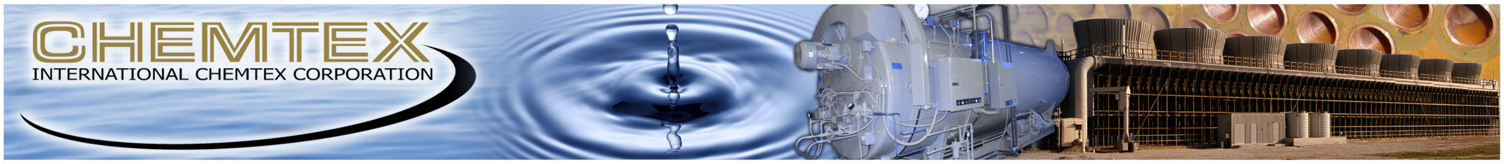

WATER TREATMENT NEWS

Choose the Right Type of Cooling Treatment Program

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The headline of the March, 2010 edition of ***The Water Treatment News*** asked the question, "Does Your Chemical Program fit Your Cooling System?" The article asserted that just as a cooling system must "fit" the facility in which it is installed – it needs to reliably and efficiently meet the cooling requirements of the facility – the cooling water treatment program must be correctly designed so that it "fits," or meets the needs of the cooling system. The article went on to detail how the chemical program must provide the correct combination of scale inhibition, corrosion prevention and microbiological growth control to be successful in doing its job.

An earlier issue of ***The Water Treatment News*** entitled "A New Population Bomb" focused on one aspect of a good cooling water treatment program – controlling cooling system microbiological growth and biofilm development. It showed how biofilm can cause a myriad of problems, including increased operating costs, damage to or destruction of the system, illness and even death (Legionnaires Disease). The article went on to detail the steps necessary to prevent these cooling system microbiological problems.

Like biofilm control, scale prevention is another important function of a good cooling water treatment program. A number of factors influence cooling system scale formation. Cooling water concentrates due to evaporation from the cooling tower. As the concentration increases, hardness – calcium and magnesium salts dissolved in the water – reaches the saturation point and precipitates, forming a gritty sludge that accumulates and deposits on condenser tubes or heat exchange surfaces and hardens into scale. The concentration of alkalinity in the cooling water also causes the pH to rise, further increasing the scaling tendency.

Temperature is another contributing factor to scale formation – the solubility of hardness salts decreases as water temperature increases. The cooling water temperature rises as it passes through the condenser or heat exchanger, causing scale to form at an increasing rate.

Like biofilm, scale causes a number of problems in cooling water systems. When it occurs in the condenser, it decreases heat transfer efficiency, making the chiller work harder to remove heat from the refrigerant and increasing electrical consumption. Scale can also form in the tower, where it impedes heat rejection, and may cause damage to or even destruction of the fill.

While biofilm can usually be removed from a heat exchanger by brushing the tubes, off-line scale removal almost always requires the use of acids like hydrochloric or sulfamic. These chemicals are dangerous to both humans and equipment, causing burns to skin and damage to or destruction of heat exchangers, piping and tower components if over-fed or improperly used. The effects of scale can be

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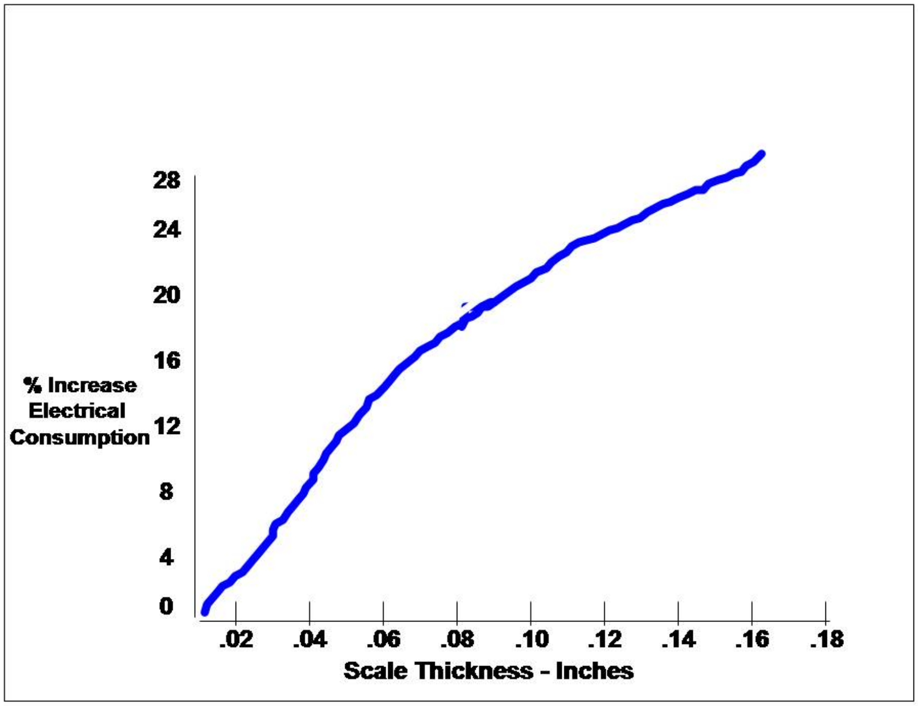
extremely costly; scale prevention is a critical function of a cooling water treatment program.



Cost of Scale—Centrifugal Chiller

Designing an efficient and cost effective treatment program for scale control requires consideration not only of the factors mentioned earlier, but also such things as system volume and cooling water retention time. Based on all this information, the water treater needs to choose one of three basic types of cooling water programs: conventional, acid-feed/alkalinity reduction or soft water.

A conventional cooling water treatment program can be effectively utilized in a system with make-up water that can be safely cycled up at least two times. With "standard" scale control technology, this has traditionally meant maintaining the cooling water Langelier Saturation Index (LSI) at or below 2.5 without the use of make-up water pretreatment equipment or alkalinity adjustment. "Standard" means the inhibitor uses AMP, HEDP or a similar phosphonate, along with an acrylic polymer and perhaps an acrylic copolymer. As the water cycles up, if an LSI of 2.5 is reached before 2.0 cycles are attained, another approach can be considered.

Advances in phosphonate and polymer technology have pushed back the line defining the limits of a conventional program. Utilizing newer generation phosphonate/polymer technology, the water treater can safely and effectively operate a cooling system at LSIs up to 3.0 without acid feed or make-up water pretreatment. It should be emphasized, however, that operating a cooling water system at 3.0 LSI requires fine control over chemical feed and blowdown, as the scale control demands on the chemical program are extreme at this LSI.

If make-up water hardness and alkalinity and/or cooling water pH or temperature push the LSI to 3.0 and beyond, or if blowdown requirements to maintain LSI below 3.0 become prohibitive, a different type of cooling treatment program should be considered. An acid-feed/alkalinity reduction type program is an inexpensive alternative.

An acid-feed program involves feeding sulfuric acid (H_2SO_4) to "destroy" make-up water bicarbonate alkalinity and suppress cooling water pH. Actually, the H_2SO_4 doesn't literally destroy the alkalinity – the reaction products of the acid with the alkalinity are calcium sulfate, a harmless, relatively soluble salt, carbon dioxide and water. The cooling water pH is suppressed in the process; the feedrate of H_2SO_4 is adjusted to maintain the cooling water pH around 8.0. At this level, hardness salts remain in solution in the cooling water, keeping heat exchange surfaces scale-free.

If an acid-feed program is selected for scale control, it is necessary to assure accurate control over the acid feed-rate. This requires the use of a good cooling water pH controller and an acid pump. The controller would normally be incorporated as an optional add-on to the bleed-off control system. If the bleed-off controller is already in place, pH controllers can be purchased and installed as stand-alone units.

In either case, the controller includes a pH sensor, which continually monitors cooling water pH, and the controller itself, which would typically feature a digital read-out of the pH. The controller has an adjustable pH set-point – a capable water treater could determine the correct set-point for the system based on make-up water chemistry and cooling system operational characteristics. With a pH set-point of, say, 8.2, the system would allow cooling water pH to rise to 8.2, at which point the acid feed pump would be actuated and H_2SO_4 would be injected into the cooling water until the pH dropped below the set-point. The controller would shut off the acid pump, and continue monitoring the cooling water, repeating the cycle when the pH again reached 8.2.

By controlling cooling water pH and alkalinity in this way, a pH controller and acid pump can quickly repay their purchase price by allowing operation of the system at increased cycles of concentration.

Take, for example, a 500 ton system operating 16 hours/day using make-up water with total hardness and alkalinity levels of 180 parts per million (ppm) each, a cooling water pH of 8.9 and a maximum temperature of 110^{o}F. Without acid feed, the system would have to be operated at a *maximum* of 1.5 cycles of concentration to avoid scale formation. Under these operating conditions, the total annual blowdown required if the system operated for 220 days per year would be 6,336,000 gallons. On an acid-feed program, the system could be operated at four cycles, reducing blowdown to 1,056,000 gallons annually, a savings of 5,280,00 gallons of water per year. At a combined water and sewer charge of $4.00/1000 gallons, the total annual savings would come to over $21,000 per year. An accurate and reliable pH controller, either an add-on or a stand-alone unit, along with a good acid feed pump, can be purchased for around $1500.

Not every cooling system on a conventional cooling water treatment program would realize this degree of savings by switching to acid-feed. The water treater and facilities engineer should carefully examine their system's operational and make-up water characteristics to determine if an acid-feed program would be a good fit for the system. A prime factor in this consideration is the fact that sulfuric acid is a hazardous corrosive material that is dangerous to handle and that can cause severe damage to the system if over-fed.

Facilities managers and engineers whose cooling system make-up water has elevated hardness and alkalinity levels, but who want to avoid the dangers inherent in an acid-feed program have another alternative – soft water make-up provided by a sodium zeolite softener.

A softener functions by exchanging make-up water calcium and magnesium ions for sodium ions. If little or no hardness enters the cooling system, no scale will form on heat exchange surfaces. A softener is safe to operate – the only chemical used in softener operation is sodium chloride – common salt.

The effluent from a properly operating softener has less than one ppm of total hardness. A consistent supply of make-up water with this hardness level will allow operation of a cooling system at the same number of cycles of concentration as an acid-feed system. A soft water program provides the same savings as an acid-feed program without the inherent dangers to personnel and equipment posed by the acid-feed program.

There *is* one caveat that must be considered if soft water is used for make-up to a new galvanized tower. White rust, a form of corrosion that results in loss of the zinc galvanizing, will almost certainly form if soft water is used during the first 60 days of tower operation. Most tower manufacturers recommend that cooling water hardness levels be maintained at a minimum of 50 ppm during the first 60 days. Also, and most importantly, tower water pH *must* be kept below 8.0 during the first 60 days to assure white rust prevention. It may be possible to accomplish this through heavy blowdown, but the surest, most cost effective way to do this is through the use of an acid-based inhibitor formulated specifically for white rust prevention and system passivation during initial system operation.

After the sixty day passivation period, the regular treatment program can be instituted, including the use of soft water, if that is the type of program that is chosen. It should be noted that some tower manufacturers recommend that tower water hardness be maintained at 50 ppm minimum for normal operation also. Much evidence exists, however, that the use of soft water make-up *after* the initial 60 day passivation period will cause no damage to the tower, provided a good chemical program for scale and corrosion control is maintained.

Softener systems are relatively inexpensive to install and operate. A softener sized for the cooling system described earlier would cost less than $10,000 installed, depending on pipe installation costs. The cost of the salt required for the 500 ton cooling system illustrated here would be less than $10.00 per day.

None of the three types of cooling water scale control programs is perfectly suited for all cooling systems, although any of the three *could* be used in *any* system. A competent water treatment professional understands the pros and cons of each type of program, and by evaluating a system's operational characteristics and make-up water chemistry, can determine which type of program will provide the best results in terms of scale prevention, overall cost, and minimizing potential for injury to operators and damage to the system. It's not always an easy or straightforward choice; make sure you chose a water treater who is capable of making the right one.

Contact your Chemtex Representative to help you choose the right type of cooling treatment program.