WESTERN AREA POWER ADMINISTRATION
An agency of the U.S. Department of Energy

Technical brief
Optimizing Cooling Tower Performance

WSUEEP98013, Rev. 2/98

Reducing energy expenditures for your cooling tower may be as simple as regular maintenance. This Technical Brief explains how proper maintenance will optimize heat transfer and help your equipment operate more efficiently. It also identifies strategies for upgrading cooling tower performance.

How Does a Cooling Tower Work?

Cooling towers reject heat from the cooling water circulating through the condenser of a chiller. There are two basic types of cooling towers.

Direct or open cooling towers *expose the cooling water directly to the atmosphere. The warm cooling water is sprayed over a fill in the cooling tower to increase the contact area, and air is blown through the fill. The majority of heat removed from the cooling water is due to evaporation. The remaining cooled water drops into a collection basin and is recirculated to the chiller.*
See Figure 1.

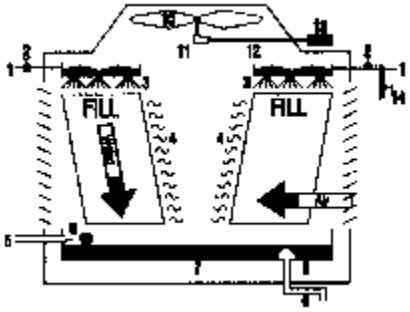

Figure 1 Direct Cooling Tower

1. Hot water from chiller
2. Flow control valve
3. Distribution nozzles
4. Draft eliminators
5. Make-up water infeed
6. Float valve
7. Collection basin
8. Strainer
9. Cooled water to chiller
10. Fan
11. Gear box
12. Drive shaft
13. Fan drive
14. Bleed water

An ***indirect or closed cooling tower*** *circulates the cooling water through the tubes of a coil bundle in the tower. A separate external circuit sprays water over the cooling tubes to evaporatively cool the coils.*

Why is Proper Maintenance Important?

An improperly maintained cooling tower will produce warmer cooling water, resulting in a condenser temperature 5 to 10 degrees F higher than a properly maintained cooling tower. This reduces the efficiency of the chiller, wastes energy, and increases cost. The chiller will consume 2.5 to 3.5 percent more energy for each degree increase in the condenser temperature.

For example, if your chiller uses $20,000 of electricity each year, it will cost you an additional $500 to $700 per year for every degree increase in condenser temperature. Thus, for a 5 to 10 degree F increase, you can expect to pay $2,500 to $7,000 a year in additional electricity costs. In addition, a poorly maintained cooling tower will have a shorter operating life, is more likely to need costly repairs, and is less reliable.

What Causes Poor Performance?

The performance of a cooling tower degrades when the efficiency of the heat transfer process declines. Some of the common causes of this degradation include:

Scale Deposits

When water evaporates from the cooling tower, it leaves scale deposits on the surface of the fill from the minerals that were dissolved in the water. Scale build-up acts as a barrier to heat transfer from the water to the air. Excessive scale build-up is a sign of water treatment problems.

Clogged Spray Nozzles

Algae and sediment that collect in the water basin as well as excessive solids get into the cooling water and can clog the spray nozzles. This causes uneven water distribution over the fill, resulting in uneven air flow through the fill and reduced heat transfer surface area. This problem is a sign of water treatment problems and clogged strainers.

Poor Air Flow

Poor air flow through the tower reduces the amount of heat transfer from the water to the air. Poor air flow can be caused by debris at the inlets or outlets of the tower or in the fill. Other causes of poor air flow are loose fan and motor mountings, poor motor and fan alignment, poor gear box maintenance, improper fan pitch, damage to fan blades, or excessive vibration. Reduced air flow due to poor fan performance can ultimately lead to motor or fan failure.

Poor Pump Performance

An indirect cooling tower uses a cooling tower pump. Proper water flow is important to achieve optimum heat transfer. Loose connections, failing bearings, cavitation, clogged strainers, excessive vibration, and non-design operating conditions result in reduced water flow, reduced efficiency, and premature equipment failure.

What Maintenance Should Be Performed?

The cooling tower manufacturer’s operation and maintenance instructions should be followed whenever possible. Table 1 provides a guide for a reasonable cooling tower maintenance program. This is only a basic guide. Larger, more complicated cooling towers with special filters or controls will demand a more comprehensive maintenance program.

Table 1. Cooling Tower Maintenance Schedule

Daily/Weekly

- Test water sample for proper concentration of dissolved solids. Adjust bleed water flow as needed.
- Measure the water treatment chemical residual in the circulating water. Maintain the residual recommended by your water treatment specialist.
- Check the strainer on the bottom of the collection basin and clean it if necessary.
- Operate the make-up water float switch manually to ensure proper operation. Inspect all moving parts such as drive shafts, pulleys,and belts.
- Check for excessive vibration in motors, fans, and pumps.
- Manually test the vibration limit switch by jarring it.
- Look for oil leaks in gear boxes.
- Check for structural deterioration, loose connectors, water leaks, and openings in the casing.
- During periods of cold weather, check winterization equipment. Make sure any ice accumulation is within acceptable limits.

Periodic

- Check the distribution spray nozzles to ensure even distribution over the fill.
- Check the distribution basin for corrosion, leaks, and sediment.
- Operate flow control valves through their range of travel and re-set for even water flow through the fill.
- Remove any sludge from the collection basin and check for corrosion that could develop into leaks.
- Check the drift eliminators, air intake louvers, and fill for scale build-up. Clean as needed.
- Look for damaged or out-of-place fill elements.
- Inspect motor supports, fan blades, and other mechanical parts for excessive wear or cracks.
- Lubricate bearings and bushings. Check the level of oil in the gear box. Add oil as needed.
- Adjust belts and pulleys.
- Make sure there is proper clearance between the fan blades and the shroud.
- Check for excessive vertical or rotational free play in the gear box output shaft to the fan.

Annual

- Check the casing, basin, and piping for corrosion and decay. Without proper maintenance, cooling towers may suffer from corrosion and wood decay. Welded repairs are especially susceptible to corrosion. The protective zinc coating on galvanized steel towers is burned off during the welding process. Prime and paint any welded repairs with a corrosion-resistant coating.
- Leaks in the cooling tower casing may allow air to bypass the fill. All cracks, holes, gaps, and door access panels should be properly sealed.
- Remove dust, scale, and algae from the fill, basin, and distribution spray nozzles to maintain proper water flow.

Where Can I Get More Information?

- Western's Energy Services:
  - Power Line Hotline at (800) 769-3756
  - Energy Services website

This Technical Brief, and others, are available on-line at this Energy Services website.

  - E-Mail your question to Western's Power Line
  - Fax your question to Western's Power Line at (360) 586-8303
- The Energy Ideas Clearinghouse Web site

Western's Energy Services

Western's Energy Services offers customers information, resources and solutions to improve their energy efficiency, use of renewable energy, and competitive positions. For additional information about energy efficient motors or any other commercial, industrial, agricultural or residential technologies, programs or products, use the Western contacts listed above.

Acknowledgment: The Washington State University Cooperative Extension Energy Program produced this technical brief. It was adapted from a Technology Update on "Optimizing Cooling Tower Performance" (CH-12) funded by the Bonneville Power Administration.