Cooling Tower Selection

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Cooling Tower Selection

Cooling towers are designed and manufactured in various sizes and configurations. Recognizing and understanding the different configurations and the advantages and limitations of each is essential to specifying the most cost effective solution for the end user. The purpose of this bulletin is to highlight the differences between crossflow and counterflow cooling towers and to describe applications where each configuration should be specified.

COOLING TOWER OVERVIEW

The primary task of a cooling tower is to reject heat into the atmosphere. This heat rejection is accomplished through the natural process of evaporation that takes place when air and water are brought into direct contact in the cooling tower. The evaporation is most efficient when the maximum water surface area is exposed to the maximum flow of air, for the longest possible period of time.

Cooling towers are designed in two different configurations, counterflow and crossflow. The specific configuration indicates the direction of air flow through the tower relative to the direction of the water flow. Cooling tower water and air distribution systems are designed in concert, with each playing an equally important role in determining the efficiency and proper application of the cooling tower.

HOT WATER DISTRIBUTION SYSTEMS

The overall efficiency of a cooling tower is directly related to the design of the tower's hot water distribution system. The primary consideration in selecting the type of hot water distribution system for a specific application is pump head. The pump head imposed by a cooling tower consists of the static lift (related to the height of the inlet) plus the pressure necessary to move the water through the distribution system and over the fill. The pump head varies according to the cooling tower configuration.

Counterflow towers use a high pressure spray nozzle hot water distribution system to achieve water coverage of the fill. The nozzle spray pattern is sensitive to changes in water flow, and consequent change in nozzle pressure. The air movement is vertically upward through the fill, counter to the downward fall of the water (Figure 1). Counterflow towers typically have a smaller footprint than crossflow towers, but require additional height, static lift, and dynamic head to achieve the same cooling effect.

Crossflow towers utilize a distinctly different type of water distribution system. Hot water is distributed to the fill by gravity through metering orifices in the floor of the inlet basin. There is no pressure spray distribution system. The air movement is horizontally through the fill, across the downward fall of the water (Figure 2). In crossflow towers, the

internal pressure component of pump head is insignificant because maximum flow is achieved by gravity.

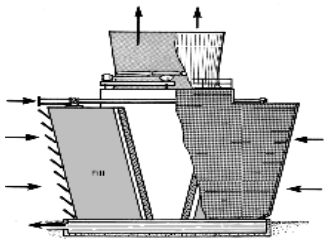
Compared to crossflow towers, counterflow towers may require up to five or six psig added pump head to achieve the proper spray distribution. The high counterflow pumping head requirement (tower height plus nozzle pressure) leads to a higher first cost pumping system and significantly higher annual pump energy consumption and operating costs. If the system condenser pumps are not properly sized, the additional pump head required in counterflow towers may result in inadequate hot water flow, reducing tower efficiency and performance.

AIR FLOW DISTRIBUTION SYSTEMS

Cooling tower performance is also related to the amount of air moving through the tower and coming into direct contact with the water. In counterflow towers the air movement is vertically upward through the fill, counter to the downward fall of the water. This configuration, along with the finer water droplet size available from pressurized spray nozzles,
allows counterflow towers to make more efficient use of available air. However, the resistance to upward air travel against the falling water results in higher static pressure loss and greater fan horsepower than a crossflow system.

Crossflow towers have a fill configuration through which air flows horizontally across the downward flow of the water. Crossflow towers utilize essentially the full tower height for inlet louvers, reducing air inlet velocity and minimizing recirculation and drift loss. The air inlet louvers in counterflow towers are restricted to the tower base, increasing inlet velocities and susceptibility to airborne trash and other debris.

CROSSFLOW;



ADVANTAGES OF CROSSFLOW cooling towers due to their gravity flow hot water distribution
system:

- Low pumping head.
- Lower first cost pumping systems.
- Lower annual energy consumption and operating costs.
- Accepts larger variation in water flow without adverse effect on the water distribution pattern (flat plate heat exchanger operation in winter).
- Easy maintenance access to distribution nozzles.

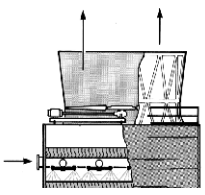
DISADVANTAGES OF CROSSFLOW cooling towers due to their gravity flow hot water distribution system:

- Low pressure head on the distribution pan may encourage orifice clogging and less water breakup at spray nozzle.
- Exposure to air in the hot water basin may accelerate algae growth. Larger footprint.

COUNTERFLOW

ADVANTAGES OF COUNTERFLOW cooling towers due to their pressurized spray water distribution system:

- Increased tower height accommodates longer ranges and closer approaches.
- More efficient use of air due to finer droplet size from pressure sprays.



DISADVANTAGES OF COUNTERFLOW cooling towers due to their pressurized spray water

distribution system:

- Increased system pumping head requirements.
- Increased energy consumption and operating costs.
- Distribution nozzles difficult to inspect and clean.
- Requires individual risers for each cell, increasing external piping costs.

CROSSFLOW

ADVANTAGES OF CROSSFLOW cooling towers due to their horizontal air distribution system:

- Low static pressure drop.
- Reduced drift.
- Reduced recirculation.
- More air per fan horsepower.
- Larger diameter fans can be used so that fewer cells are required for a given capacity.
- Lower energy and operating costs.

DISADVANTAGES OF CROSSFLOW cooling towers due to their horizontal air distribution system:

- Larger louver surface area makes icing more difficult to control.

COUNTERFLOW

ADVANTAGES OF COUNTERFLOW cooling towers due to their vertical air distribution system:

- The vertical air movement across the fill allows the coldest waterto be in contact with the driest air maximizing tower performance.

DISADVANTAGES OF COUNTERFLOW cooling towers due to their vertical air distribution system:

- The resistance to upward air travel against the falling water results in higher static pressure loss and a greater fan horsepower than in crossflow towers.
- The restricted louver area at the base with high velocity of inlet air increases the fan horsepower.
- Tendency for uneven distribution of air through the fill with very little movement near the walls and center of the tower.
- High inlet velocities are liable to suck airborne trash and dirt into the tower.

CONCLUSIONS AND RECOMMENDATIONS

The air and water distribution systems for counterflow and crossflow cooling towers have advantages and disadvantages inherent in their respective designs. It cannot be said that one is better than the other. Rather, with the proper application, both configurations are cost effective and can serve the end user well.

Crossflow cooling towers should be specified when the following criteria and limitations are important:

- To minimize pump head.
- To minimize pumping and piping first costs.
- To minimize operating costs.
- When condenser water flow variance is expected.
- When ease of maintenance is a concern.

Counterflow cooling towers should be specified when the following criteria and limitations are important:

- When space (footprint) is restricted.
- When icing is of extreme concern.
- When pumping is designed for additional pressure drop.

CAUTION: Never replace an existing crossflow tower with a counterflow tower without engineering evaluation to determine the available condenser water pumping capacity.
If a crossflow tower is specified, a counterflow tower is not an equal alternative.

Cooling tower performance is related to the amount of air moving through the tower and coming into direct contact with the water.

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