YWCT
Custom Cooling Towers

Cooling tower water treatment

General

The cooling tower is a unit designed to remove heat produced from a certain (usually industrial) process into the surrounding air via water. The removal of surplus heat is carried out by creating a direct encounter between hot water resulting from the process and the surrounding air. The encounter between water and air causes condensation of a small quantity of the water, which leads to cooling of the water to a few degrees below the ambient temperature. The cooled water is normally circulated via heat exchangers which transfer the heat from end user to the cooled water. To maintain the heat-exchanging equipment intact and in working order, the water in the cooling tower must be properly treated.

Objectives of water treatment in the cooling tower – prevention of:

- Residue and mineral buildup
- Corrosion
- Micro-organism growth

These objectives are achieved via filtering; softening or distilling; drainage, and adding appropriate chemicals.

Terminology

- **Evaporation –** The water that evaporates during the cooling process. The quantity of evaporating water in the tower is in direct proportion to the heat that the tower removes. Roughly, as a rule of thumb, the rate of evaporation is about 1% of the total circulating flow. Below is a slightly more precise formula that enables estimating the evaporation:

  0.0016 x [OC] DT x total circulating flow (m^3/h) = Evaporation (m^3/h)
- **Blow down –** Drainage of water from the system. As a result of the water condensation, the level of solids (and dissolves solids) in the circulating water in the cooling tower rises. To maintain a defined level of solids in the water, deliberate blow down must be carried out in. This quantity is determined by a pre-defined level of electrical conductivity of the water that constitutes an indicator of the level of salts in the water.
- **Makeup water –** As its name implies, makeup water's function is to make up the quantity taken out by evaporation and blow down. As a rule of thumb, the quantity of makeup water is approximately 1.33%-2% of the total circulating flow of the cooling tower.

YWCT
Custom Cooling Towers
Yerushalmi Water Cooling Towers 30 Hutzot Hayotzer, Ashkelon, Israel
08-6718802 | 08-6718713 | info@ywct.com | www.YWCT.com

- **Number of Concentration cycles –** this is the ratio between the chloride levels (or conductivity) in the cooling tower circulated water and the chloride levels (or conductivity) in the makeup water (Normally 3-4). This ration is determined by the water treatment company as per the ability of the components in the system (the cooling tower and the heat exchangers) to cope with the concentrated water parameters. A simple formula showing the ratio between the number of concentration cycles, the quantity of evaporated water, and the blow down water in the cooling tower is:

$$\frac{Evaporation}{\text{Concentration Cycles} - 1} = \text{Blowdown}$$

Factors that must be treated in a cooling tower

- **Suspended solids –** The makeup water contains solids that do not dissolve, such as sand, clay, organic decay compounds, and corrosion byproducts. In addition, open cooling towers are exposed to the environment, and therefore accumulate contaminants from the air. These solids settle in the basin, pipes and other equipment, impeding the heat exchange process, and sometimes causing blockage.
- **Calcium and magnesium (non-soluble salts) –** Non-soluble minerals are the main cause of scaling (mineral buildup) in the system. The mineral buildup on top of the heat exchange surfaces reduces the efficiency of the heat removal and can decreases the flow cross-section in the pipes. The consequence of the mineral buildup is energy waste and inefficient cooling process. For example - A 1-mm layer of mineral buildup results in a 3% waste of energy.
- **Other minerals –** These minerals / salts in the water break down into negative ions (chlorides, bicarbonates, sulfates, and others), and positive ions (mainly alkaline metals). They increase the levels of conductivity and corrosion. The corrosion process in turn creates additional residues and can damage the system's components.
- **Micro-organisms –** The cooling system provides favorable conditions for the development of micro-organisms such as algae, bacteria, mold, and fungus, which reduces the efficiency of the heat removal and can decreases the flow cross-section in the pipes.

Types of cooling tower water treatment

- **Filtering –** The filter system decreases the level of suspended particles such as sand and clay, in turn decreasing the danger of residues. In cooling towers, it is acceptable to filter a side stream of about 10% of the total circulating flow at a filtration level of about 50-200 microns.
- **Chemically treating the water –** To prevent the buildup of non-soluble minerals on the heat exchange surfaces, chemicals are added that and connect to the minerals / salts thus creating particles that can be drained from the system. The chemicals are added in proportion to the make-up water quantity. Cooling tower treatment systems for the most part include monitoring of acidity levels and the quantity of inhibitor that curbs corrosion. In addition, the chemicals used create a layer of kinetic passivation on the metals that acts as protection from corrosion.
- **Softening –** A water softener can be installed in the cooling tower that replaces the calcium and magnesium ions with nitrate or potassium ions. The softening process lowers the non-soluble mineral levels in the water, in turn lowering the risk of mineral buildup.

- **Electro-chemical systems –** These include a reactor tank fitted with electrodes. The electric current that passes through the electrodes creates a chemical reaction that depends upon the water quality, the coating of the electrodes, and the size of the current. A settling process is created inside the tank, thus preventing residue in the system. In addition, the process produces oxidation compounds that offer a certain degree of disinfection of the water.
- **Desalination/Distilling –** This system (either reverse osmosis or ion exchange, DI) removes the salts from the water, and consequently the calcium and magnesium. The resulting water contains fewer salts, which enable to operate In a higher number of concertation cycles thus reduce the makeup water quantity and save water, energy, and chemical costs.
- **Preventing micro-organism growth –** In order to prevent micro-organism and algal growth, a biocide is added to the cooling tower pool. This chemical is injected in certain dosages once or twice weekly.

The table below shows monitoring values and water quality values in the cooling tower

Parameter being tested	*Units*	*Importance of the test*	*required value in the cooling tower*	*Quality of Israeli water*
EC-Conductivity	MicroSiemens µS	The water's electrical conductivity increases the larger the quantity of salts therein. Indicator of water's overall salinity levels.	100-1000	< 3,000 (25 c°)
TDS Total Dissolved Solids	Mg/L ppm	This value expresses the quantity of dissolved solids in the water (total ion quantity).	100-1,000 standard 600 >	< 2,000
Chloride levels (Cl-)	Mg/L ppm	Corrosion can occur as a result of high chloride levels.	20-500	< 300
(SO_4) sulfates	Mg/L ppm	Expresses high phosphorous acid saline levels, which can contribute to corrosion.	10-60	< 250
LSI	Mg/L ppm	This value expresses the corrosiveness level of sediments in the water. The value is comprised of pH, CaCO3, Alk; TDS, T(C°).		Positive close to 0
TH – Total Hardness (as CaCO3)	Mg/L ppm	This value expresses the water's hardness and settling potential, particularly the level of calcium and magnesium ions, an indicator of the presence of all ions in the water, including bicarbonates, chlorides, and others.	200-350	< 750

Yerushalmi Water Cooling Towers 30 Hutzot Hayotzer, Ashkelon, Israel
08-6718802 | 08-6718713 | info@ywct.com | www.YWCT.com

Parameter being tested	*Units*	*Importance of the test*	*required value in the cooling tower*	*Quality of Israeli water*
Alkalinity – (temporary hardness, as CaCO3)	Mg/L ppm	Expresses the carbonate levels in the water. Along with calcium and magnesium, carbonates cause hardness. The origin of the term "temporary" lies in the fact that water hardness is not a constant state, but rather depends upon the water's temperature and pH levels.	200-300	< 800
(Si) silica fixed hardness	Mg/L ppm	This value represents the potential for formation of sediments that can't dissolve (silica produces carbon): Non-soluble minerals, for example calcium sulfate, which settles at temperatures above 130 OC, and which are difficult to remove , as opposed to temporary hardness salts.	10-20	< 150 as SiO_2
Total Suspended Solids TSS	Mg/L ppm	This value expresses particles of various sizes, from 0.45 micron, that cause turbidity and sediments in the water. The desired specific value for cooling towers depends on the type of fill installed. This is the most significant datum predicting the fill's tendency to clog.	~1	< 50
Particle size distribution PSD		This test determines the range of the size of the particles by filtering at various levels. It helps in deciding which type of filter is best for the water in use.		
temperature	c°	Water temperatures can change the rate and force of chemical activity significantly.	17-22	15-40
High pH		Low PH value (< 7) indicates of high potential for corrosion. High PH value (> 7) indicates of high potential for sedimentation.	7-8	7 – 9 (at 25 c°)

Yerushalmi Water Cooling Towers 30 Hutzot Hayotzer, Ashkelon, Israel
08-6718802 | 08-6718713 | info@ywct.com | www.YWCT.com