CROSS FLOW or COUNTER FLOW COOLING TOWER.

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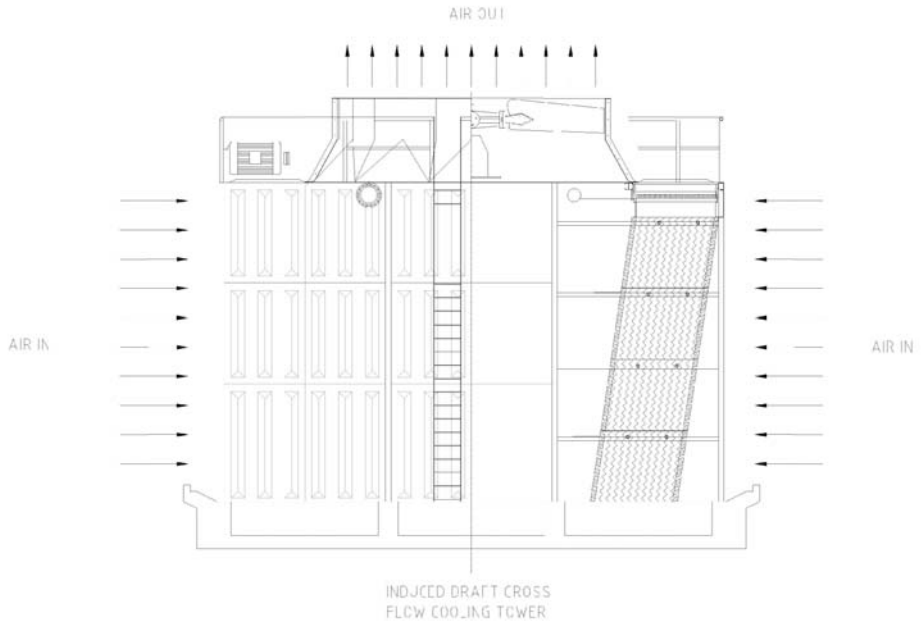
COOLING TOWER SELECTION:

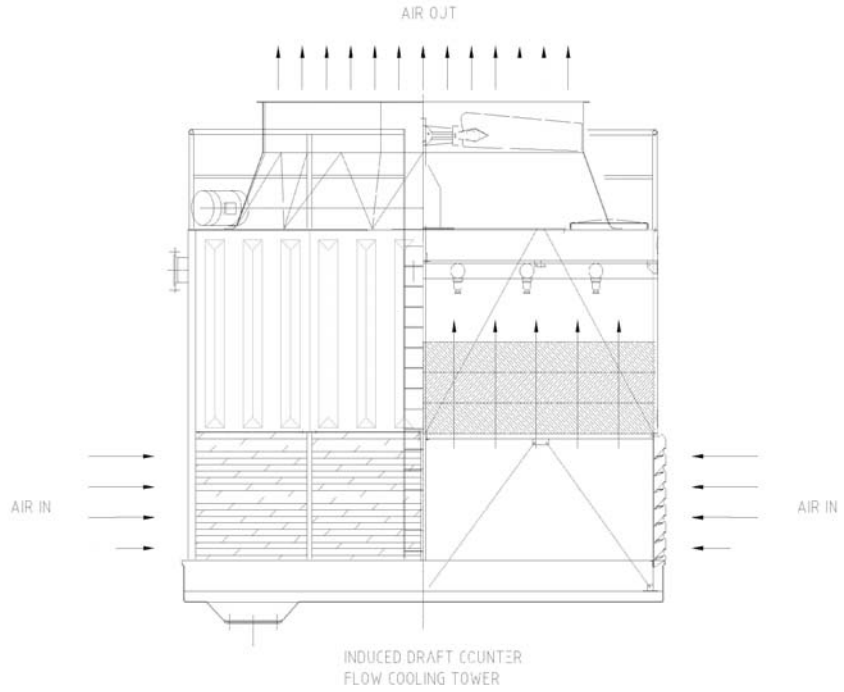
Cooling towers are designed and manufactured in many sizes and configurations. Recognizing and understanding the different configurations and advantages is essential for specifying the most cost effective solution for the end user. The purpose of this bulletin is to highlight the differences between crossflow and counterflow cooling towers. Also a recommendation is given, were each type of tower 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 is 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 in the longest possible period of time.

Cooling towers are designed in two different configurations, counterflow and crossflow. The specific configuration indicates the direction of the air flow in relation to the water flow. Cooling water distribution and air distribution are designed in a harmonious configuration and are equally important to determine a maximum efficiency in heat rejection.





HOT WATER DISTRIBUTION SYSTEMS

The overall efficiency of a cooling tower is directly related to the design of the towers water distribution and heat exchange surface. The design of the distribution system affects the pump head to bring the hot water to the tower inlet. Depending on the type of distribution system the pump head required is the static lift plus the required pressure at the distributor.

Counterflow towers in general use low pressure spray nozzles to divide the hot water equally over the infill surface in fine droplets. A drift eliminator section above the water distribution rejects all the water in liquid form and keeps this in the circulating system. Only water evaporated in the air leaves the tower with the saturated air. A nozzle distribution is sensitive to changes in water flow thus it affects the overall efficiency.
The air movement is vertically through the fill in counter flow to the downwards fall of the water. Counterflow towers have in general a smaller footprint than crossflow towers but require a higher pump head due to the typical distribution system with nozzles.

Crossflow towers use a distinctly different type of water distribution. The hot water is distributed to the fill by gravity thought perforated basins sometimes supported by metering orifices in the floor plate of the distribution basin. The water runs down over the infill surface as a fine film. The air turbulates in the honey comb infill structure to maximize the contact with the hot water. The hot water enters the distribution system at atmospheric pressure. The pump head required is in general the tower height as static lift. The air movement is horizontally through the infill, across the downward fall of the water.

Compared to crossflow towers, counter flow towers may require up to 0.5 bar / 7 PSI pressure at the water inlet to achieve an efficient water distribution in the tower. This leads to higher operational costs in pump energy consumption.

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 crossflow towers the air comes into the infill over the total infill height. Due to the fan configuration on top of the tower the air distribution is not equal over the whole inlet surface.
In counterflow towers the air passes through the air inlet louvers and bends into the infill section. The inlet louvers reject splash water coming out of the tower and create a slightly higher airside pressure drop.

NOISE

Noise is a critical item in cooling towers. The movement of air and the movement of water are the main sources. The fan, gear and motor are responsible for the mechanical noise production were the water distribution is added.
Silencers are used to reduce the spreading of noise but more important is the selection of the right type of tower and components in a tower when noise is a critical item.
The fan produces a typical sound character in lower frequencies. When the fan is close to an obstacle, e.g. a support for the gear it will produce a chop noise, which also has effect on the force of the blade.
Gear boxes are typical loud sources were V-belts, if installed and serviced well have a lower impact. Motors have a typical noise at full load.
In counterflow towers the water produces a rain noise in the spraying area as well when it is falling from the infill on to the water surface. In crossflow towers the noise of water is nearly absent.

TOWER CHARACTERISTICS

CROSSFLOW TOWERS

+ Low pumping head, thus lower operational cost.
+ Accepts variations in water flow without changing the distribution system
+ Easy maintenance access to vital parts.
+ Reduced drift loss due to the absence of water droplets.
+ Lower in noise due to absence of water noise.
- Larger foot print of the tower.
- Large air inlet surface makes icing difficult to control.
- Tendency of uneven air distribution through the infill due to the large inlet surface.

COUNTER FLOW TOWERS

+ The coldest water comes in contact with the driest air maximizing tower performance.
+ Smaller foot print of the tower
+ Smaller tower height due to compact infill.
+ More efficient air/water contact due to droplet distribution.
- Noise production due to spraying and falling water.
- Direct sunlight in the tower basin might trigger algae growth.
- Water distribution system might clog due to water borne debris.
- Uneasy maintenance of water distribution system.
- Drift loss due to droplet distribution system.
- Icing of the air inlet louvers in winter time.

CONCLUSIONS and RECOMENDATIONS

The air distribution systems for counterflow and crossflow towers have advantages and disadvantages inherent in their respective designs.

Both tower systems are designed to a required cooling tower duty thus the thermal performance and cooling capability for both tower systems, if designed well, are equal.

Crossflow towers should be specified when the following specifications are important:

- To minimize pump head.
- To minimize pumping and piping cost.
- To minimize operating cost.
- When noise limitations are a significant factor.
- When variance in hot water flow is expected.
- When easy maintenance is a concern

Counterflow towers should be specified when the following specifications are important:

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

CAUTION:
Never replace crossflow with counterflow towers or vice versa without engineering evaluation of the total cooling system and pump systems.

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