YWCT
Custom Cooling Towers

Basic cooling tower terminology

General

A cooling tower is a facility used to remove excess heat. The heat removal process is based on a special property of water: the ability to evaporate a portion of the circulated water after it has had contact with surrounding air. The evaporation process releases apportion of the Latent heat energy in the water and transfer the heat from the water to the surrounding air.

Design parameters

In order to choose the appropriate cooling tower, first a number of thermal calculations must be performed. For these to be done, first and foremost, at least 4 parameters must be determined:

- **Flow rate:** the flow rate of the circulated water in the cooling tower.
- **inlet Temperature:** planned hot water temperature in the cooling tower
- **Outlet temperature:** desired cold temperature
- **Wet bulb design temperature:** the temperature shown on a regular thermometer that is wrapped in moist fabric (wet bulb thermometer) in the area of the cooling tower at the tower's design point. As evaporation is an endothermic, or heat-consuming process, the temperatures measured by the wet bulb thermometer are lower than those measured by a regular (dry) thermometer. The WBT is the benchmark for the cooling tower's performances, and the temperature of the cooled water exiting it may approach this temperature but may not reach it.
- **Delta Δ:** the difference between the water's entry and exit temperatures (range)
- **Approach:** the difference between the exit temperature and that shown on the wet bulb thermometer is called the *approach*, because as explained above, the cooled water temperature may only approach the wet bulb temperature but may not reach it.

ΔT
- Inlet water temperature – hot water
- Outlet water temperature – cold water

Approac
- Wet bulb temperature

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Basic equation

The basic equation for a cooling tower is: $Q = m * C * Delta\ \Delta T$ where:

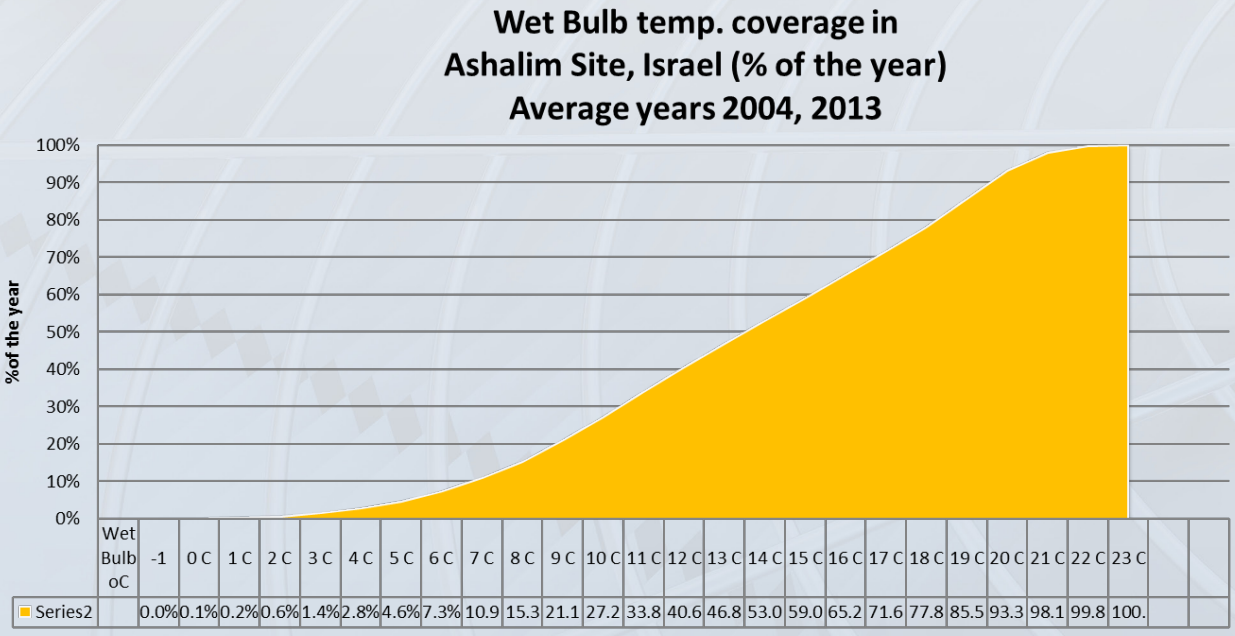
- **M – mass of water (in kgs)**
- **C – the specific heat of the water equals or nearly equals 1 (calorie/gram)**
- **Delta Δ - see above (Celsius)**
- **Q – quantity of heat that to be removed (calories)**

To calculate the size of the required cooling tower, double the ΔT (range) in the water flow rate (in liters/kg). In other cases, we know the quantity of heat that must be removed from the process in calories per hour.

At the same time, the quantity of heat that must be removed (calories) is not sufficient to design the physical size of the tower. In order to obtain the required heat exchange area, we must take into account the required approach to the wet bulb temperature.

Design wet bulb temperature

The design wet bulb temperature is the benchmark for the cooling tower designer. In the vast majority of cases, an annual per-hour spread of wet bulb readings can be obtained at the tower's planned location. This temperature is derived from the geographic locale and environmental conditions (ambient temperature and humidity). This temperature fluctuates over a 24-hour period, and also over the seasons. A sample graph of a temperature spread is shown below:



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In the above example, we see that 98.8% of the time, i.e., 8,742 hours of the year, the wet bulb temperature did not exceed 22° C.; and that in 100% of the readings, it did not exceed 23°. The decision regarding the design wet bulb temperature is in the client's hands: If he is willing to accept a situation wherein 18 hours (18 = 8,760 – 8,742) a year, the water's exit temperature is slightly higher than required he must choose a wet bulb design temperature of 22°. If he wants to be more stringent and be sure that the water supplied by the cooling tower is colder than the required cold water temperature at all points throughout the year, he should choose a wet bulb design temperature of 23°. This difference (of 1° approach) can have significant implications for the size of the tower and its price: The more important it is to achieve approach (i.e., smaller difference) between the cooled water and the wet bulb temperature, the larger the cooling tower must be.

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