COOL TUNES

Run an Efficient Cooling Tower (v 1.0)

Water Smart Technology Program

Seattle Public Utilities

Resource Venture

Saving Water Partnership
Seattle and Participating Local Water Utilities

How to Use This Manual

How to Use This Manual

Increased cooling tower efficiency reduces your use of water, energy, and water treatment chemicals and extends the life of your equipment. The purpose of this manual is to help you operate your cooling tower efficiently and reduce your operating costs.

The first section of this manual is a primer on cooling tower mechanics and the types of towers to choose from. With a focus on water conservation, the first half of the manual describes the ways that water is lost from a cooling tower and the need to balance continuous water recirculation with the associated increased risks of corrosion, scaling, and biological growth. The second section of the manual provides direction on the types of monitoring that help to improve system efficiency. This includes monitoring water use and quality. The third section lists maintenance and capital upgrades that lead to increases in water and energy efficiency. The final section is a series of checklists that will prompt building operators to schedule daily, weekly, monthly, quarterly/semi-annual, or annual maintenance inspections.

Contents

Monitoring Your System

5. Monitoring Water Use

6. Monitoring Water Quality

- Conductivity
- Corrosion (coupons or probes)
- pH
- Calcium, Magnesium, and Silica
- Biological Activity

Improving the Efficiency of Your System

8. Water Conservation Opportunities

- High Efficiency Chemical Treatment
- Non-Chemical Treatment
- Monitoring Water Levels
- Reducing Blowdown
- Sidestream Filtration
- Alternative Sources of Makeup Water
- Hybrid Cooling Towers
- Alternatives to Cooling Towers
- Calculating Savings

Maintaining Your System

10. Using a Maintenance Checklist

- Moderate to High Frequency Tasks
    - Water Conservation
    - Energy Efficiency
    - General
- Moderate to Low Frequency Tasks
    - Water Conservation
    - Energy Conservation
    - General
- Off-Season Tasks
- Seasonal Shut-down Tasks
- Seasonal Start-up Tasks
- After the System has been Energized

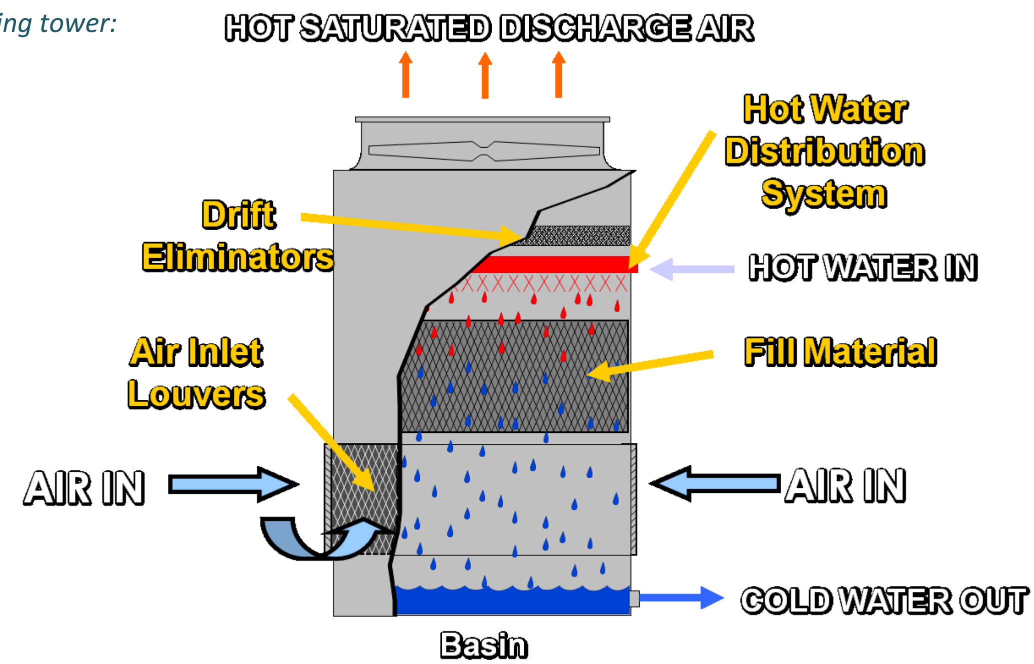
Understanding Your System

Understanding Your System

How a Cooling Tower Works

Heating, cooling, and ventilation (HVAC) consume large amounts of water in industrial plants, office buildings, grocery stores, commercial and retail centers, hospitals, and other facilities. Cooling towers account for between 21 percent (commercial and retail centers) and 49 percent (grocery stores) of water consumption in these buildings.[1] The purpose of a cooling tower is to reject thermal energy (heat) using the evaporation of water as the heat-transfer mechanism. Thermal energy generated by electrical, industrial, and electronic equipment and lighting is generally transferred to a cooling water loop circulating between the building spaces and the chiller (large heat pump). A second loop carries heat rejected from the chiller to the cooling tower which transfers the heat to air through sensible (convective) and latent (evaporative) heat exchange processes. As this thermal energy transfer occurs, the water is cooled and is returned to the equipment to begin the process again; this is known as a recirculating water system.

Typical cooling tower:



Thermal energy (heat) transfer can only occur if there is a difference in temperature between two mediums. Efficient thermal energy transfer also requires that the heat transfer surface be maximized.

[1] West Bay Municipal Utility District, 2008. Watersmart Guidebook: A water-use efficiency plan review guide for new businesses.

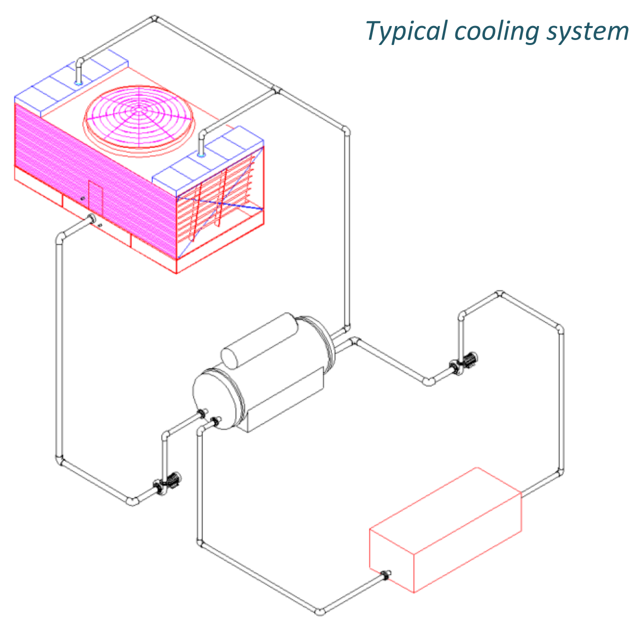
Cooling towers are designed to take advantage of these facts – they maximize contact between the warm recirculating water sprayed onto rough media ("fill") or finned heat exchangers and cool air flowing through the cooling tower. This maximizes the transfer of thermal energy in the water to the air.

Thermal energy transfer occurs through two primary means: sensible and latent. Sensible heat is heat you can feel and measure with an ordinary thermometer. Water that enters a heat exchanger at 80 degrees Fahrenheit (^{o}F) and leaves at 75 ^{o}F has given up 5 degrees sensible heat.

Latent heat is experienced when a substance goes through a change of state without a change in temperature. When water boiling at 212 ^{o}F changes from water to steam, we refer to this as a "change of state." The temperature stays a constant 212 degrees during this change of state.

Thermal energy content is measured in British Thermal Units (BTU). One BTU is the amount of energy required to raise the temperature of one pound of water by one degree F. The cooling capability of a cooling tower is generally rated in terms of "tons of cooling." One ton of cooling capacity is defined as the ability to transfer 12,000 BTUs per hour. [2]

Typical cooling system



During sensible heat transfer, adding one BTU of thermal energy to one pound of water will raise the water temperature one ^{o}F. Likewise lowering the temperature of one pound of water one degree requires giving up one BTU of thermal energy. This is the thermal heat rejection method involved in single pass cooling, where warmed cooling water is sent directly to drain, rather than being recirculated, and is in effect, a much less water efficient method.

Significantly more thermal energy is transferred per pound (or gallon) of water when a substance goes through a change of state (i.e., the latent heat process). It requires approximately 970 BTUs of thermal energy to change one pound of water to one pound of steam. Likewise, removing 970 BTUs of thermal energy from one pound of steam will change it to one pound of water. In other words, there is significantly greater thermal energy transfer per lb of water

[2] The cooling load seen by the tower is usually greater than that seen by the space. This is because additional amount of waste heat is generated by the refrigeration compressors that require rejection at the tower. The cooling tower industry therefore often uses a value of 15,000 BTUs as a "cooling tower ton".

consumed when water goes from liquid to a vapor rather than just being heated a few degrees and sent directly to drain. Cooling towers with recirculating water loops make use of latent heat transfer and are a smart conservation choice as opposed to single pass cooling. This is especially true because evaporative processes can achieve lower temperatures than sensible processes since the effective temperature difference the process "sees" is to the ambient wet bulb temperature and not the warmer dry bulb temperature to which sensible processes work.[3] As always, routine maintenance and checks increases cooling tower operating efficiency and may help reduce costs.

Cooling Towers: Types, Materials, and Other Variables

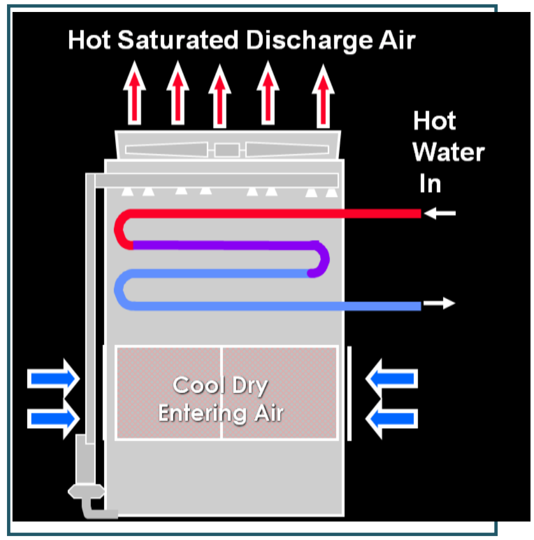
Open vs. Closed-Circuit Towers

One of the primary differentiations between cooling towers is whether it is an open or closed-circuit tower. In open towers, the cooling water is pumped through the equipment where it picks up thermal energy and then flows directly to the cooling tower where it is dispersed through spray nozzles over the fill, where heat transfer occurs. Then, this same water is collected in the tower sump and is sent back to the equipment to begin the process again. In an open tower any contaminants in the water are circulated through the equipment being cooled.

In a closed-circuit tower, sometimes referred to as a fluid cooler, the cooling water flows through the equipment as in the open tower. The difference is when the water is pumped to the cooling tower, it is pumped through a closed loop heat exchanger that is internal to the cooling tower, then returned to the equipment. In this application, water in the closed loop is not in direct contact with the evaporative water in the tower, which means contaminants are not circulated through the equipment. In a closed-circuit tower, a small pump, known as a "spray pump" circulates a separate body of evaporative water from the tower sump, through the spray nozzles and over the internal heat exchanger piping. This "open" evaporative body of water is contained within the tower and needs to be regularly made up to replenish evaporative and other losses. However, once water treatment in the closed cooling loop is stabilized, the only time it needs to be made up or adjusted is if there is a leak.

[3] Wet bulb temperature: The thermodynamic wet-bulb temperature is the minimum temperature which may be achieved by purely evaporative cooling of a water-wetted thermometer.
Dry bulb temperature: The temperature measured by a regular thermometer.

Direct Expansion Fluid Coolers



A Direct Expansion (DX) Fluid Cooler is special type of closed tower in which refrigerant from a DX system, is circulated through the heat exchanger coils within the tower, instead of water. These units are known as evaporative condensers, although they have limited applications. A DX Fluid Cooler can generally serve only a single piece of refrigeration equipment to which it must be relatively closely located. This avoids long runs of refrigerant piping, which are unable to maintain the required pressure for the refrigerant. For these reasons there are limited applications for this type of cooler.

Hybrid Towers

Hybrid towers are closed towers which can operate either in the sensible heat transfer mode only (without evaporation) or a combination of sensible and latent heat transfer (with evaporation). During periods of low load and/or low ambient temperature, the spray of water is stopped and heat is sensibly transferred to the flow of air across the fins of the coils containing the cooling fluid. During periods when this is not enough, a latent heat transfer system is activated by switching on an evaporative cooler or water is sprayed across the dry coils to allow for increased heat transfer through evaporation. These processes offer substantial savings in water.

Construction Materials

The life of a cooling tower can be extended if the optimal construction materials are selected. Galvanized steel is the most common material used for cooling towers. These towers are relatively sturdy and inexpensive and come in a wide variety of sizes and configurations. However, galvanized steel is vulnerable to eventual corrosion. Many of these towers may be ordered in stainless steel, although this is substantially more expensive. A more cost-effective option is to install a stainless steel sump while maintaining the rest of the tower in galvanized steel. This assembly reduces the probability of expensive leaks and associated water damage over time. Some tower manufacturers also offer towers with special protective coatings which may increase tower life. Contact your cooling tower vendor for more information on protective coatings offered. If your tower is being refurbished, special coatings can also be applied at this time.

Plastic, fiberglass, and concrete are able to withstand corrosion better than galvanized towers, but may not be applicable for many situations. Concrete is used only for very large towers. Plastic and fiberglass are generally used for small towers where weight may be an issue, but these materials do not have the structural strength necessary for moderate to large towers.

Other Variables (Fan Type, etc.)

Other variables in tower construction include type of fan or blower (forced draft with the fan at the air inlet, or induced draft with the fan at the air outlet), and the configuration of the airflow (counterflow or crossflow). More efficient fans with lower noise ratings are also available. Different types of fill are available and are used for a variety of different situations, including for gray water applications.

Water Losses in Cooling Towers

Evaporation

As outlined earlier, water and air are the primary cooling agents in a cooling tower. As water is evaporated through the heat transfer process, additional water, known as make-up water, is added to the tower to replace it. The quantity of water evaporated is generally dictated by the load, (i.e., the amount of heat to be transferred). Water lost through evaporation can be reduced by decreasing the cooling load requirements of the building. A rule of thumb is that evaporation loss from a cooling tower will equal approximately 3 gallons per minute (gpm) per 100 tons of cooling.

Blowdown

Blowdown, also known as bleed, removes a portion of the recirculating water from the cooling tower. Water naturally contains dissolved minerals. As water evaporates and recirculates in the system, those dissolved minerals are concentrated in this water. Blowdown, therefore, is important because it prevents the buildup of these minerals in solid form (“scale”) on heat transfer surfaces. Scale acts as an insulator and quickly reduces the rate at which the tower can reject heat. Unfortunately, many system operators seeking to guard against scaling may release too much water via blowdown. Excessive blowdown may lead to reduced pH and a corresponding higher corrosion potential, along with higher water bills.

Other Losses : Stuck Float Valves and Drift

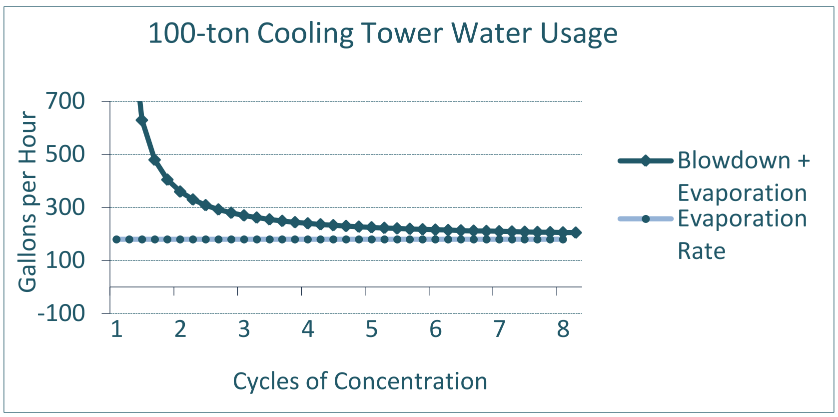
A significant source of water loss often comes from overflows due to stuck or poorly-adjusted fill valves. Float valves located within the cooling tower are also subject to choppiness in the water due to air flows, which can cause them to overflow and/or malfunction.It is recommended that ballcock style (float on a rod) fill valves be replaced with solenoid operated valves using an external level sensor. Check valves may also be installed to keep sumps from overfilling when the pump shuts off.

Drift is defined as water droplets which leave the tower with the exhausted air. In an effort to minimize this water loss, cooling towers are often fitted with drift eliminators. These drift eliminators are installed at the top of the cooling tower. As the air blows through the drift eliminators, any water mixed with the air collects on them and falls by gravity back into the tower. Water lost to drift is usually not significant, especially if it is less than that required to be bled off to maintain concentrations of dissolved solids below some maximum.[4] For zero blowdown systems, drift may end up accounting for most of the dissolved solids elimination.

Water Quality and System Protection

Water treatment in cooling towers is primarily directed towards minimizing scaling, corrosion, and biological growth, while maximizing water efficiency. Water treatment is always a balancing act. Measures taken to minimize one parameter may end up aggravating another (e.g., lowering pH may reduce scaling while at the same time increasing corrosion). In this section, each of these objectives is described in greater detail.

Maximizing Water Efficiency and Concentration Ratio (Cycles of Concentration)



Cooling tower water usage showing the effect of increased cycles of concentration

Concentration Ratio (also known as cycles of concentration) is a measure of the relative water efficiency of a cooling tower. It is the ratio of the concentration of dissolved solids in the recirculating water to the concentration of makeup water.[5] Total dissolved solids (TDS) is the concentration of minerals in water and is reported in milligrams per liter (mg/l) or parts per million (ppm). Since the electrical conductivity (measured in microseimens, µS) of water is related to its TDS, it is often used as a measure of TDS.[6] As shown below, a conductivity controller measures the conductivity of both recirculating and makeup water.

[4] In chemically treated towers, this drift represents an uncontrolled pollution stream into the environment.

[5] Makeup water replaces water lost from the tower due to blowdown, drift and leaks.

[6] Conductivity readings may be significantly affected by temperature, loss of calibration, changes in makeup water quality, and precipitation or exchange of certain ions.

$$\text{Concentration Ratio} = \frac{\text{Conductivity of recirculating water } (\mu S)}{\text{Conductivity of makeup water } (\mu S)}$$

The water treatment system in use determines the ideal concentration ratio, so that water is conserved while the risk of scale, biological growth, and corrosion is minimized. Regular monitoring ensures that this target is maintained.

Minimizing Corrosion

In an aqueous environment, corrosion can never be completely eliminated, although with good water quality management it can be substantially reduced, potentially doubling the life of a tower. Good water quality management means striking a cost-effective and environmentally sound balance between pH, suspended solids, concentration of various dissolved minerals, additives, and biocides.

Corrosion potential can either be monitored using metal corrosion coupons or probes. You may wish to contact your water treatment provider or cooling tower representative regarding coupon testing services. Alternatively, corrosion potential (for towers not using anti-corrosion additives) can be calculated using an index such as the Ryznar Stability Index (RSI).[7]

Minimizing Scale

The buildup of minerals from recirculated water in solid form is known as scale. Scaling can impede the flow of water in pipes and through the tower, and coat surfaces which prevents the efficient transfer of heat. Scaling often occurs at the hottest surfaces, where heat transfer is most important, such as inside heat exchangers and inside the equipment being cooled.

The primary scale forming constituents include calcium, magnesium, and silica. Actual scale formation will depend on pH and temperature; available anions such as carbonate phosphate, and sulfate; the presence of anti-scaling additives such as polymers and sequestering agents; and the various construction materials used in the system. Scale types are generally not pure and various constituents will often combine and contribute to the scaling potential of each other. Silica, especially, is more likely to form scale in the presence of calcium and magnesium.

The amounts of the different minerals dissolved in the makeup water vary greatly according to region of the country and the source. In the Pacific Northwest, west of the Cascades, water is relatively pure, especially when obtained from surface waters, as in Seattle. Out of the tap, Seattle water is relatively pure, with a pH around 7.5, hardness around 30 mg/l (as $CaCO_3$), dissolved silica around 8 mg/l (as

[7] An online RSI calculator is available at the American Water Works Association (AWWA) website at www.awwa.org/Science/sun/docs/RTWCorrosivityCalc.cfm.

SiO_2), and a conductivity of around 70 uS (micro-Siemens). A water analysis for Seattle Public Utilities supplies is available on the web.[8]

Scale can be minimized using a variety of techniques such as through the addition of anti-scaling additives such as polymers and sequestering agents, pH control, and removal of calcium and/or magnesium ions through water softening or other means such as pulsed power.

For towers operated without anti-scaling additives, a relative scaling versus corrosion potential can be obtained by entering various water quality parameters in one of several scaling indices, including the Ryznar Scaling Index (RSI).

Minimizing Biological Growth

Biological growth is a concern because it can lead to increased localized corrosion at the site of growth and potential health issues if harmful bacteria, such as *Legionella*—the cause of legionnaires' disease—are released through the drift. Biological growth can also reduce heat transfer or airflow through the tower.

A number of biological control strategies are available including regular additions of alternating biocides (to avoid building up resistance to a single biocide), pH control (high pH can be toxic to most bacteria), filtration, pulsed power water treatment, and use of electrostatic devices which may kill bacteria in the water. Regular monitoring should be conducted to evaluate the continued effectiveness of the chosen strategy.

Minimizing Foreign Matter

Foreign matter such as dust particles, leaves, and insects are continuously being introduced into the cooling tower and washed into the sump. This foreign material may contribute to an increase in biological growth, both as a food source and as sites on which to grow, potentially leading to increased corrosion, reduced heat transfer, and human health issues. Sidestream filtration and regular (automatic or manual) cleaning of the sump can help alleviate these problems.

[8] Information can be found here:
http://www.seattle.gov/util/About_SPU/Water_System/Water_Quality/Water_Quality_Analyses/index.asp

Monitoring Your System

Monitoring Your System

By monitoring a building's cooling system closely, a system operator can create a baseline for important parameters to monitor. Good tracking helps identify opportunities for system efficiencies while minimizing wear and tear. Monitoring includes tracking water use and water quality and ensuring that scaling, corrosion, and biological growth are controlled. While many towers are equipped with monitoring devices, regular manual checks are essential to ensure that the installed meters are functioning as designed. This section provides a brief primer on conducting these manual inspections.

Monitoring Water Use

The easiest way to monitor water use is to install a water meter on the incoming makeup water line and all outgoing water lines. Regular meter readings allow a building operator to track actual water use by the tower. A meter on the blowdown/overflow line allows for an even more accurate tracking of water use by the tower, including the ability to track overflows due to poorly operating or out of adjustment fill valves, a major cause of excessive water use.[9] Ideally, any installed meter should be tied into the building management system, allowing for real time monitoring and trending, and making it easier to spot severe problems such as stuck fill valves. If a deduct credit from the utility is desired, be sure to contact the utility first to ensure the meter being purchased meets the utility's requirements.

Monitoring Water Quality

Water quality in a cooling tower should regularly be monitored for the following factors: conductivity, corrosion potential, pH, hardness, silica, and biological activity.[10] The following sections provide information on tests, tools, and recommended ranges for each.

Conductivity

Conductivity can easily be measured using an inexpensive hand-held conductivity tester. It is vital that the tower conductivity controllers should regularly be recalibrated (ideally monthly) against a hand held meter which has just been calibrated using standard calibration fluid. Otherwise one runs the risk of unknowingly running at much higher (or lower) concentration ratios than desired, with the increased risks associated with this.

---

[9] Many utilities require that a blowdown meter be installed if the business seeks sewer credits for the use of a cooling tower.

[10] Hardness is caused by components of calcium and magnesium. The hardness of water is referred to by three types of measurements: grains per gallon, milligrams per liter (mg/L), or parts per million (ppm).

The conductivity tester should be temperature compensated, easily calibrated using standard calibration solution, and read in microsiemens (µS) rather than in TDS. The range will be dependent on expected conditions. In the Seattle area, a measurement range up to 2000 µS is generally generally recommended. (Zero blowdown systems may need a higher scale.) A midrange standard calibration solution such as 447 should be used for calibration purposes.

Many cooling towers will already have a conductivity controller for blowdown with a continuous readout in µS. However, these conductivity controllers are often not regularly calibrated and can give incorrect readings, resulting in increased scaling or corrosion potential. Use of a regularly-calibrated hand-held conductivity tester is the best way to check an installed conductivity controller and recalibrate at least quarterly, if not monthly.

Corrosion Potential

Some type of corrosion potential monitoring should be installed on all cooling towers. Corrosion will be the final cause of failure for most cooling towers in the Seattle area, and replacement of cooling towers is generally quite expensive. Coupon racks or installation of permanent probes are relatively inexpensive ways to monitor corrosion potential. Coupons or probes covering a variety of materials of concern should be used. At a minimum for galvanized towers, both mild steel and galvanized coupons or probes should be used. Although coupons are more widely used and are generally considered more reliable, they must be sent to a laboratory for analysis after several months of installation, while permanently installed probes (with replaceable tips) can provide more immediate results.

pH

Regular monitoring of pH is important to ensure the water treatment system is maintaining the necessary parameters. Moderately higher or lower pH can substantially affect both corrosion and scaling potential. Undesirable rates of corrosion can occur at both higher and lower pH, with corrosion of mild steel and copper increasing at lower pH, and increased corrosion of the galvanized coating potentially occurring at higher pH if the cooling tower has not been properly treated (i.e. passified).[11] A reliable hand-held pH meter is an indispensible tool in monitoring pH. Any pH meter should be recalibrated before each use (maximum of once per day) using a standard buffer solution, and the probe must generally be stored between uses in special pH probe storage solution.

Hardness (Calcium + Magnesium), and Silica

Regular monitoring of calcium, magnesium, and silica can be very helpful in keeping track of scaling potential, and in initially setting the target conductivity setpoint for the conductivity controller. An

---

[11] Passivation is a process that allows a protective oxide coating to form on the new galvanized surface at lower pH over a period of a month or so. Contact your cooling tower representative for more exact instructions.

inexpensive water quality monitoring kit can be ordered which will cover these parameters, or these analyses can be done by a qualified water treatment professional.

Acceptable limits for calcium and magnesium will depend on the pH and water treatment system being used, or alternatively on the target RSI value. The maximum acceptable limit for silica is generally given as 150 ppm, although values of 200 or more may be acceptable at higher pH or 9 or higher (silica solubility increases with pH). In the case of very low concentrations of calcium and magnesium, as with the use of softened water, silica concentrations may be allowed to rise substantially above that, especially at elevated pH (9.5-9.8).

Zinc

White rust is a type of destructive corrosion of the zinc coating (as opposed to passivation) which exposes the mild steel underneath to corrosion.[12] A visual inspection of the tower sump and subsequent analysis for zinc may be helpful, especially if pH is above 8.3. As with calcium, magnesium, and silica, zinc analysis can be done by an outside water quality professional.

Biological Activity

Biological activity can be monitored both through direct observation (for algae), and through regular laboratory testing of water samples. Water samples are generally tested by applying a sample amount to Petri dishes under sterile conditions and recording colony counts after a specified time period. Additional analysis can be used to determine bacteria type. Samples for this type of analysis are best sent to a professional lab.

[12] A comprehensive discussion of white rust and the factors that cause it can be found in the Association of Water Technologies (AWT) 2002 paper on the subject, found on the web at http://www.awt.org/IndustryResources/white_rust_2002.pdf.

Improving the Efficiency of Your System

Improving the Efficiency of Your System

The use of cooling towers is a key strategy in reducing energy use in many cooling systems. But this energy efficiency is traded off for increased water use over sensibly cooled systems. With cooling towers being responsible for a sizeable percentage of water consumption in a building, water conservation through its monitoring and maintenance is a smart choice. Monitoring plays the role of recording baseline information while also allowing building operators to monitor the physical components of the cooling tower and implement improvements to increase water and energy efficiency. Here are some of the top water conservation opportunities.

Water Conservation Opportunities

One of the primary water conservation strategies is to increase the concentration ratio (or cycles of concentration) without compromising the long term integrity of the tower and associated equipment or encountering biological control issues. Water treatment systems that do this are described here. This section also contains brief descriptions on reducing water use via simple responses to physical observations.

High Efficiency Chemical Treatment

Ask a reputable water treatment professional! Significant strides are being made in chemical treatment systems, which monitor and minimize chemical use, and reduce the potential for corrosion, scaling, and biological growth, while allowing towers to operate safely at higher concentration ratios. **For the Seattle area, requesting a treatment system that allows operation at a concentration ration of 10 or above is recommended for higher efficiency.**

Non-Chemical Treatment (Ion Exchange, Electrostatic Field)

A number of non-chemical treatment options are available where hazardous waste handling, local water quality or other concerns (such as LEED certification) may be important factors. While cooling towers in the Seattle area are often successfully operated in the 6-8 cycle range without any treatment, there are a few non-chemical options that have shown promise in the Seattle area. Two are described here: (These descriptions are not meant to recommendations of any particular system.)

- An ion exchange column (periodically recharged with ordinary salt) can be used to provide softened water for makeup, with the calcium and magnesium ions removed and replaced with sodium ions, which do not contribute to scale. Additionally, silica does not readily form harmful scale in the presence of high sodium and low calcium and magnesium. A small amount of silica scale produced may actually be beneficial in reducing corrosion potential. However, as with all treatment systems, it is wise to implement a regular corrosion monitoring system to ensure that corrosion does not become a problem.

- There is a class of precipitation induction devices (PIDs) water treatment systems available which shows some promise in reducing scaling potential and minimizing biological growth. These operate by allowing the precipitation of calcium without the formation of adherent scale, allowing operation at higher actual cycles. Although towers so equipped may be able to operate at higher conductivity readings, the conductivity readings may not give a good approximation of cycles due to a portion of the calcium being removed from solution. Chemical analysis for a non-affected constituent such as magnesium, chlorides, or silica may give a better picture. In areas with moderate to high silica, silica concentrations may then provide the upper limit to the number of cycles safely obtainable. As with all other systems, a regular water analysis and corrosion monitoring system is recommended.

Monitoring Water Levels

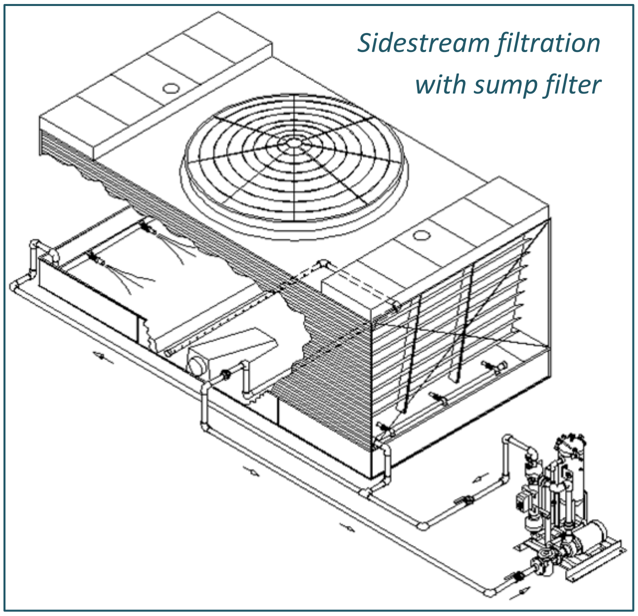
Ballcock style fill valves are prone to leakage and get out of adjustment, resulting in a continuous overflow to drain, which may or may not be noticed. Consider switching these to more reliable fill valves which do not use a ballcock style float on a rod. Another source of water loss may be when the fill level is set too high. In such cases, strong airflow in the sump can cause choppiness on the water surface and water overflow. The water level in the sump should be regularly checked to ensure it is adequately below the overflow outlet to avoid excessive water use.

Reducing Blowdown

Without adequate information about the system, system operators may be tempted to increase blowdown water from the cooling tower in an attempt to minimize scaling and biological growth. However, excessive blowdown may actually increase corrosion by lowering the pH. With good monitoring systems and agreed-upon setpoints, such as described above, water loss through blowdown can often be reduced significantly. As mentioned previously, controlled blowdown helps conserve water and a blowdown meter can serve to inform the system operator better on water volumes going to drain.[13] Since the sewer rate per hundred cubic feet (CCF) may be approximately three times that of the water rate, controlling blowdown may result in significant cost savings.

[13] A blowdown meter, as mentioned earlier, may be more expensive to install due to the generally larger pipe size for the drain line.

Sidestream Filtration



Sidestream filtration with sump filter

Side-stream filtration can be particularly useful in improving water quality in a cooling tower where turbid water is being used, such as when the tower is subject to elevated levels of dust or organic debris or when higher concentration ratios are being attained. Side-stream filtration works to continuously remove particles by drawing and filtering a portion of the water (5-20 percent) from the center of the sump before returning it for recirculation. A variety of filtration systems are available, including vortex filters, canister filters, and sand filters. In addition to sidestream filtration, systems are available with nozzles which spray water along the bottom of the sump to keep sediments from building up there. These "sump sweeper" systems can significantly reduce the potential for corrosion of the basin, and reduce the hours required for periodic maintenance by keeping sediment buildup to a minimum.

Alternative Sources of Makeup Water

Alternative sources of water (as opposed to municipal potable water) include steam condensate, captured rainwater, well water, and industrial process water. These alternative sources may also contribute to important LEED points. However, a water quality analysis for each of these sources is important and they should be evaluated for supply especially during peak cooling loads. Some type of storage and filtration is generally required with these systems.

Hybrid Cooling Towers

Hybrid cooling towers are available which can switch between air cooling only to a combination of air and evaporative cooling, as conditions and load allow. These towers are somewhat more expensive than standard evaporative towers but can save substantial amounts of water and may qualify the building for additional LEED points.

Alternatives to Cooling Towers (Dry Coolers and Heat Sinks)

Dry coolers, involving only a fan and fan coil, may often be a more cost effective solution for cooling, especially for smaller loads in regions with moderate summer temperatures. Although dry coolers may not be able to cool quite as well or as efficiently as evaporative coolers, reduced water use and especially reduced installation and maintenance costs may more than offset a moderate increase in energy use. Dry coolers are lower weight, less expensive, virtually maintenance free, require less structural support and have a lower profile. A full cost/benefit analysis may often demonstrate that dry cooling is the most cost effective solution. Dry coolers can also be used in combination with evaporative equipment to eliminate a portion of the load before evaporation is applied. Then evaporation can be used on the reduced load to reach the desired cooling water temperature.

Other alternatives to cooling towers include ground or water source heat pumps, or heat recovery for domestic hot water.

Calculating Savings

If you are considering implementing any of major upgrades to your system that are predicted to result in conservation, please first contact Seattle Public Utilities. Contact Phil Paschke at 206-684-5883.

Maintaining Your System

Maintaining Your System

Using the Maintenance Checklists

Setting-up a regular maintenance schedule may the most cost-effective step you can take to increase the efficiency and the longevity of your cooling tower. This manual provides checklists which categorize these maintenance tasks by the frequency with which they ideally should occur and are further split with an eye towards water and energy efficiency and general maintenance. These checklists ensure that tasks are completed as scheduled or as needed.

The “Moderate to High Frequency” checklists include daily, weekly, monthly, and as needed activities. The “Moderate to Low Frequency” checklists include quarterly, as needed and annual tasks.

A second set of checklists are also included. These cover tasks that maintain the system in the off-season, during period of shut down, at start-up, and after the system has been energized. It is always recommended that you consult with your regular water treatment service provider prior to undertaking new or unusual activities with regard to your cooling tower.

It is recommended that you make copies as needed for on-going use.

ACKNOWLEDGEMENTS

This manual has truly been a group effort. Many people contributed to the content, reviewed the final product, and provided diagrams to illustrate points. We list them below with our sincerest thanks for their help.

Ray Congdon, Group Health-CB Richard Ellis
Rand Conger, Johnson Barrow, Inc.
Mike Groh, Homeyer Consulting
Roger van Gelder, Water Conservation Consultant

This is a work-in-progress. We welcome comments, corrections, and additions from users and vendors of proven new technologies to expand the depth and breadth of this manual. Please email us at info@resourceventure.org.