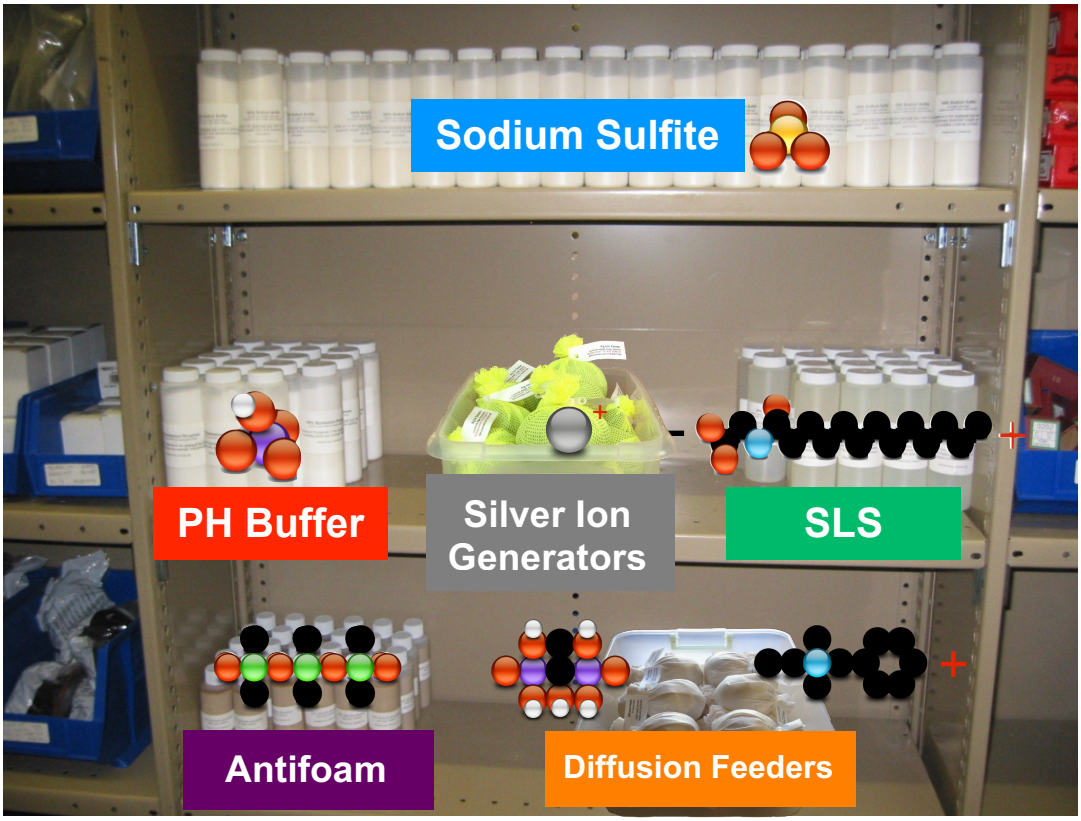
Treatment Chemical Storage



Within the cost of your program, we supply corrective treatment chemicals as pure, undiluted active ingredients, packaged and labeled by their real, scientific names.

When the inventory gets low, you tell us what you need and we supply more chemicals at no additional cost.

Closed Systems

Treatment chemicals are inexpensive.
We supply them to our clients as needed, at no charge,
as part of their HVAC Protective Treatment program.

sulfite ion - the chemical tool which reacts with oxygen dissolved in water, making it not available for metal oxidation (rusting).

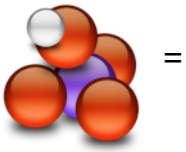
sulfite ion oxygen sulfate ion

scientific name: 100% sodium sulfite (powder)
price: $0.73 / lb.
source: Univar USA

lauryl sarcosinate - the polar chemical tool used to form a insulting boundary on metals which impedes bimetal (galvanic) corrosion.

scientific name: 30% “sodium lauryl sarcosinate” (liquid)
price: $5.12 / lb.
source: Walsh and Associates, Denver CO

hydrogen phosphate ion - the chemical tool used to neutralize acids and maintain a mildly alkaline water solution



scientific name: 100% dipotassium phosphate (powder)
price: $1.59 / lb.
source: Univar USA

Prices as of 2009

Closed Water Systems

A system which circulates water through a loop, without intentional water loss, is a closed water system or *closed loop*. Example: a vehicle's cooling system carries water from the radiator (water cooled / air heated) to the engine (engine cooled / water heated). Closed heated and chilled loops within buildings are not circulating domestic hot water (body contact) potable water systems.

Common Problems

A closed loop which is in fact closed, requires little or no chemical treatment because water impurities which cause corrosion and scaling were introduced only once - when the system was originally filled. In operation, however, many "closed" systems are, in fact, indeed open. Water losses from plumbing repairs, leaking pump seals or faulty air-release valves cause make-up water, containing scale-forming minerals and corrosive oxygen and carbon dioxide, to enter. Also, air (20% oxygen) is drawn in during large system temperature / pressure changes in the spring and fall. Too often, the first signs of failure are expensive repairs.

Rusting Corrosion

problem - Oxygen, dissolved in water, not water itself, reacts with iron and forms "rust". If no oxygen were present in a closed loop, oxidation or rusting would be impossible. Scavenging or "using up" the dissolved oxygen in a closed loop ends the possibility of rusting and pitting corrosion.

solution - Sulfite ion ($SO_3^{=}$) reacts with dissolved oxygen (O_2), forming sulfate ion ($SO_4^{=}$) oxygen is made permanently unavailable for any other reaction - including that of rusting iron and steel.

Bi-metal Corrosion

problem - Bi-metal corrosion occurs if two or more types of metals are connected in an electrically conductive medium. A closed loop containing tap water which has been dosed with electrically conductive (salty) treatment chemicals satisfies all the conditions necessary for this type of corrosion.

solution - SLS (sodium lauryl sarcosinate) molecules are electrically charged dielectrics (insulators) which are attracted by and adhere to metal surfaces. Electrical potentials (voltages) between bi-metals coated with SLS are insulated from each other by SLS and do not carry electrical currents and corrode.

Glycol Degradation

problem - In the presence of dissolved oxygen, hot ethylene and propylene glycols can oxidize and form corrosive organic acids. $COH + O \rightarrow COOH \rightarrow COO^{-} + H^{+}$

solution - Remove dissolved oxygen with sodium sulfite: $O + SO_3^{=} \rightarrow$  $SO_4^{=}$
Neutralize acids with dipotassium phosphate pH buffer. 

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Steam Systems

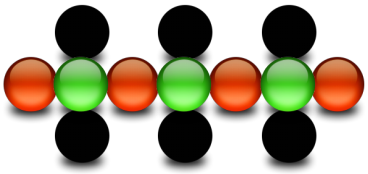
Treatment chemicals are inexpensive.
We supply them to our clients as needed, at no charge,
as part of their HVAC Protective Treatment program.

sulfite ion - the chemical tool which reacts with oxygen dissolved in water, making it not available for metal oxidation (rusting).

sulfite ion oxygen sulfate ion

scientific name:	100% sodium sulfite (powder)
price:	$0.73 / lb.
source:	Univar USA

silicone polymer - is the chemical tool used to eliminate foaming by increasing the surface tension of a water solution.



scientific name:	10% silicone emulsion (liquid)
price:	$1.88 / lb.
source:	Univar USA

hydrogen phosphate ion - the chemical tool used to neutralize acids and maintain a mildly alkaline water solution.

scientific name:	100% dipotassium phosphate (powder)
price:	$1.59 / lb.
source:	Univar USA

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Steam Heating Systems

A steam boiler is a large teakettle. The spout is connected to a coil wherein steam is cooled, condenses to liquid water and drips back into the kettle. The chemistry of three waters must be controlled to protect a closed steam heating system:

Make-up water is tap water which enters the system to "make-up" for any water losses anywhere in the system (boiler water, steam or condensate).

Boiler water is water from the guts of the boiler. Boiler water is composed of water which enters the boiler as make-up water and condensed steam.

Condensate is condensed steam. If steam bubbles break properly at the boiling surface, chemically-rich water stays in the boiler and pure steam results.

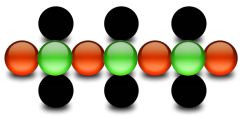
Rusting Corrosion

problem - Oxygen, dissolved in water, not water itself, reacts with iron and forms "rust". If no oxygen were present in a closed loop, oxidation or rusting would be impossible. Scavenging or "using up" the dissolved oxygen in a closed loop ends the possibility of rusting and pitting corrosion.

solution - **Sulfite** (sodium sulfite) - mailed to client if water analysis indicates it is needed. Sulfite ion ($SO_3^{=}$) reacts with dissolved oxygen (O_2), forming sulfate ion ($SO_4^{=}$). Thus, dissolved oxygen molecules are withdrawn from solution and made permanently unavailable for any other reaction - including that of rusting and pitting iron and steel.

Foaming

problem - The tendency for boiler water steam bubbles not to break at the surface, that is, for the boiler water to "foam" and "carry over" with the steam, is contributed to by: high boiler water conductivity (high concentration of dissolved salts) or organic contaminants such as oils or surfactants in the feed-water.



solution - **Antifoam** increases the surface tension of boiling water, causing steam bubbles to break easily and not be "carried over" as foam with the steam leaving the boiler.

Steam Line Corrosion

problem - Carbon dioxide enters a steam boiler in the feed water as a dissolved gas or associated with water hardness and alkalinity. CO_2 molecules leave the boiler as a gas and dissolve in the cooler condensed steam, carbonating it and making it mildly acidic.

solution - **Volatile amine** - a base (the opposite of an acid) which evaporates and condenses much like water. Amine molecules go through the water-steam-condensate cycle with water, carbon dioxide and volatile acids and neutralize them.

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Cooling Towers

Treatment chemicals are inexpensive.
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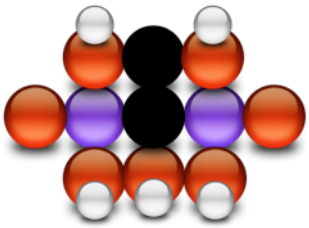
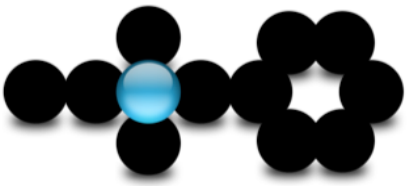
as part of their HVAC Protective Treatment program.

HEDP - the chemical tool used to prevent scale formation in cooling towers, boilers and heat exchangers.



scientific name: 1 Hydroxy Ethylidene Di-Phosphonate (powder)
price: $5.17 / lb.
source: Univar USA

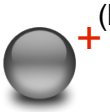
quat - the chemical tool used to disinfect. Quat biocide is effective against fungi, molds, bacteria (including Legionella), algae and viruses.



quaternary ammonium ion

scientific name: quaternary ammonium (liquid)
price: $3.55 / lb.
source: Univar USA

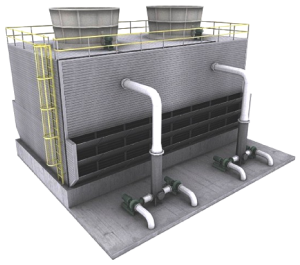
silver ion - the chemical tool used to prevent bacteria, algae and fungi growth (biofilms) and keep tower water clean and odorless.



scientific name: silver metal
price: $30 / troy oz.

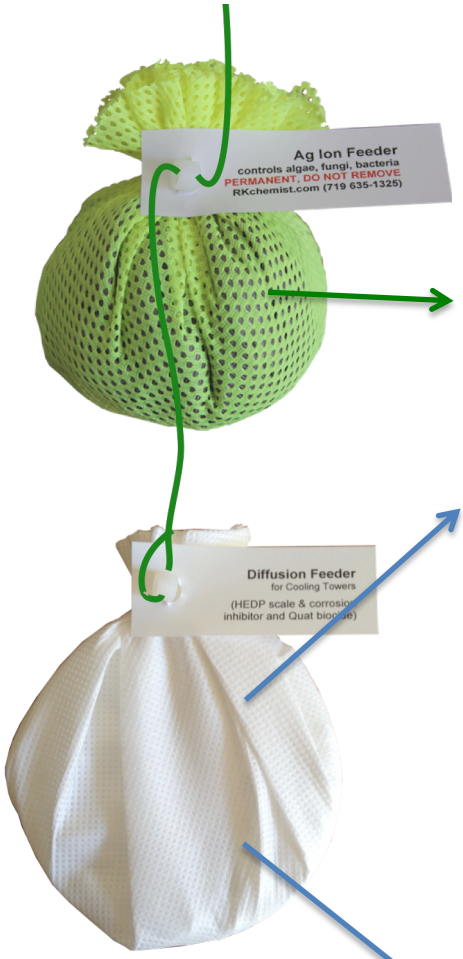
Prices as of 2009

A Chemist Explains the Science Behind Protective Water Chemistry for …



Cooling Towers

Cooling towers release internal building heat to the outdoors by evaporation, wherein hotter water molecules escape and cooler ones remain behind.



Biological Fouling

problem - All of the ingredients necessary for biological growth (warmth, moisture, sunlight or darkness, nutrients and food) are present in a tower. Microorganisms - algae, fungi and bacteria - cause biological fouling which can corrode metals, rot wood, "gum up" heat exchangers and generally make for a dirty, "fouled" tower. The challenge is to inhibit <u>any</u> visible growth, not kill growth which has already occurred.

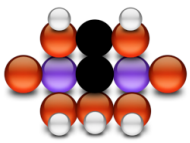
solution - **Silver Ions** (released by the silver ion generator) are potent, broad-spectrum biocides which kill most micro-organisms, including *legionella,* but completely harmless to humans.

solution - **QUAT** (supplied in the diffusion feeder) is a <u>surface active agent</u> or detergent. It reduces the ability of algae, bacteria and fungi to exclude outside materials from the micro-organism cell and interior materials from leaking out. Metabolism is disrupted and the organism dies.

Scaling & Corrosion

problem - Water evaporating from a cooling tower is pure, so the mineral concentration of the water left behind increases to the point of forming scale deposits.

solution - water and scale-forming minerals are "bled" out of the tower to the sewer at a controlled rate and concentrations are maintained within a safe level.



solution - **HEDP** (supplied in the diffusion feeder) is a "denucleating" agent which alters the growth-pattern of scale crystals so they are small, distorted and structurally weak. These do not build up on tower surfaces, but leave the tower dissolved in bleed water.

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