Cooling Towers

Industrial process cooling towers recirculate water to cool hot process fluids. The largest cooling towers in Washington are located at petroleum refineries.

Description of Process

Cooling towers are heat exchangers that are used to dissipate large heat loads to the atmosphere. They are used in a variety of settings, including process cooling, power generation cycles, and air conditioning cycles. All cooling towers that are used to remove heat from an industrial process or chemical reaction are referred to as industrial process cooling towers (IPCT). Cooling towers used for heating, ventilation, and air conditioning (HVAC), are referred to as comfort cooling towers (CCT). Cooling towers are classified as either wet towers or dry towers. Dry towers use a radiator like cooling unit instead of water evaporation. Dry cooling towers, HVAC, and CCT are not included in this report.

Most plants use *indirect contact* cooling. Hot process fluids pass through one or more heat exchangers, condensers, etc., which allow heat to be transferred from the process fluids to the cooling tower water without any contact with the process materials.

Some industries use *direct contact* cooling. Cooling is achieved by placing the water in direct contact with hot materials, picking up surface contaminants like oils and dirt. The warmed water is then is collected, cleaned, (e.g. sent through an oil water separator,) then returned to the cooling tower.

Cooling towers cool the warm water by contacting it with ambient air. The warm water is pumped to the top of the IPCT and is distributed across the distribution deck where it flows through a series of nozzles onto the top of the tower's fill material. Fill material is used in cooling towers to create as much water surface as possible to enhance evaporation and heat transfer. As the water flows down the fill material, it contacts air that is drawn or forced across the fill material by one or more fans at the top of the tower. A small percentage of the water evaporates, cooling the circulating water and heating the air. A smaller portion of the water is entrained in the air stream as droplets of water which are called "drift" if they leave the tower. The warm, moist air then passes through the drift eliminator and exits the tower through the fan stack(s), carrying some residual drift out of the tower. The cooled water falls into a cold water basin, which typically is at the base of the IPCT. From there, the water in the cold water basin is pumped back to the processes served by the tower.

Methods of Determining Emissions

The two types of emissions from cooling towers are evaporative and drift. Evaporative emissions are made up of pure water and possibly volatile contaminants. Drift emissions are water droplets containing dissolved and suspended solids. Drift droplets have the same water chemistry as the water circulating through the tower. Water treatment additives contain anti-corrosion, anti-scaling, anti-fouling, and biocidal additives which can create emissions of VOCs, particulate matter, and toxic compounds. If an industrial process leaks into, or direct contact cooling contaminates the cooling water, these contaminants can be

emitted either as volatilized gas, or dissolved and suspended in water drift droplets. Cooling towers can scrub particulates from ambient air, contaminating the cooling water.

For contamination calculations, each will best be done on an individual basis, using process specific knowledge of chemical exposure potential, tower water analysis, and material balances done using best engineering judgment. EPA emission factors can be used as guidelines, but process specific analyses are better.

Particulates are the traditional cooling tower emission measured. Emissions of cooling water treatment chemicals in "drift" can create salting near the tower and PM10 emissions. Particulate and drift emissions can be estimated using AP-42, Chapter 13.4 emission factors.

The NESHAP for Industrial Process Cooling Towers (FR 94-21957) eliminated the use of chromium-based water treatment chemicals for IPCTs that are a major source, or an integral part of a larger major source. Chromium in the +6 valence, a toxic air pollutant, was used in these treatment systems. Phosphate and polymeric dispersant based water treatment chemicals are a typical alternative. Molybdates and zinc are also used. The NESHAP discourages smaller area source IPCTs from using chromium-based water treatment systems through record-keeping requirements.

Biocides are added to cooling towers to inhibit biological growth. Washington State IPCTs have reported chlorine, bleach, and bromine usage. Other biocide systems are probably used also.

Water treatment systems are continually being improved, and system chemistries are often kept confidential by the supplier. For permitting purposes, a supplier will usually divulge the chemistry, but often will label it confidential.

References

Air and Waste Management Association. *Air Pollution Engineering Manual*. New York: Van Nostrand Rienhold, 1992.

Code of Federal Regulations, 40CFR 63 Subpart Q.

National Emission Standards for Hazardous Air Pollutants for Industrial Process Cooling Towers, Federal Register (FR) Doc. No. 94-21957, September 8, 1994.

Prohibition of Hexavalent Chromium Chemicals in Comfort Cooling Towers, Federal Register, 55 FR 222, January 3, 1990.

U.S. Environmental Protection Agency, *Compilation of Air Pollutant Emissions Factors Volume 1: Stationary Point and Area Sources*, Fifth Edition with Supplements, January 1995, Document No. AP-42. (Section 13.4 Wet Cooling Towers, January 1995.)
(available by section on Internet at http://www.epa.gov/ttn/chief/ap42.html)

U.S. Environmental Protection Agency. *Methodologies for Estimating Air Emissions from Three Non-Traditional Source Categories: Oil Spills, Petroleum Vessel Loading and Unloading, and Cooling Towers*, June 1993, EPA/600/SR-93/063.