The Value of Maintaining Evaporative Cooling Equipment

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1. Cooling Tower Maintenance and Upgrades... What's in it for You? How about Savings in Time, Money, Energy and Longer Life?

An evaporative heat rejection device enables building owners and operators to take advantage of the operating cost savings inherent in water-cooled systems. A well-maintained tower enables the entire cooling system toperform at optimum efficiency by conserving both energy and water.

A cooling tower is selected to provide a fluid (usually water) to a system at a specific design temperature and specific flow rate (l/s). If the delivered temperature of the fluid to the system is higher than desired, system performance suffers.

Owners gain operating cost benefits when they implement a regular, comprehensive cooling tower maintenance program. Today's building owners are constantly challenged to keep operating costs down and are anxious to learn ways to get the most out of their systems with the least expense. Therefore, owners are motivated to purchase system equipment that is energy-efficient, reliable, and maintenance-friendly. When properly maintained, water-cooled systems meet these objectives.

The cooling tower is often the forgotten component of the system when it comes to maintenance. It's a good example of the phrase "out of sight, out of mind". A newly installed cooling tower reliably delivers the design fluid temperature and flow rate. However, since its heat transfer operation creates a "hurricane-like" environment and is a natural "air-washer", the cooling tower needs routine inspection and maintenance to continue performing as designed.

2. A Cost-Saving Opportunity

Owners and operators who have a working knowledge of cooling tower preventive maintenance and upgrade technology will get the most out of their cooling towers.

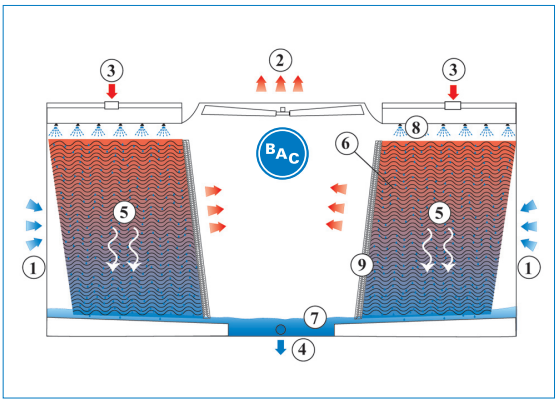
Their efforts can yield beneficial results, including:

- keeping them running smoothly and reliably
- increasing cooling tower life expectancy
- maintaining and potentially improving performance

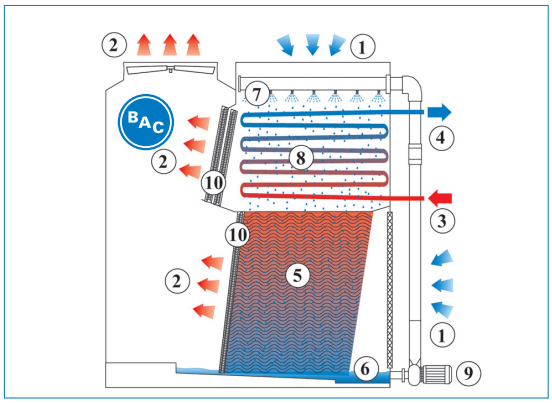
This article will take a look at routine maintenance and suggest ways to improve cooling tower performance.

3. Cooling Tower Basics

In an open circuit cooling tower, warm water from the heat source is evenly distributed via a gravity or pressurized nozzle system directly over a heat transfer surface called "fill" or "wet deck", while air is simultaneously forced or drawn through the tower, causing a small percentage of the water to evaporate. The evaporation process removes heat and cools the remaining water, which is collected in the tower's cold water basin and returned to the heat source (typically a water-cooled condenser or other heat exchanger).



Open Cooling Tower
1. Air in; 2. Air out; 3. Hot Water in; 4. Cooled Water out;
5. Water; 6. Wet Deck Surface; 7. Cold Water Basin;
8. Water Distribution system; 9. Eliminators



Closed Circuit Cooling Tower
1.Air in; 2. Air out; 3. Fluid in; 4. Fluid out; 5. Wet Deck Surface;
6. Cold Water Basin; 7. Water Distribution System; 8. Coil;
9. Spray Water Pump; 10. Eliminators.

Similarly, in a closed circuit cooling tower or evaporative condenser, the heat is rejected indirectly from a fluid or vapour flowing through the coil section by spraying re-circulated water over the coil section, again evaporating a small percentage of the water in the process.
The temperature at which the cooled fluid is returned to the system measures tower performance. This temperature can vary depending upon the actual cooling load, water flow, airflow, and the entering air conditions.

4. Preventive Maintenance

Performing routine preventive maintenance is paramount for consistently achieving the desired temperature and flow rate, and plays an important role in maximizing cooling tower operating life. Today, those manufacturers conscious of the importance of maintenance offer many features which simplify these procedures, saving time and money. To perform properly, all tower components must be kept clean and free of obstructions. The following sections describe standard maintenance procedures for optimized operation. These procedures can prevent loss of efficiency in the heat transfer section by maintaining proper water and air flow, as well as preventing corrosion in the cooling tower.
Maintenance frequency will depend largely upon the condition of the circulating water, the cleanliness of the ambient air used by the tower, and the environment in which the tower is operating. More detailed information is provided by BAC's Operating and Maintenance Manual.

5. Strainer

Fundamentally important to the performance of a cooling tower is a method to minimize contact between air and waterborne debris and the system components. This is accomplished with strainers. Strainers in the tower provide a means

Inspecting Cold Water Basin Strainer

Hot Water Basin Strainer Cleaning

of keeping debris out of the condenser water loop. Strainers in the cold water basin outlet prevent debris from reaching the pump. Some towers feature low-pressure drop pre-strainers upstream of the hot water basin to prevent clogging of distribution nozzles. This added feature eliminates the need to access the distribution nozzles. Both strainers should be routinely inspected and cleaned as necessary. Some tower designs allow external access to the strainers, which enables maintenance to take place without the need to turn off the unit.

6. Water Distribution

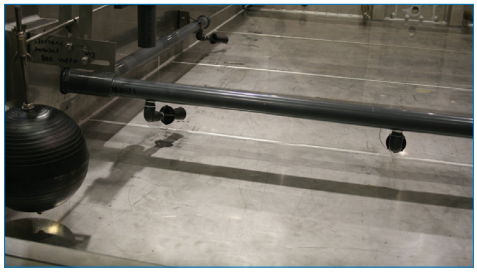
The water distribution system should evenly distribute water over the fill section or coil section via either a gravity distribution system or a pressurized spray system. If the water distribution is found to be uneven, the nozzles need to be checked. Clogged nozzles should be cleaned in accordance with the manufacturer's recommendations.
In a gravity distribution system, the nozzles can be externally accessed, visually inspected and cleaned by removing the hot water basin covers on the fan deck. Most pressurized spray distribution systems use nozzles and branches held in place by snap-in rubber grommets, which allow easy removal to clean and flush debris.

Pressurized Spray Water Distribution

Hot Water Basin with Gravity Water Distribution

7. Cold Water Basin

Since some debris will eventually make its way into the cooling tower, the unit design should facilitate debris removal. A well-designed cold water basin is sloped toward the strainer to keep dirt (which can accelerate corrosion) from accumulating throughout the cold water basin. The basin should be kept clean by occasionally flushing the dirt out of the system through the tower drain. Another way to accomplish this is to install **basin sweeper piping** in conjunction with **water filtration or separator devices**. Water filtration saves maintenance costs by reducing the dirt in the cooling water system, which in turn reduces the time required to clean the cold water basins.
It also reduces water treatment cost, as water treatment chemicals tend to work more effectively in clean water. Foreign particles in dirty water can absorb treatment chemicals, thus requiring the distribution of even more chemicals to properly treat the tower water. For more information refer to Chapter 14: Fundamentals of Filtration.



Cold Water Basin with Sweeper Piping

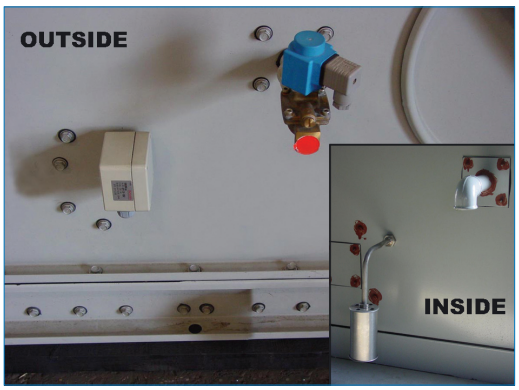
8. Make-Up

Though most of the water in the system is recirculated, some water must be added to replace what is lost by evaporation and bleed. Bleed is the defined as the water that is discharged to prevent the accumulation of solids in the recirculated water. The make-up water system provides the means to replace the water via a mechanical float ball and valve assembly or an electronic water level probe assembly (with solenoid valve), which measures water depth in the cold water basin.

The make-up water supply pressure should typically be maintained between 1 bar and 3,5 to ensure proper valve shut-off and avoid "chatter". If the supply pressure is higher than 3,5 bar, install a pressure reducing valve.

The operating water level of the cooling tower will vary with system thermal load (evaporation rate), the bleed rate employed, and the make-up water supply pressure. Some tower designs offer access to the make-up assembly external to the

Mechanical Water Level Control



Electronic Water Level Control

cooling tower, which allows easy basin water depth inspection and adjustment without the need to turn off the unit. The tower water level should be set in accordance with the BAC's recommendations to ensure no air enters the pump suction, but not so high that water is wasted through the overflow when the tower is shut down.

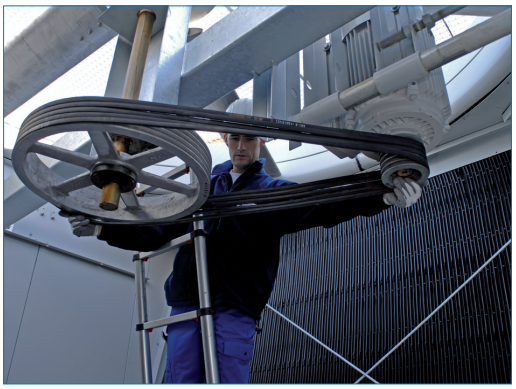
9. Bleed

To prevent the accumulation of solids in the recirculating water, the tower should be equipped with a bleed line (including a metering connection and globe valve) connected to a nearby drain. In a closed circuit cooling tower or evaporative condenser with a circulating pump, a metering valve to control the bleed rate should be provided at the pump discharge. While a manually adjusted bleed valve is the simplest system, getting the proper bleed rate can be a problem, as cooling tower loads vary throughout the day. A conductivity meter connected to a solenoid valve solves this problem by maintaining the proper cycles of concentration at all times. Also, it is recommended that a separate meter is installed to measure bleed volume, since less water is discharged to drain than supplied to the cooling tower. This can reduce sewer water charges.

The bleed rate should be adjusted to prevent an excessive build-up of impurities in the re-circulating water. This is largely dependent upon the local water quality and the evaporation rate. Constant bleed and replacement with fresh water will prevent the accumulation of impurities. To obtain specific recommendations, contact a competent water treatment professional for your area.

10. Mechanical Drive System

The mechanical fan drive system has several components, which should be checked regularly. Many of these components operate at high speed. Follow proper lock-out/tag-out procedures, including locking out all motor disconnect switches before working on the mechanical system.



Mechanical Belt Drive System

Cooling tower fans are typically driven by belt or gear drive systems. Both require routine maintenance to ensure reliable, trouble-free performance. Belt drive systems are popular, yet reliable, offer single point adjustment, and have no limit on turndown capabilities for variable speed applications. If a problem does occur, a simple change of the belt is usually all that is required, and replacement components are readily available.

Gear drives provide reliable operation, when properly maintained. If a problem occurs, resolution may be more involved if a gear box rebuild or replacement is required. Some manufacturers offer both systems to meet user needs or preferences. To ensure proper operation of a belt drive system, tighten drive belts to manufacturer's specifications. In gear drive systems, the oil level and quality, as well as shaft alignment should be checked regularly in accordance with the manufacturer's recommendations.

When starting up a new unit, lubrication for the fan shaft bearings is typically not necessary, since most units leave the factory already greased. However, for seasonal start-up, purge the fan shaft bearings with new grease (per manufacturer's recommendations). Fan shaft bearings should be lubricated after every 2,000 hours of operation or every three months (whichever occurs sooner). Motor bearings should be lubricated as recommended by the manufacturer's instructions. For maximum life, it is best to install motors with a "cooling tower duty" rating.

11. The Importance of Clean Operation

Cooling tower components must be kept clean and free of obstructions. Neglecting the cooling tower will lead to higher than desired return water temperatures to the system, which will result in higher energy usage from two perspectives. First, the system (chiller) will consume more energy because it must operate at a higher than necessary condensing pressure (head) to satisfy the load. Due to the higher fluid temperatures provided by the cooling tower. As little as 1°C higher temperature can result in 6% more energy being consumed by the chiller. Second, the tower must operate longer at higher fan horsepower while trying to attain the design cold water temperature.

12. Common Problems: Causes, Effects and Solutions

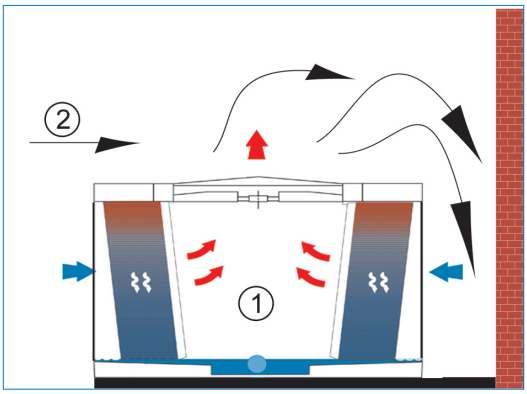
Regardless of how often routine maintenance is performed, like any other mechanical component, problems with cooling towers may sometimes materialize unexpectedly. These include elevated leaving water temperatures, drift, and corrosion. Should any of these problems occur, follow the actions listed and contact the cooling tower manufacturer's representative or water treatment supplier for assistance.

Check Cooling Load: If the actual cooling load exceeds the design load for which the tower was selected the leaving water temperature will exceed the design specification.

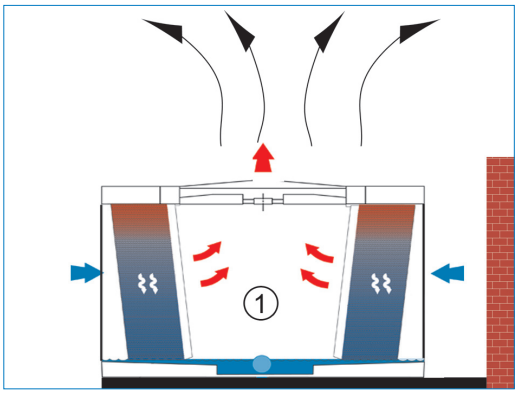
Check Water Flow and Distribution: Visually inspect the water distribution system to ensure the spray distribution nozzles are clean and correctly installed and are distributing a uniform spray pattern over the fill. In counterflow towers, measure the pressure at the cooling tower inlet connection and compare it to the design pressure provided by BAC. For towers with a gravity distribution system, the operating level in the hot water basin (typically between 5 cm and 13 cm) can be correlated to a specific flow rate.

Inspecting Spray Distribution Nozzles

Check Air Flow: Cooling towers should be located where an unimpeded supply of fresh air is available to the air inlets. The cooling tower air discharge should also be at least as high as any surrounding walls to reduce the possibility of hot, moist discharge air being recirculated into the air inlets, creating artificially elevated entering wet-bulb and leaving water temperatures. For more information refer to Chapter 11: Layout Guidelines. To insure full design air flow, the cooling tower drive system must be adjusted according to the BAC's Operating and Maintenance Manual.



Incorrect Orientation of Tower and Neighbouring Walls
1. Induced Draft Cooling tower; 2. Prevailing Wind



Proper Orientation of Tower and Neighbouring Walls
1. Induced Draft Cooling Tower

The cooling tower and surrounding area should be examined for air flow restrictions which may cause blockage of the air inlets. Check for clogging or improper distribution of water across the tower fill and check for proper operation of capacity control dampers in centrifugal fan towers to ensure proper air flow. The dampers, airfoil blades located in the discharge of the fan housing, help achieve tight temperature control and energy savings by matching cooling tower airflow to actual load requirements.

Though you may encounter dampers in older existing units, today's towers tend to take advantage of variable frequency drive technology (VFD's) to control capacity. VFD's help save energy, do a better job of following the load, and help reduce wear and tear on the drive system.

Check Ambient Conditions: Cooling towers are selected to produce the required leaving water temperature at the design cooling load and entering wet-bulb temperature. Whenever the actual entering wet-bulb temperature is higher than design conditions, the leaving water temperature will also be higher. The result is decreased energy efficiency.

Drift occurs as air flows through the cooling tower and carries water droplets out of the tower. Drift eliminators are installed in the discharge stream to remove water droplets from the air. In a properly maintained system, efficient eliminators will reduce drift loss to a negligible percentage of the design flow rate.

If excess drift occurs, check drift eliminators for proper installation, spacing, and overall condition. Examine the fill for even spacing, to insure there is no clogging or blockage, and check water and air flow as described above. Repair or replace eliminators as necessary.

Inspecting Coil

Inspecting Drift Eliminator

Corrosion is always a concern with cooling towers because of their ability to wash the air of impurities. These impurities cause scale, corrosion, and eventually damage to system components after long-term exposure.

If a constant bleed of the system is ineffective to combat scale or corrosion, chemical treatment may be necessary. A successful chemical or water treatment program should satisfy the specific guidelines set by the manufacturer, provide effective microbiological control, and be compatible with the system's materials of construction as an integral part of the total water treatment program.

Potential airborne impurities and biological contamination (such as Legionella) should be controlled through the use of biocides, and such treatment should be initiated at system start-up and continued regularly. ASHRAE has taken proactive steps to understand and deal with Legionella through its popular publication, ASHRAE Guideline 12 – 2000, entitled "Minimizing the Risk of Legionellosis Associated with Building Water Systems". Contact ASHRAE to secure a copy of this important document. In some European countries health and safety regulations require specific control and maintenance, see Chapter 21: Application Guidelines.

13. Performance Improvements

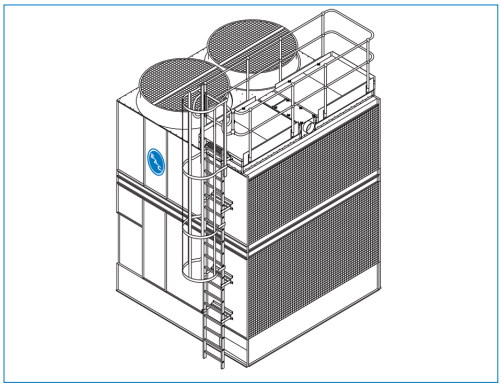
Older, structurally sound cooling towers can be retrofitted with upgrade kits to:

- conserve energy
- restore or improve performance
- facilitate maintenance

To conserve energy, two-speed motors or variable frequency drives (VFD's) or the BALTIGUARD® Fan System can be added to the mechanical drive system. VFD's offer a wide range of speeds to closely parallel operating requirements, and pony motors provide the added benefit of redundancy in the event of a motor failure. A popular energy conservation approach employs a pony motor system with a VFD controlling the lower horsepower motor.

To improve performance on water distribution systems, kits are available to replace older, smaller nozzles or troughs with large-orifice, clog-free design. Retrofit fill kits now exist that easily replace the original fill that may be clogged with scale or airborne debris. Access platforms can also be added to existing cooling towers to facilitate maintenance.

Installing Retrofit Kit



Access Platforms and Ladder

14. Conclusion

Paying regular attention to the forgotten system component, the cooling tower, through a regular, comprehensive maintenance program can save time, money and energy while increasing the tower's life expectancy. A well-maintained tower is a candidate for retrofit kits designed to enhance performance and lengthen its life. Owners and operators save money through preventative maintenance technology. If you are not regularly performing routine maintenance on your cooling tower, implement a comprehensive maintenance program today.

For more information on how to get started, contact your local BAC Balticare Representative.