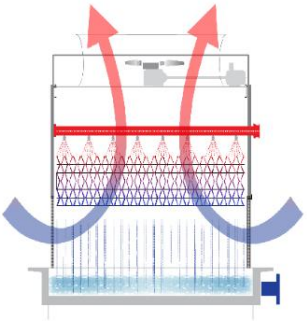
YWCT
Custom Cooling Towers

Crossflow and counterflow cooling towers: The differences

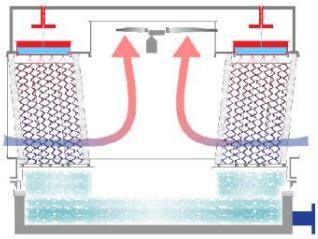
General

Cooling towers can be classified in various ways. One of the basic distinctions between them has to do with the direction of the air flow through the fill inside the cooling tower. When the air flow is contrary (180º) to the water flow, the tower is a *counterflow tower*, whereas when the air flow through the fill is vertical (90º) to the water flow, the tower is a *crossflow tower*.

The diagram shown below depicts the difference between the two cooling tower types:



Counter-flow



Cross -flow

Direction of air flow and the cooling tower's structure

How the air flow in the fill affects the tower's structure

In crossflow cooling towers, the water flows freely into the distribution basin (hot water basin) located in the upper part of the tower. At the bottom of the distribution basin are holes wherein nozzles are installed that distribute the water onto the fill located beneath them. The water flows onto the fill and is cooled by the surrounding air, which is forced by the fan into the tower itself. The air, as aforementioned, flows horizontally, perpendicular to the cooled water. The fill type, its depth, and its height determine the degree to which the water is cooled.

The fan in the crossflow tower can be of forced type (located on the side of the tower) or induced type (located atop the tower). The tower can operate with a single distribution basin, called a single-side tower; or two distribution basins with an inducing fan between them, called a dual-side tower.

In a counterflow cooling tower, the water enters the tower via closed, pressurized piping system (usually not less than 0.2 atms). The entry into the tower is via a main header that splits into two pipes of smaller diameters, in each of which are installed nozzles that convert the water flow into droplets.

In a counterflow cooling tower, the air enters the tower via dedicated openings located below fill level. The air enters the space underneath the fill (called rain zone), then changes direction and enters the fill vertically, upwards, where it flows counter to the direction of the water that is falling (and not perpendicular thereto).

The air inlet location in a counterflow cooling tower create a plenum underneath the fill (following the air louvers), as well as a plenum over the fill, between the fan deck and the drift eliminator layer.

Differences between counterflow and crossflow

The two aforementioned differences (differing water distribution, and lower and upper plenum) create differences in the properties of the two tower types:

- **Foot print –** Due to the plenum in counterflow cooling towers, these towers for the most part have higher profiles and take up less land area than do crossflow towers, for the same capacity (does not necessarily apply to site-erected towers[1]).
- **Tower height –** For the same reason, a crossflow tower can be designed such that it is lower than a similar counterflow tower. This configuration can be appropriate for cooling towers located atop a building, where the height profile is architecturally significant, or in the case of a low ceiling, such as in a parking garage.
- **Convenience of operation –** The crossflow tower's structure is easier to maintain than that of a counterflow tower for two reasons:
    - Access to distribution system. In a crossflow tower, access to the nozzles (which are located in the distribution basin) is available at any given moment, giving the ability to check them, clean them, and replace them if needed; while in a counterflow tower, one must go inside the tower (which they cannot be done when the tower is in operation), where access to the sprayers is difficult.
    - Access into the tower plenum. In a crossflow tower, fitted with a induced draft fan (atop the tower) – the standard configuration – one can reach mid-plenum, located underneath the fan, while the tower is in operation. In this configuration, it is possible to examine and check the drift eliminator layer and the mechanical system from underneath; while a counterflow tower cannot be entered while it is in operation.
- **Water supply –** The form of gravitational distribution in a crossflow tower enables more operational flexibility and enables changing the cooling tower output flow more than does a counterflow tower. In general, the output in a crossflow tower can be increased / decreased by dozens of percentages simply by replacing the orifices installed inside the gravitational nozzles. A counterflow tower offers less flexibility, as access to the sprayers (and the sleeves) is more difficult.

[1] Large, site-erected towers can be designed such that on a given piece of land, a crossflow tower might be taller than a counterflow tower.

- **Water pressure –** In principle, the water pressure needed crossflow cooling tower should be slightly less than that needed by a counterflow cooling tower, as in the latter, the pump must create enough pressure (about 0.3 atms) for the distribution system to work. This extra pressure slightly increases the electricity consumption of the pump in a counterflow tower.
- **Exposure to light –** The counterflow cooling tower is in most cases fitted with anti-light louvers that significantly block algae growth that results from sunlight, in turn decreasing the quantities of chemicals needed to treat it. In a crossflow tower (that is fitted with an induced-flow fan), the plenum underneath the fan is exposed to sunlight, and in order to cover it, a dedicated solution must be found (covering part of the exposed pool with a sealed platform, for example).
- **Cold weather –** It is commonly claimed that crossflow cooling is more appropriate for cold climates (sub-zero temperatures), as it enables decreasing the quantity of water on the fill surface by blocking some of the nozzles located close to the fan thus, increasing the hydraulic load on the rest of the fill and decreasing the risk that the water will freeze; and enabling more precise forecasting of the tower's operation in such conditions.
- **Noise –** In counterflow towers, noise is produced as a result of the droplets falling the surface of the cold water basin. This noise can be muffled by a number of means, such as installing sound attenuators at the air inlet or on top of the water. The problem is significantly reduced at the outset in crossflow cooling towers wherein the lower edge of the fill nearly touches the pool's surface.

Summary

Counterflow cooling towers for the most part require less foot-print, and enable better utilization of a given area, so that this configuration is acceptable in the HVAC market (where roof area is a costly resource); as well as in any case where space is scarce.

Counterflow towers are considered more convenient to operate and are appropriate in cases wherein a low cellulate is required as well as low noise levels.

The choice between the two configurations depends upon the specific conditions and on the special requirements of each individual project.