COOLING TOWER

INTRODUCTION

Cooling is a process of transfer of thermal energy via thermal radiation, heat conduction or convection. The cooling process is an unavoidable phenomenon in the world which starts from the hydrologic cycle and extends up to various other processes. Cooling is done through various processes and with different components.

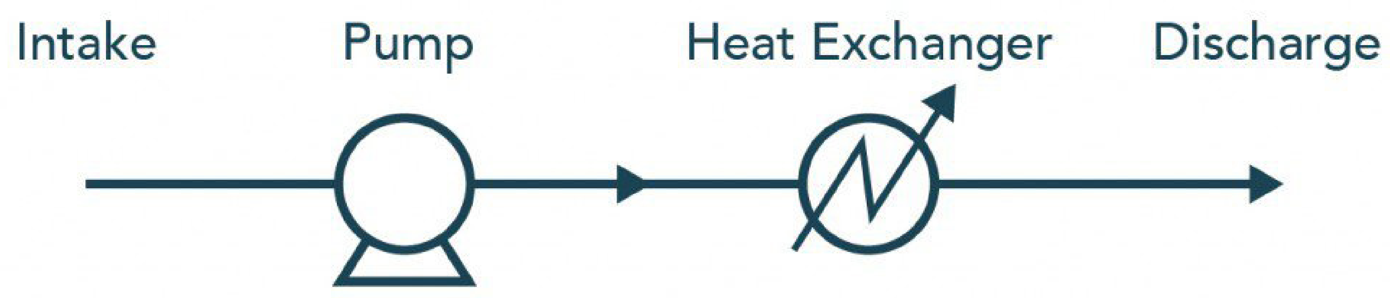
Water is used as general transfer medium for cooling purposes for the following reasons:

- High specific heat
- High heat of vaporization
- High boiling point
- Inexpensive

Once-Through Cooling System:

In a once-through cooling design, water is pumped from a water source, and passes only once through the system to absorb process heat. It is then discharged, back into the original source. This source may be a river, lake, ocean or well.

This design is common where large volumes of low-cost water are available, such as in coastal areas, lake or riverfront locations. These are chosen if the cooling demand is not high, the process is not critical, and there is room to accommodate the larger equipment that will be needed to process these high volumes of water. Many installations of the once-through cooling system are being decommissioned, because of the emphasis on conservation and environmental water quality. If decommissioned, equipment changes are needed to adapt the system to a recirculating design. Applications for once-through systems are usually potable water supply or other process water needs. These systems often experience upsets if water quality varies.



TYPES OF COOLING TOWERS

No two cooling water systems are alike. They differ in water make-up quality, purpose, operating schedule, and stressors. While there are only three basic types of cooling towers, those design and operational differences make them a challenge to characterize and draw conclusions about performance. Cooling systems are grouped according to what happens with the cooling water.

<u>Average Temperature Change:</u> 5-10° F (3-6° C)
<u>Amount of Water Used:</u> High
<u>Examples:</u> Potable Water Systems, Process Water, General Service

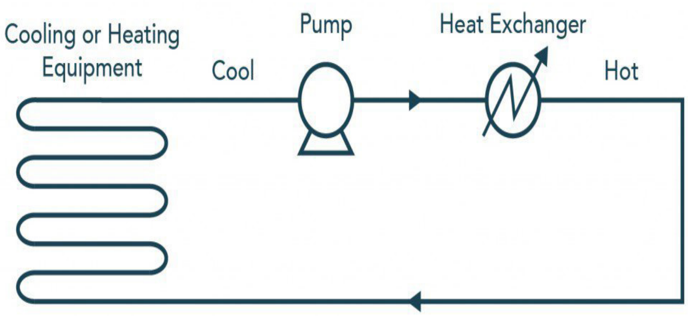
Closed Recirculating Cooling System:

In closed recirculating systems, heat absorbed by the cooling water is either transferred to a second coolant, or released into the atmosphere in a dry cooling tower. The word dry is used because the water is never exposed to the air, and as a result, very little water is lost.

An automobile engine is a good example of a closed cooling system. First, heat is transferred from the hot metal surfaces around the cylinders to a liquid coolant that circulates through the engine. The heat is then carried away by the coolant and released into the atmosphere in the radiator, which acts as a dry cooling tower.

Evaporation is not used in this type of cooling tower; instead, cool air rushes over a series of small hot tubes that contain the circulating coolant, cools the tubes, and as a result, takes heat from the hot liquid inside. The coolant is then returned back into the engine, and the whole process is repeated.

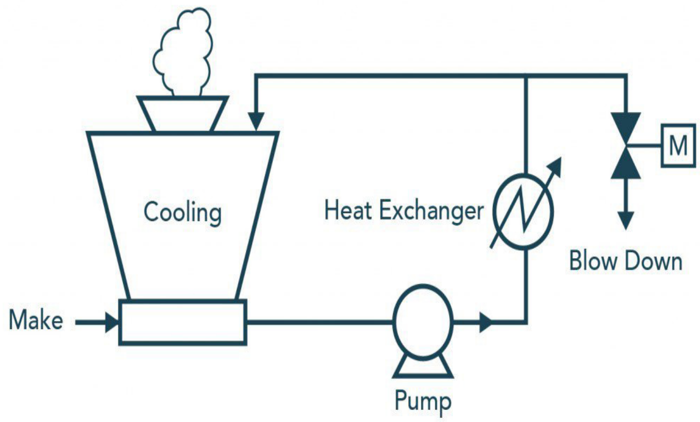
Industrial applications are chilled water loops, computer room coolers, food temperature controllers or any process where a small change in the temperature is important to the product or environment.



<u>Average Temperature Change:</u> 10-30° F (6-17° C)
<u>Amount of Water Used:</u> Moderate
<u>Examples:</u> Cooling Towers, Spray Ponds

Open Recirculation Cooling System:
Open recirculating cooling water systems are the most widely used designs in industry. Just as in closed recirculating systems, the open system uses the same water over and over again. Its most visible feature is the large, outdoor cooling tower that uses evaporation to release heat from the cooling water. This system consists of three main pieces of equipment: the recirculating water pump(s), the heat exchanger(s), and the cooling tower.

The cooling tower is where evaporation removes heat from the water. Theses are called “wet towers”, with the cooling water coming in direct contact with the air that flows upward in the tower. A cooling tower is a heat rejection device, which extracts waste heat to the atmosphere though the cooling of a water stream to a lower temperature. Cooling towers use the evaporation of water to remove process heat and cool the working fluid to near the wet-bulb air temperature. In the case of closed circuit dry cooling towers, they rely solely on air to cool the working fluid to near the dry-bulb air temperature.



Water coming from the heat exchanger is pumped evenly over the top deck of the cooling tower. It cascades down and is broken into tiny droplets as it passes through a series of splash plates, called tower fill. This “fill” can be corrugated plastic sheets, wooden slats, or other devices that provide maximum surface area. The splashing and film forming action increases the amount of surface area, breaking up the water molecules and enhancing evaporation. As the water droplets bounce off the tower fill, the hottest molecules break away from the water and are carried up and out of the tower as “drift”. The remaining cooled water collects in a tank at the bottom of the tower, called the basin. This cooled water can now be pumped back into the heat exchanger.

These designs are chosen in applications where larger temperature changes are desired and water costs are relatively high.

The drawback to this system is that water is evaporating over and over, which concentrates dissolved and suspended solids. If such a system is left untreated or a portion of the water is not released from the system, problems can occur. These solids eventually reach a saturation point and begin to precipitate and deposit. Water treatment processes can extend the saturation point, prevent scaling and corrosion, and also conserve water.

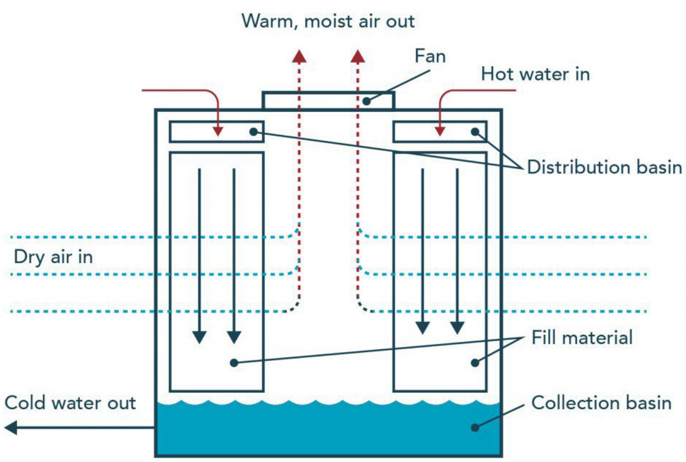
Chemical inhibitors and better mineral control allow cooling water to operate at much higher solids concentration which results in conservation of energy. However, there is a limit to the solids concentration or "cycles" of concentration that can managed by an inhibitor. For this reason, dissolved solids in the cooling water are reduced by wasting or "blowing-down" a percentage of water from the system with the help of a conductivity controller. Blowdown quantities and timing are critical activities in managing such cooling systems.

Poor blowdown control will lead to scale, corrosion, deposits and wasting of water and treatment chemicals. It is for this reason, that it is necessary to determine the blowdown amount mathematically and chemically.

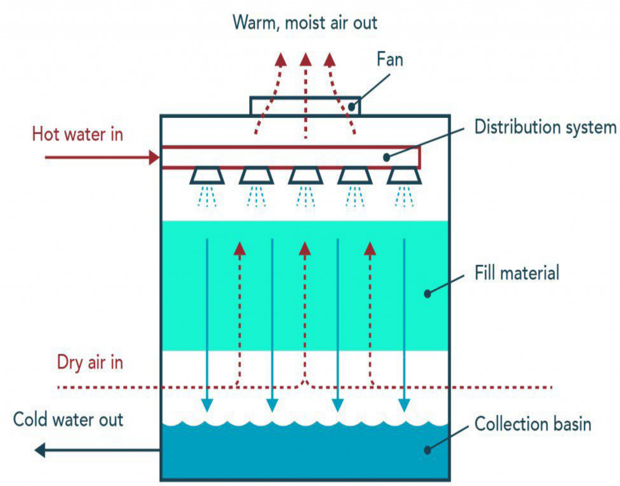
Cooling Towers are classified with respect to water flow:

Crossflow is a design in which the air flow is directed perpendicular to the water flow (see diagram at left). Air flow enters one or more vertical faces of the cooling tower to meet the fill material. Water flows (perpendicular to the air) through the fill by gravity. The air continues through the fill and thus past the water flow into an open plenum volume. Lastly, a fan forces the air out into the atmosphere.

A distribution or hot water basin consisting of a deep pan with holes or nozzles in its bottom is located near the top of a crossflow tower. Gravity distributes the water through the nozzles uniformly across the fill material.



Counterflow is when the air flow is directly opposite to the water flow (see diagram at left). Air flow first enters an open area beneath the fill media, and is then drawn up vertically. The water is sprayed through pressurized nozzles near the top of the tower, and then flows downward through the fill, opposite to the air flow.



Common aspects of both designs:

- The interactions of the air and water flow allow a partial equaliztation of temperature, and evaporation of water.
- The air, now saturated with water vapor, is discharged from the top of the cooling tower.
- A "collection basin" or "cold water basin" is used to collect and contain the cooled water after its interaction with the air flow.

Both crossflow and counter flow designs can be used in natural draft and in mechanical draft cooling towers.

SENSORS & INSTRUMENTATION FOR COOLING TOWER WATER TREATMENT:

The most important instrumentation control parameters in cooling tower water treatment are Conductivity and pH. Additional water quality parameters that should be measured online or sampled frequently include turbidity, total suspended solids (TSS), free chlorine, and oxidation reduction potential (ORP).