COOLING TOWER & BOILER MAINTENANCE & OPERATIONS

CONTENTS

COOLING TOWERS

What is a Cooling Tower?

A cooling tower is a specialized heat exchanger in which air and water are brought into direct contact with each other in order to reduce the water's temperature. As this occurs, a small volume of water is evaporated, reducing the temperature of the water being circulated through the tower.

How does it Work

Water, which has been heated by an industrial process or in an air-conditioning condenser, is pumped to the cooling tower through pipes. The water sprays through nozzles onto banks of material called "fill," which slows the flow of water through the cooling tower, and exposes as much water surface area as possible for maximum air-water contact. As the water flows through the cooling tower, it is exposed to air, which is being pulled through the tower by the electric motor-driven fan.

When the water and air meet, a small amount of water is evaporated, creating a cooling action. The cooled water is then pumped back to the condenser or process equipment where it absorbs heat. It will then be pumped back to the cooling tower to be cooled once again.

Any water source has various levels of dissolved or suspended solids. When water evaporates from the system, these solids are left behind, causing the remaining cooling tower water to become more concentrated. In order to continue to recirculate the same volume of water back through the cooling system, more source water needs to be added to the system. Again, this source water contains solids. Therefore, although the source water helps to dilute the concentrated recirculated stream, the fact that the source water also contains some solids results in a net increase in concentration of solids in the recirculated stream. Therefore, as the system recirculates the water in the cooling tower, the water's impurities become more and more concentrated.

Common cooling water issues

- **Scale**

  Scale and scalelike deposits include calcium carbonate, calcium phosphate, magnesium silicate, silica and other mineral compounds. They build up on heat exchanger tubes, reducing heat transfer. In sufficient amounts they can restrict water flow. When heat transfer is reduced, efficiency of production is reduced and the quality of products can be compromised. Equipment can suffer damage from overheating. Scale can cause expensive downtime for cleaning or repair, resulting in lost revenue. In addition, scale and scalelike deposits can accelerate corrosion.

- **Corrosion**

  Corrosion occurs when electrically charged particles flow through metal components, causing the metal to oxidize and eventually lose thickness. Corrosion causes pitting and leaks in cooling systems and can lead to the replacement of pipes, pumps, heat exchanger tubes and even entire cooling towers. Iron oxide, especially, contributes to fouling and deposition, which interfere with heat transfer. Downtime for equipment repair or replacement is always costly.

- **Microbiological Deposits**

  Biofilms severely restrict heat transfer. Slime masses bind inorganic and organic foulants and plug systems. Algae and fungi cause extensive plugging and fouling of heat exchanger tubes, water lines, tower spray nozzles, distribution pans, screens and fill. Microbiological fouling also contributes to under-deposit corrosion as well as the growth of corrosion-causing bacteria.

- **Foam**

  Cascading water, the continuous recycling of contaminants and a high concentration of foam stabilizers can cause foam to overflow the tower sump, blow off the towers or even cause an airlock in the water pumps. Worst of all, foam concentrates deposit-forming materials, increasing the chance of fouling in the system.

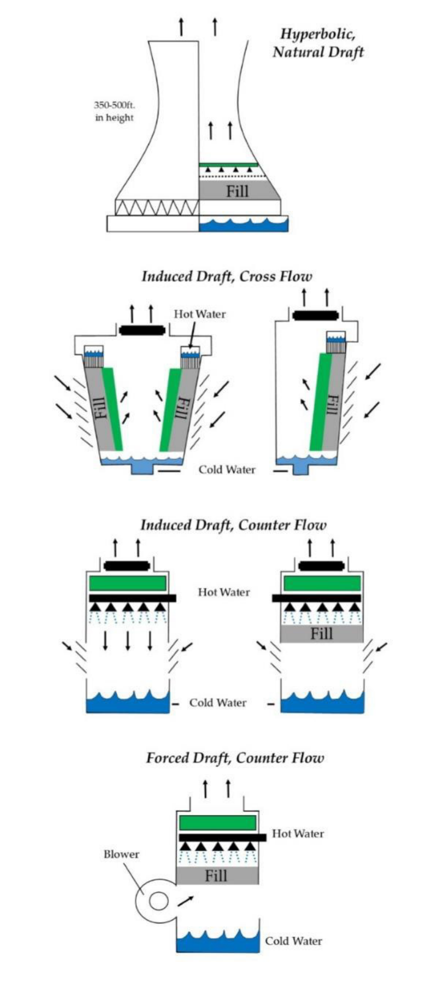
- **Organic Fouling**

  Mud, sand, silt, clay, biological matter and even oil can enter the system through its makeup supply or from the air. These suspended materials can accumulate and settle in the system, blocking flow and reducing efficiency. Oil film can reduce heat transfer and encourage the growth of microorganisms.

Term	Description
Blowdown	Is a portion of the concentrated cooling tower water intentionally discharged from the cooling tower to maintain an acceptable water quality in the cooling tower.
Cycle of Concentration	Is the number of times the solids content of the cooling water is increased in multiples of itself, such as twofold, threefold, etc.
Drift	Is small water droplets that are emitted from cooling towers. As air moves up the tower, it entrains a fraction of the sprayed water droplets outside of tower and into the ambient.
Drift Eliminators	Are used to reduce the loss of water and emissions. Above the water distribution and the cooling fills, a layer of drift eliminators is installed for this purpose. It catches the water drops which are carried away with the air flow and redirects them into the cooling water circuit.
Evaporation	As air passes through a cooling tower, it induces evaporation. For water to evaporate it must consume a large amount of energy to change state from a liquid to a gas. This is known as latent heat of vaporization, which at atmospheric conditions is typically around 2326 kJ/kg.
Fan	Cooling tower fans must move large volumes of air efficiently, and with minimum vibration. The materials of manufacture must not only be compatible with their design, but must also be capable of withstanding the corrosive effects of the environment in which the fans are required to operate.
Fill	Fill, or wet deck or surface, is a medium used in cooling towers to increase the surface area of the tower. This enlarged surface area allows for utmost contact between the air and the water, which allowing greater evaporation rates. The fill section is the heart of any cooling tower. Sometimes called packing, filling, or baffles, this is the area where water and air mix to achieve the cooling effect. A cooling tower can only perform if the Cooling Tower Fill Material is in good condition, providing the greatest possible heat transfer surface.
Inlet Louvre	Are not only hold back unwanted elements (e.g. leaves) but also prevent water splash-out which can cause icing and loss of expensive water and treatment chemicals. Moreover, an inlet louvre restricts the amount of sunlight entering the cooling tower thereby impeding algae growth.
Makeup Water	Is the new water added to compensate for the volume of water lost through evaporation, blowdown, and other water losses.
Spray Nozzle	Are nozzles that direct the hot water in need of cooling to the tower fill. These provide the water sprays to wet the fill. Uniform water distribution at the top of the fill is essential to achieve proper wetting of the entire fill surface. Nozzles can either be fixed in place and have either round or square spray patterns, or can be part of a rotating assembly as found in some circular cross-section towers. Cooling tower nozzles disperse water across the heat exchanger. They are usually made of PVC, glass or ceramic. Some nozzles are high-temperature resistant and have a non-clogging design. Cooling tower nozzles come in both cross flow and counter flow designs.

Cooling towers use large amounts of water and are excellent opportunities to conserve water.

TYPES OF COOLING TOWERS



OPERATION OF COOLING TOWERS

Before effective treatment can be provided, a thorough assessment of conditions in your cooling water system must be made. Experienced field engineers backed by laboratory resources can audit your system, perform accurate tests to measure water quality and troubleshoot problems. The assessment should look at:

- Condition of cooling tower surfaces (water basin & casing)
- Louvers (for wear and tear)
- Cooling water distribution from the nozzles
- Condition of tubes on evaporative condensers
- Condition of drift eliminators
- Condition of cooling tower fans
- Make-up water valve
- Make-up water meter
- Side stream filtration
- Make-up water quality
- Recirculation water quality

To control scale, corrosion, microbiological fouling, and foam, water quality must be maintained at all times, and the right microbicides must be applied in just the right doses. That takes a delicate balance of chemistries and application expertise. Table 1 below is a list of our specially formulated chemicals for cooling towers.



Table 1

Chemical Name	Area of Use	Description	Purpose	Composition	Use Concentration
Aquatech CT420	Cooling Towers and Humidifiers	Antiscalant	Controls scale formation and corrosion in cooling systems.	Phosphonate blend	20 - 30 ppm
Aquatech CT920		Scale Inhibitor	Slows or prevents the formation of scale from blocking or hindering fluid flow through pipelines, valves, and pumps.	Phosphonate blend	20 - 30 ppm
Aquatech CT261		Biodispersant	Eliminates oil, silt and other contaminants to allow for better surface treatment.	Dioctyl Sodium Sulfosuccinate	-
Aquatech BC110		Primary biocide	For prevention of micro and biofilm growth.	Isothiazolene-based	-
Aquatech BC735		Alternative biocide	For prevention of micro and biofilm growth.	Quaternary ammonium compound & BIS (TRIBUTYLTIN) OXIDE	-

The more control you have over your cooling water treatment program, the better you can control fouling, plant efficiency and costs. By continuously monitoring key parameters the performance of your cooling tower can be better understood and therefore controlled. The recommending monitoring of a cooling tower is shown in Table 2 below.



Table 2

Recommended Monitoring Schedule		
• Visually inspect the equipment to verify that it is working properly. • Check to see if additive chemical supply is adequate. • Investigate any system anomalies or changes since the last inspection.		
Daily	**Monthly**	**Other**
Record the daily volumes of makeup and blowdown water. (During the winter, volumes should be checked and recorded at least weekly.) Significant variations in daily flow may give early warning of system malfunctions.	Inspect the system, checking for proper equipment function and physical evidence of corrosion.	Determine scaling and suspended solids when opening chiller tubes or other heated surfaces of heat exchangers.
Check conditioning chemical dosage.	Check corrosion rate.	Corrosion rates should be checked quarterly using corrosion coupons, corrosion rate meters, or other monitoring devices. The coupons are also examined after cleaning for pitting or localized attack.
Check pH, temperature, and conductivity. Significant variation from normal values may indicate malfunctions or need for additive feed rate adjustment.	Check water velocity in system piping.	Examine any opened piping or strainers.
Perform chemical and biological testing on cooling system water. Compare results to the values in Table 4.	-	Replace heat exchangers and piping on an as-needed basis.
Inspect surfaces contacted by cooling waters for deposits and algae.	-	-
Clean heat exchanger surfaces on a daily basis to minimize buildup of anaerobic microorganisms. "Air Rumble" heat exchangers with compressed air to remove biological film.	-	-

To monitor your cooling tower effectively you need to have the right tools Table 3 outlines the parameters that can be easily tested and the recommended instruments that can be used.

Table 3

The recommended instrumentation needed for monitoring cooling tower performance		
*The samples to be tested must be taken from the basin of the cooling tower		
Measurement	**Purpose**	**Instrument**
pH	Increasing cooling system pH has two key effects on system performance: (1) decreases metal corrosion rates and (2) increases potential scaling due to increasing supersaturation of scaling salts (e.g., calcium carbonate, calcium phosphate, and calcium phosphonates). It is therefore important to ensure the pH is within the advised range.	Hanna Combo pH & EC (measures pH, electro-conductivity (EC), total dissolved solids (TDS), and temperature).
Temperature	The temperature of the water in the basin indicates the performance of the cooling tower. Increases in temperature (over and above the ambient temperature changes) indicate a decline in performance of the cooling tower. Sudden and severe changes in temperature indicate an issue in the system.	
Conductivity (TDS)	Indicates the cycles of concentration in the cooling tower. If the conductivity increases above the suppliers recommended limits the water should be blowdown and topped up with fresh water.	
Phosphate	The phosphate level in the water indicates the amount of residual antiscalant is present in the water. Low levels of residual phosphates mean more antiscalant is required. High levels of residual phosphates indicate over dosing of antiscalant.	Hanna HI706 Checker HC ® - Phosphorous (Fresh Water), HR.
Iron	Controlling the quantity of iron in the cooling system is essential in preventing iron oxide fouling. Measuring iron contact can also indicate if the system has any corrosion issues.	Hanna HI721 | Iron Checker HC® Colorimeter (0.00 to 5.00 ppm) mg/L.
Chlorine	Chlorine frequently is used as a cooling tower biocide because it is cost effective and controls bacteria counts in bulk water. However, chlorine also is corrosive to metals because it is highly oxidizing, and it has additional problems such as causing vapor lock and quickly degrading. In order to control corrosion, it is important to keep free chlorine concentration below 0.3 ppm to minimize this corrosive effect of chlorine.	Hanna HI721 | Iron Checker HC® Colorimeter (0.00 to 5.00 ppm) mg/L.
T-Hardness	Water hardness is caused almost entirely by calcium and magnesium ion. Other di- and trivalent metals have a similar effect, but usually are not present in high enough concentration in potable waters to cause problems. Hardness causes scale in cooling towers.	Hach Total hardness test kit, model 5-EP.

TROUBLE SHOOTING FOR COOLING TOWERS

Table 4

Diagnostic Indicators for Cooling Systems		
Indicator	**Possible Problem**	**Possible Solution**
Metals: • Copper > 0.25mg/l • Iron > 1.0 mg/l • Zinc > 0.5 mg/l OR Measured corrosion rate: • Copper > 0.2 MPY • Mild Steel Piping > 3 MPY • Mild steel Hx tubing > 0.5 MPY • Galvanised steel > 4 MPY	• High corrosion rate. • Inadequate chemical dosage control. • Use of conditioning chemicals containing copper or zinc.	• Improve corrosion protection through use of an additive or by other means. • Improve additive dosage control and/or monitoring. • Eliminate use of additives containing copper or zinc. • Consider replacing copper components or piping.
Additives: Chlorine > 0.5 mg/l Ozone >0.2 mg/l	Overuse of these oxidizing chemicals • Leads to high corrosion rates.	• Reduce or stabilize additive dosage. • Improve monitoring. • Install an automatic conductivity probe controlled oxidizing agent feed system.
Carbon dioxide > 5 mg/l	Copper oxide protection is inhibited.	• Raise pH.
pH < 7.0	Inadequate pH control.	• Implement pH control. • Check dosage of low-pH additives.
Water velocity: > 1 m/sec @ > 65°C > 1.5 m/sec @ 50°C > 2.5 m/sec @ < 32°C	Leaks or system failure • High rate of corrosion of copper piping; could cause leaks or system failure.	• Reduce recirculation rate. • Increase line size. • Replace copper elements with nonmetallic parts or other noncopper parts.
Conductivity outside the manufacturer's recommended range.	System operation not optimized • Possible misuse of additives. • Improper blowdown rate.	Investigate: • System settings. • Chemical dosing rates. • Blowdown system operation.
Conductivity outside the manufacturer's recommended range.	The heat load to the system has greatly increased. • Possible massive system leak.	• Check if additional heat load has been added on the system today. • Check the system for leaks. Inspect sanitary sewer and storm sewer manholes on site for unusually high flows.

BOILERS

What is a Boiler?

A boiler is an enclosed vessel that provides a means for combustion and transfers heat to water until it becomes hot water or steam. The hot water or steam under pressure is then usable for transferring the heat to a process.

Water is useful and cheap medium for transferring heat to a process. When water is boiled into steam its volume increases about 1,600 times, producing a force that is almost as explosive as gunpowder. This causes the boiler to be extremely dangerous equipment and should be treated carefully.

Liquid when heated up to the gaseous state this process is called evaporation.

The heating surface is any part of the boiler; hot gases of combustion are on one side and water on the other. Any part of the boiler metal that actually contributes to making steam is heating surface. The amount of heating surface of a boiler is expressed in square meters. The larger the heating surface a boiler has, the more efficient it becomes.

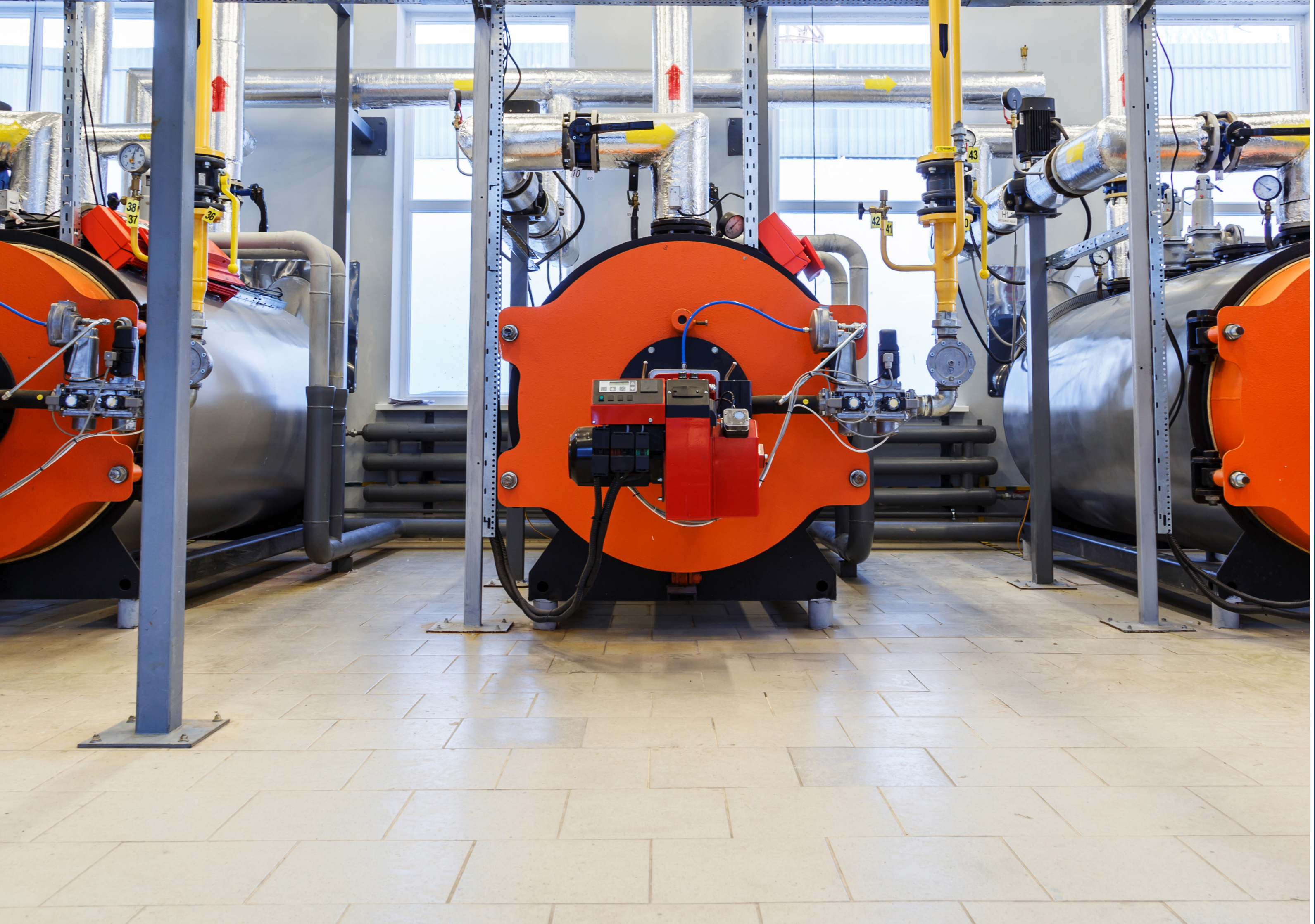
The boiler system is made up of:

1. Feed water system
2. Steam system
3. Fuel system

The feed water system provides water to the boiler and regulates it automatically to meet the steam demand. The water supplied to boiler that is converted to steam is called feed water. The sources of feed water are:

1. Condensate or condensed steam returned from the processes
2. Makeup water which is the raw water which must come from outside the boiler room and plant processes.

The steam system collects and controls the steam produced in the boiler. Steam is directed through a piping system to the point of use. Throughout the system, steam pressure is regulated using valves and checked with steam pressure gauges.



The fuel system includes all equipment used to provide fuel to generate the necessary heat. The equipment required in the fuel system depend on the type of fuel used in the system.

How does it Work

Whether it's an industrial hot water boiler or an industrial steam boiler, they all depend on fuel to run. The process of heating is initiated as the burner heats or eventually evaporates the waer inside of it. It's actually transported via intricate pipe systems.

Steam boilers transport through the pressure created by the process, while hot water boilers use pumps to move heat throughout the system. Eventually the condensed steam or cooled water returns back through the pipes to the boiler system, so the heating process can be initiated again.

As the boiler creates heat energy, a byproduct of the process — flue gases — are exited through a chimney system. Because of this, regulating the industrial boiler emissions is a very serious issue.

BOILER TERMS

Table 5

Term	Description
Blowdown	Boiler blowdown is water intentionally wasted from a boiler to avoid concentration of impurities during continuing evaporation of steam. The water is blown out of the boiler with some force by steam or water pressure within the boiler.
Burner	The burner is the key equipment component for combustion control systems, providing the heat required for a boiler to convert water into steam. Ideally, a burner should achieve the highest degree of combustion efficiency with the lowest possible excess air.
Condensate	Steam that has been condensed back into water by either raising its pressure or lowering its temperature. Not to be confused with demineralized, de-ionized, make up, or softened water. When the condensate enters the boiler feed pump additional chemicals are added and the product is now called boiler feed water.
Condensate return	This is water that has converted back into water from steam along the heating process that is then sent back to the boiler. This water still contains quite a lot of heat energy as well as boiler treatment chemicals and therefore can make the boiler more economical when condensate is reused instead of being sent to drain. With high energy costs, you must return as much condensate as possible to the boiler plant for reuse. The benchmark for optimal condensate return is as high as 90%. This is possible if the plant doesn't use direct steam injection for process applications.
Cycle of Concentration	Refers to the accumulation of impurities in the boiler water.

TYPES OF BOILERS

With the classification of hot water and steam boilers, there are a vast range of different types of boilers.

1. Firetube Boilers may be a valued solution for facilities with low-pressure steam applications, high-pressure steam applications, or hot water applications. Firetube boilers are often used for applications ranging from 51 up to 2,200 HP.
2. Watertube boilers produce steam or hot water for commercial or industrial applications. Watertube boilers are used significantly for comfort heating applications and typically have BTU inputs ranging from 500,000 to more than 20,000,000.
3. Industrial watertube boilers are primarily steam boilers utilized for applications that require higher pressures and large amounts of steam. Industrial watertube boilers boast the ability to provide additional heat via superheaters.
4. Commercial boilers are some of the most diverse and can be designed with a firetube, small water tube, electric resistance. Commercial boilers boast efficiencies as high as 99%.

5. Condensing boilers are commonly fueled by gas or oil and are engineered to achieve thermal efficiencies up to 98%.
6. Electric boilers are most commonly associated with being compact, clean, easy to install and quiet. Electric boilers do not have combustion considerations, which means they have minimal complexity.

OPERATION OF BOILERS

Before effective treatment can be provided, a thorough assessment of conditions in your system system must be made. Experienced field engineers backed by laboratory resources can audit your system, perform accurate tests to measure water quality and troubleshoot problems.

The assessment should look at:

- Condition of water softeners (water & steam boilers)
- Condition of hot wells in steam boilers
- Make-up water meter
- Condition of boiler unit and associated piping (wear and tear)

To control scale and corrosion water quality must be maintained at all times. That takes a delicate balance of chemistries and application expertise. Table 6 below is a list of our specially formulated chemicals for cooling towers.



Table 6

Chemical Name	Area of Use	Description	Purpose	Composition	Use Concentration
Aquatech CT325	Cold Closed Loop Circuits	Corrosion inhibitor	Forms a protective gamma iron oxide film on a metal surface, which protects the metal surface from corrosive attack.	Sodium nitrite-based blend	300 - 1000 ppm
Aquatech BT125	Steam Boilers	Boiler Water Oxygen Scavenger	Removes dissolved oxygen from the boiler feed water and boilers. Dissolved oxygen in the boiler is very corrosive at higher temperatures and pressures.	Sodium Bisulfite	-
Aquatech BT955		Boiler water scale inhibitor	Control scale in boilers (phosphate compounds react with any remaining hard water compounds to create a soft sludge that is eliminated through blowdown.	Phosphate blend	30 - 50 ppm
Aquatech BT730		Boiler water scale and corrosion inhibitor	Combination of hardness removal and oxygen scavenger.	Phosphate and sulphite blend	30 - 50 ppm

The more control you have over your heating water treatment program, the better you can control fouling, plant efficiency and costs. By continuously monitoring key parameters the performance of your boilers can be better understood and therefore controlled. The recommending monitoring of a cooling tower is shown in Table 7 below.

Table 7

<table>
<tr><th colspan="3">Recommended Monitoring Schedule</th></tr>
<tr><td colspan="3">• Visually inspect the equipment to verify that it is working properly.
• Check to see if additive chemical supply is adequate.
• Investigate any system anomalies or changes since the last inspection.</td></tr>
<tr><th>Daily</th><th>Monthly</th><th>Other</th></tr>
<tr><td>Record the daily volumes of makeup and blowdown water. (During the winter, volumes should be checked and recorded at least weekly.) Significant variations in daily flow may give early warning of system malfunctions.</td><td>Inspect the system, checking for proper equipment function and physical evidence of corrosion.</td><td>Determine scaling and suspended solids when opening chiller tubes or other heated surfaces of heat exchangers.</td></tr>
<tr><td>Check conditioning chemical dosage.</td><td>Check corrosion rate.</td><td>Corrosion rates should be checked quarterly using corrosion coupons, corrosion rate meters, or other monitoring devices. The coupons are also examined after cleaning for pitting or localized attack.</td></tr>
<tr><td>Check pH, temperature, and conductivity. Significant variation from normal values may indicate malfunctions or need for additive feed rate adjustment.</td><td>Check water velocity in system piping.</td><td>Examine any opened piping or strainers.</td></tr>
<tr><td>-</td><td>-</td><td>Replace steam injectors, heat exchangers and piping on an as-needed basis.</td></tr>
</table>

To monitor boilers effectively it is important to have the right instruments as shown in Table 8.

Table 8

The recommended instrumentation needed for monitoring cooling tower performance		
*The samples to be tested must be taken from the basin of the cooling tower		
Measurement	**Purpose**	**Instrument**
pH	Increasing cooling system pH has two key effects on system performance: (1) decreases metal corrosion rates and (2) increases potential scaling due to increasing supersaturation of scaling salts (e.g., calcium carbonate, calcium phosphate, and calcium phosphonates). It is therefore important to ensure the pH is within the advised range.	Hanna Combo pH & EC (measures pH, electro-conductivity (EC), total dissolved solids (TDS), and temperature)
Temperature	The temperature of the water in the basin indicates the performance of the cooling tower. Increases in temperature (over and above the ambient temperature changes) indicate a decline in performance of the cooling tower. Sudden and severe changes in temperature indicate an issue in the system.	
Conductivity (TDS)	Indicates the cycles of concentration in the cooling tower. If the conductivity increases above the suppliers recommended limits the water should be blowdown and topped up with fresh water.	
Phosphate	The phosphate level in the water indicates the amount of residual antiscalant is present in the water. Low levels of residual phosphates mean more antiscalant is required. High levels of residual phosphates indicate over dosing of antiscalant.	Hanna HI706 Checker HC ® - Phosphorous (Fresh Water), HR
Iron	Controlling the quantity of iron in the cooling system is essential in preventing iron oxide fouling. Measuring iron contact can also indicate if the system has any corrosion issues.	Hanna HI721 | Iron Checker HC® Colorimeter (0.00 to 5.00 ppm) mg/L
Chlorine	Chlorine frequently is used as a cooling tower biocide because it is cost effective and controls bacteria counts in bulk water. However, chlorine also is corrosive to metals because it is highly oxidizing, and it has additional problems such as causing vapor lock and quickly degrading. In order to control corrosion, it is important to keep free chlorine concentration below 0.3 ppm to minimize this corrosive effect of chlorine.	NutroChem Free Chlorine Test Kit or Hanna HI701 Free Chlorine Checker
T-Hardness	Water hardness is caused almost entirely by calcium and magnesium ion. Other di- and trivalent metals have a similar effect, but usually are not present in high enough concentration in potable waters to cause problems. Hardness causes scale in cooling towers.	Checked with NutroChem Hardness Test Kit

TROUBLE SHOOTING FOR BOILERS

Table 9

Diagnostic Indicators for Cooling Systems		
Indicator	**Possible Problem**	**Possible Solution**
Corrosion or Leaks in the Pipes	• Oxygen damage: Pitting over a localized or widespread area in portions of the boiler carrying hot water indicate this type of damage. • Acid damage: When the pH of the water is too low, the water is acidic. Without neutralizing the acid, it will cause overall thinning of the metal inside a boiler. • Caustic corrosion: At the other end of the pH spectrum is damage caused by water that is too basic or has too high of a pH. Typically, this type of damage occurs under scale deposits where the water can boil. This type of damage often causes an irregular gouging pattern.	• Correcting the water to prevent scale, reduce dissolved oxygen and raise low pH can protect against future corrosion and boiler failure. Consulting with professionals in providing you with a clean boiler system can prevent corrosion and subsequent leaks, as well.
Scale or Sludge Buildup in the Boiler also presents as a decrease in boiler performance	• To treat scale or sludge buildup in the boiler, you must consider your water composition.	• Both the makeup water and return line water need chemical treatment. Both issues will cause problems with increased water pressure or reduced flow. Plus, they prevent efficient heating of the boiler. • For severe problems, you will likely need to drain and clean the system. Then, start with properly treated and filtered water. • Scale prevention chemicals will also stop sludge from depositing inside the boiler. Therefore, ask your water experts about how to protect your boiler from scale and sludge with future use.
Boiler Tank Water Foaming	• Caused by high concentrations of any solids in the boiler water bubble to form as air is entrained.	• As with other boiler problems, clean the boiler of any contamination caused by foaming before correcting the water chemistry problem. Treating the water with anti-foaming agents prevents the chain reaction caused by foam production. The chemicals alter the surface tension to prevent any solids from creating foam in the water.

EFFECT OF WATER QUALITY ON HEATING AND COOLING SYSTEMS

Possible Problem	Possible Solution
Hardness (A measure of the combined calcium and magnesium concentrations)	Although both can contribute to scale, calcium is particularly troublesome because certain calcium salts exhibit an inverse solubility in water. Magnesium is usually not as much of a problem unless the silica levels are also high. This could result in magnesium silicate scale in the heat exchangers or boilers. Unlike most salts in solution, which become more soluble with increasing temperature, calcium carbonate becomes less soluble with increasing temperature
Alkalinity (Alkalinity is a measure of water's ability to neutralize acids.)	Bicarbonates normally represent the major portion of the measured alkalinity, although under certain conditions, appreciable amounts of carbonate and hydroxide alkalinity may also be present. Alkalinity is an important means of predicting calcium carbonate scale potential.
Silica	Can produce difficult-to-remove scale deposits. Pretreatment or sidestream filtration is often required if the silica levels are above 150 ppm (as SiO_2).
Total Suspended Solids (TSS) (Consists of undissolved material such as silt, sand, fine clay, and vegetation.)	Unlike dissolved solids, not all suspended solids enter the cooling system with the makeup water. Some might be generated as corrosion and scale byproducts or from air/water contact. Suspended solids can adhere to biofilms and cause under-deposit corrosion. TSS can be controlled through pretreatment, sidestream filtration or through use of deposit control agents.
Ammonia	An ideal nutrient for many microorganisms, it can promote biofilm development and growth in the heat exchangers and cooling tower fill. It is also extremely corrosive to copper alloys (even those well passivated with chemicals). There have been documented cases of stress corrosion cracking in copper alloys from ammonia concentrations as low as 2.0 ppm. Ammonia also can combine with chloride to form chloramines that are one tenth the effectiveness of free chlorine residual. Chloroamines are also quite volatile and are stripped from the water as it passes the tower, negating any disinfecting affect. Ammonia also can reduce or negate some non-oxidizing biocides such as glutaraldehyde. (Bromine is a more cost-effective biocide than chlorine if ammonia is present.)

Possible Problem	Possible Solution
Phosphate	An ideal nutrient for many microorganisms, it can promote biofilm development and growth in the heat exchangers and cooling tower fill. It is also extremely corrosive to copper alloys (even those well passivated with chemicals). There have been documented cases of stress corrosion cracking in copper alloys from ammonia concentrations as low as 2.0 ppm. Ammonia also can combine with chloride to form chloramines that are one tenth the effectiveness of free chlorine residual. Chloroamines are also quite volatile and are stripped from the water as it passes the tower, negating any disinfecting affect. Ammonia also can reduce or negate some non-oxidizing biocides such as glutaraldehyde. (Bromine is a more cost-effective biocide than chlorine if ammonia is present.)
Chloride	Can be corrosive to most metals, especially mild steel. A chloride limit of 300 ppm is often used for stainless steel, but limits for other metals may go as high as 1,000 ppm.
Iron	May be a concern if it combines with phosphate to form undesirable foulants. It may also deactivate specialized polymers used to inhibit calcium phosphate scaling. Recycled water may have a high concentration at 0.12 to 0.32 of iron. Specialized treatment of iron is expected to be required for this concentration.
Biological Oxygen Demand (BOD)	Reflects the organic content for biological organisms and the associated demand for oxidizing biocide in addition to the amount used for bio fouling control.
Nitrates and Nitrites	Can provide additional mild steel corrosion control at levels above 300 mg/l in the concentrated cooling water. Can contribute to reductions in stainless steel cracking and pitting erosion. Nitrates do not attack copper alloys or protect them from corrosion.
Zinc	Can assist phosphates and nitrates in reducing mild steel corrosion rates and pitting tendencies. Levels in cooling water above 0.5 mg/l are beneficial, but levels above 3.0 mg/l can contribute to deposits.
Organics	Can act literally as fertilizer for microorganisms. Water-soluble cationic polymers can react with some anionic treatment biocides, as well as some scale and corrosion inhibitors.
Fluoride	At 10 ppm or more can combine with calcium to cause scale formation.
Heavy Metals (e.g. Cu, Ni, and Pb)	Copper and nickel can plate out on steel, causing localized galvanic corrosion that can rapidly penetrate thin steel heat exchanger tubes.

CONTACT US

For more information, please do not hesitate to contact us.

Geoff Bayman
C: +27 (0)83 263 8945 | E: geoff@nutrochem.co.za

Johan Herholdt
C: +27 (0)82 378 3334 | E: johan@nutrochem.co.za

Hercules Barnardt
C: +27 (0)73 286 3267 | E: hercules@nutrochem.co.za

Hentie Nel
C: +27 (0)82 810 5419 | E: hentie@nutrochem.co.za

nutrochem™

Waar Kwaliteit en Diens ontmoet • Where Quality and Service meet