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Cooling-tower Water: A Hybrid Problem Calls for a Hybrid Solution

In addition to the usual woes, new issues are creating a situation that calls for a hybrid approach to water treatment

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Scaling, fouling and corrosion have long been the enemy of cooling-tower water. While these issues still present significant water-treatment hurdles, today's processors are also dealing with "impaired" water streams and increasing restrictions affecting intake and discharge water, among other challenges. This one-two punch has necessitated a hybrid approach — one that includes both advanced chemistries and modern, automated equipment — to cooling-tower water treatment (Figure 1).

Figure 1. Processors are faced with the traditional cooling-tower water-treatment issues, as well as new problems related to water scarcity and intake and discharge restrictions, which require a new approach to water-treatment programs
BWA Water Additives

Classic treatment objectives

Cooling-tower water treatment is an integral part of operations for processors because productivity and product quality can be adversely affected by scale, corrosion, fouling and microbiological contamination. These water-treatment problems can be very costly when they lead to the loss of heat transfer in the cooling tower, equipment failure, and health and safety concerns, according to Narasimha Rao, vice president, R&D and Automation, with Nalco Co. (Naperville, Ill.; www.nalco.com).

For this reason, delicately balanced chemistries are used to prevent scale, fouling and corrosion in cooling tower water. "A good water treatment company will create a tailored program to help processors tackle the particular issues that apply to the local stream of make-up water," says Tom Falsey, senior vice president of corporate sales with C.C.I. Chemical Corp. (Vernon, Calif.; www.ccichemical.com). "Every program will differ because make-up water will differ based on where it comes from, the region in which the facility is located, and factors such as the alkalinity, hardness, and other characteristics of the water."

Usually, a robust treatment program will include a balanced chemistry containing one or more biocides, algaecides, biodispersants, corrosion and scale inhibitors, anti-scalants, and cleaners.

Today's treatment objectives

As if finding the proper chemistry balance were not tricky enough, a recent set of water-related issues complicate matters further. The scarcity of water in many places and the tightening of discharge permits are among some of the reasons processors need to optimize water use. Additional factors include the anticipated U.S. Environmental Protection Agency (EPA; Washington, D.C.) regulation

Figure 2. Here, BWA scientists are developing biodegradable, high-performance antiscalants for water treatment

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surrounding cooling-tower intake water. Section 316(b) of the Clean Water Act will require that the location, design, construction and capacity of cooling-water intake structures reflect the best technology available for minimizing adverse environmental impact. “These anticipated regulations will force processors to either install equipment that will reduce fish entrainment at the intake or draw their cooling tower water from elsewhere,” says Kaveh Someah, global director, oil-and-gas and refining and petrochemical industries with Ovivo USA (Salt Lake City, Utah; www.ovivowater.com).

“For these and other reasons, it’s not unusual to see a cooling system with multiple sources of water blended together in varying ratios being used as cooling tower makeup water,” says Eric Thungstrom, global cooling product manager, water and process technologies, with GE Power & Water (Trevose, Pa.; www.ge-energy.com). “This can lead to variable water quality, and if a treatment program is designed around a projected water quality, but if that water quality is more variable than what was projected, it may put additional stress on the treatment program and cause performance issues, such as corrosion or scaling.”

Food Processor Uses Technology to Control Cooling Costs and White Rust Problem

For one food processor, make-up water hardness was so low, alkalinity so high, and variation in water chemistry so frequent that white rust — corrosion of galvanized steel — resulted in capital cost expenditures of $750,000 to replace failed cooling towers.

White rust caused premature failure of galvanized-steel components. A white gelatinous or waxy deposit often identifies white-rust corrosion. This deposit, a zinc-rich oxide, is porous and generally non-protective. High alkalinity, high pH and low hardness cause the problem. All of these conditions existed at this facility and were aggravated by variations in water chemistry that made control problematic.

The cooling-system make-up water contained 4–6 parts per million (ppm) of calcium hardness, necessitating high-cycle operation to obtain the minimum 50 ppm calcium hardness recommended by the Cooling Tower Institute (CTI; Houston; www.cti.org) to prevent white rust. Acid feed was also required to bring the alkalinity within CTI guidelines.

New evaporative condensers were installed in November 2003, and a very small amount of white rust became apparent upon inspection months later. Concerned that this condition would result in further damage to the cooling towers, the plant engineering staff installed Nalco’s 3D Trasar system in January 2004. The technology measures key parameters related to system stress. When upsets occur, 3D Trasar technology takes timely, appropriate, corrective action. It then communicates with system users, informing them of what happened, as well as the actions taken to compensate.

High-cycle operation required acid feed in order to reduce alkalinity. If the acid-feed system failed, the tower pH would rise. At higher pH, conditions would be right for white rust formation. Timely attention to any failure of the acid-feed system was critical to preventing this operational problem. The automated technology provided alarm notification via cell phone, text message, email, or digital pager, ensuring the right people knew about any problem immediately and could take corrective action.

Weekly inspections are conducted on the cooling tower and results since installation of the technology have been excellent. The automation program has been able to better control the system water chemistry, white rust has been abated and an expected $45,000 per year in cost savings has been realized. An important key to the success of the program is the alarm notification feature. It contacts Nalco via cell phone and communicates specific problems so that immediate response can occur. This has helped keep the program in compliance more than 99% of the time.

No scale or other mild steel corrosion problems have been observed and cost savings have come from longer expected evaporative condenser life ($25,000 per year), reduced cooling-water sewer costs ($10,000 per year), reduced treatment chemical costs ($8,000 per year) and labor savings from reduced testing ($2,500 per year). ❑

Often, processors use a blend of waters, such as reverse osmosis (RO) reject water, well water, river water with suspended solids, blowdown water from the boiler or cooling-tower and municipal wastewater. In addition, many facilities are being forced to achieve zero

liquid discharge, so the water sources may be highly concentrated. This mixed, impaired water stream can create a host of challenges, says Thungstrom.

Adding to the water-source-related issues are tightening discharge issues. “Processors now have to deal with meeting regulations that affect effluent limitations, such as requirements that demand lower discharge limits on phosphorus, nitrogen, and BOD/COD (biochemical oxygen demand and chemical oxygen demand),” says Nozi Hamidi, vice president of marketing with BWA Water Additives (Atlanta, Ga.; www.wateradditives.com).

The cost of complying with such limitations, combined with a global awareness of environmentally responsible use of chemicals, has caused many processors to pursue controlling these factors within the plant rather than passing them on to the local water treatment facility, which might be treatment limited or invoke surcharges for wastewaters with high levels of certain constituents, says Hamidi. “This has led to processors targeting reduction or elimination of any contributors to the plant effluent that will tip the limits for phosphorus, nitrogen and other constituents,” she says. “Often, typical phosphonate-based cooling water chemistries will be the largest contributor of phosphorus and nitrogen, and therefore will spur substitution to ‘P-free and N-free’ cooling-water treatment chemistries.”

Cleaning Beyond the Cooling Tower

With so many processors using reclaimed water, the challenge becomes how to treat a reclaimed water source and turn it into useable water, notes Kaveh Someah, global director for the oil and gas industries with Ovivo USA. “Reclaimed water is often high in nutrients, which can cause microfouling that leads to slime on the heat exchangers. High salt, phosphate and ammonia levels may coat metals and create cracking in equipment, so proper treatments must be found.”

Traditional processes for handling these issues might include combinations of biological, physical and chemical treatments. For example, multimedia filters might be used to remove total suspended solids and floating solids. Then, nutrients might be removed via a clarifier or other biological treatment, which may be followed by reverse osmosis to remove dissolved solids from the stream. All this would be done prior to running the water through the cooling system.

“Although these methods combined with chemistry in the cooling tower may prevent scale from forming in the cooling tower, scale will still eventually form. The chemicals just delay where the scaling occurs,” says Someah. “As the water leaves the cooling tower and heads into the process equipment where the temperature rises, the salt precipitates out, which can lead to scaling. However, an online cleaning system can be installed inside the heat exchanger and condensers to prevent and remove scale and fouling.”

To assist, Ovivo offers the Automatic Tube Cleaning System, which prevents scale deposits and microfouling 24 hours a day, increasing reliability, performance, plant output and service life of the equipment. The system injects elastomer rubber balls that are slightly larger than the tube diameter into the water supply line so that the flow of cooling water forces them through the condenser tubes. The balls wipe the tubes clean of deposits including silt, scale, and biological fouling. A strainer section in the cooling water outlet extracts the balls and a centrifugal pump moves them into a collector section where they are ready for the next cycle. Balls can be recirculated continuously or intermittently to suit the plant.❑

Solving combined challenges

Between handling tough-to-treat water sources and stricter discharge limits, water treatment experts say a hybrid water-treatment approach is needed. New and advanced chemistries designed to meet the discharge limits should be combined with technologies that can help consistently, accurately and automatically dose the chemicals and keep track of making sure nothing is off balance.

New and advanced chemistries might include something like BWA Water Additives’ Belclene 810, which is a biodegradable “PMA,” or polymaleic acid, that can be used in cooling-water treatment programs where the processor requires P-free, N-free or metals-free formulations and also wants to achieve very high cycles of concentration within the cooling tower to save water. This chemistry

Figure 3. TrueSense Online for Cooling is an integrated platform that directly measures and controls applied chemistries that are critical for managing cooling-water efficiency and preserving key assets in industrial cooling systems

Nalco

is considered environmentally acceptable and is both a threshold and a crystal growth inhibitor, which makes it better at scale inhibition than phosphonates that are typically just threshold inhibitors, while meeting P-free and N-free treatment objectives (Figure 2).

For the processor who has RO membranes in their operations, BWA has also developed Flocon 885, a biodegradable, P-free and N-free antiscalant used to control organic deposits that can develop on RO membranes.

Figure 4. A technician looks inside a 3D Trasar Controller, which helps maintain control over critical cooling assets

Nalco

Figure 5. This image shows the 3D Trasar technology set up on a cooling tower.

Nalco

In addition to chemistries that meet modern discharge requirements, Thungstrom says processors also require more stable and effective chemistries. GE Power & Water offers GenGard 8000 for control of corrosion and deposits in open recirculating cooling systems. GenGard programs can be applied across the entire pH spectrum from neutral to alkaline and ensure results even under stressful conditions. The technology includes a stress-tolerant polymer (STP), alkaline-enhanced chemistry (AEC) and halogen-resistant azole (HRA) in combination with phosphate-based steel corrosion inhibitors.

Even with advanced chemistries, chemicals alone are not enough, say the experts. “Likely the most important tool is one that can control the treatment program,” says Thungstrom. “And, with all the possible variation in today’s water streams, a sophisticated control system is often needed.”

Simple control systems will take a single input and turn the chemical feed pump on and off accordingly. However, sophisticated monitoring can make adjustments to the chemicals and send alerts when additional actions need to be taken.

Among the sophisticated systems is GE’s TrueSense Online (Figure 3) for Cooling. The integrated platform directly measures and controls applied chemistries that are critical for managing cooling water efficiency and preserving key assets in industrial cooling systems.

Figure 6. Here, the 3D Trasar technology is set up for a cooling water skid

Nalco

Nalco offers the 3D Trasar System (Figure 4–6), which uses real-time monitoring, patented control technology, stress-resistant chemistry and 24/7 information management capabilities to detect, determine and deliver improved scale, corrosion and microbiological performance in cooling systems. It is able to detect the upsets that precede scaling, corrosion and biofouling and then deliver the appropriate chemical response. The result is a balanced, efficient and safe cooling system that requires less maintenance, no over- or under-dosing of chemicals, lower operating costs, and maximum asset protection.

While cooling-tower water treatment may present more challenges than it did in the past, service providers are working hard to make sure their offerings help processors continue to go with the flow.

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