EnviroAqua CONSULTANTS INC.

Water Talk

Volume 10, Issue 8 *August 2010*

Water Fundamentals for Cooling Towers & Heat Exchangers

Cooling Towers and heat exchangers are used in the processes and cooling of machines in many industries and in the air conditioning of buildings, etc. They are designed and made in several types and numerous sizes, water and atmospheric air being the common media of heat exchange in all of them. It is essential to maintain the water quality, which is highly effected by the atmospheric air, for the efficient operation of the cooling towers, heat exchangers, and other downstream equipment.

Air quality affects water quality

Water quality is affected by the air quality at any particular site. The air quality at many sites in the western United States is dusty and is the cause of serious adverse effects upon both a cooling towers longevity of service and its ability to function efficiently. This is because the cooling towers are extremely effective air washers; the quality of water being circulated in a tower quickly reflects the quality of the air with which it is in intimate contact. Cooling towers pick up a lot of dust and other airborne particles from air, which then gets washed out by the circulating water and carried away as sediments into the downstream processes.

This constant washing of the incoming atmospheric air as well as the base characteristics of the water supply are the parameters that establish the ultimate quality of the continuously recirculated water. The quality of circulating water is further complicated by the fact that the process of evaporation causes incoming contaminant levels of concentrate tremendously.

As the airborne contaminants and total dissolved solids become concentrated in the cooling water circulating system, it leads to build up of sediments, clogging or deposition, and eventually the system loses its efficiency and capacity to cool effectively. Pipelines, internal passages of heat exchangers and other equipments may be difficult, time consuming or even impossible to clean properly.

Filtration

Filtration is an essential requirement to remove contaminants like rust, sand, silt, sediments, and other suspended impurities. If not filtered out, these particulates tend to settle out in the cooling tower basin and other parts of the system where they can become a breeding ground for bacteria, requiring frequent cleaning and flushing. *Such contaminations, apart from degrading system heat transfer efficiency, by their very presence, drastically increase the cost of chemicals for water treatment.*

Benefits of filtration

Clean filtered water offers many benefits:

1. Savings in energy use due to better heat transfer.
2. Savings in cost of water treatment chemicals, cleaner water, and lower dosage of chemicals required to control scale and algae, etc.
3. Chemical treatment programs give more predictable results with filtered water.
4. Savings in maintenance labor and cleaning costs.
5. Less equipment downtime as filtration is the major part of the preventative maintenance of cooling systems.
6. Filtration protects and improves life of plate, frame, shell and tube heat exchangers; pump seals, spray nozzles, valves & seats, piping and other downstream equipment.

Contamination and Turbidity

High level of contaminants and turbidity, depending on their character and content, can cause many problems in a cooling tower and related downstream equipment. In mild form, contaminants may only increase the frequency of silt removal and cleaning. In the more aggressive form, contaminants may clog water distribution system, silt buildup in water basins, and obstruct passages in heat exchangers, etc. Some forms of contaminants like iron oxide and sulfurous compounds may build up and solidify on all surfaces, proper cleaning of which may be difficult, costly and even impossible.

Bacterial slime in cooling towers can form rapidly on towers where the circulating water has high level of particles, sediments, and other contaminants, ultimately plugging up the water and air passages. With dirty water, bacteriological build-up has to be removed from the cooling tower more frequently by use of higher dosage of chemicals with physical cleaning and flushing of the system.

Filtration system design

Filtering systems can comprise of one or more methods depending on the area and location of the cooling tower site. An increasing number of installations are now utilizing cartridge filtration systems to control particulate levels and thus maintain cleanliness levels of the tower and overall water circulation system. A graded density cartridge filter removing particles in the range of 5 to 20 microns is normally used in cooling water filtration as 90% of the contamination is in this range. Typically, these systems are sized to continuously filter the cooling tower basin water inventory at a rate equivalent to about 5% of the total circulation rate over the tower, depending on the rate at which particulates are reintroduced into the system. Most dusty locations need filtration rates designed in excess of 10% of main flow.

Although filtration can be accomplished at almost any section of the water circulation system by means of a by-pass (side stream) arrangement, location such that only the basin water inventory is filtered with an independent pump and circulation piping is also satisfactory. Here the filtered return stream into the basin can be directed, through perforated piping, to sweep collected sediments toward the filter's sump connection. Depending on location, cartridge filtration alone may be used. However, in particularly dusty locations, sedimentation tanks need to be incorporated in addition to cartridges for economical filtration. Sometimes the water from cooling towers is piped to various points of use; additional cartridge filtration may be employed by filtering 100% of the water entering those sensitive heat exchangers and other equipments having fine and intricate cooling passages susceptible to clogging or where any particles can be detrimental to the process.

Blowdown

Blowdown is the method used for controlling TDS concentration where a portion of the circulating water flow is wasted and replenished with clean make-up water. Water continuously evaporates from cooling towers in a pure vapor state; it leaves behind its burden of total dissolved solids (TDS) to concentrate in the circulating mass of water. Without regular blowdown, the TDS level in the circulating water increases tremendously, jeopardizing not only the cooling tower, but also the heat exchanger and all other water circuit related components as well.

Chemical treatment

Chemical treatment of water, in addition to blowdown and filtration, is required to prevent scale formation, corrosion, or biological growth. For the proper chemical treatment, the services of a reliable company supplying such chemicals should be obtained.

Scale prevention

The major scale forming dissolved contaminant in cooling water is calcium carbonate, which is formed by the decomposition of calcium bicarbonate. The amount of calcium bicarbonate held in solution depends upon the temperature and the free carbon dioxide content of the water. Raising the temperature or reducing the free carbon dioxide, at the point of equilibrium, will result in the deposition of scale. Advice of a treatment company is required to select the chemical compounds to keep scale-forming solids in solution.

Corrosion control

The materials used in the construction of cooling towers and heat exchangers are susceptible to corrosion in varying degrees. Circulation water usually has corrosion characteristics and requires treatment. This corrosive character may be due to the high oxygen content, carbon dioxide, low ph, or the contact of dissimilar metals. Various treatment compounds are used as inhibitors, which act to build and maintain a protective film on the metal parts. In most water systems corrosion occurs as a result of electrolytic action. With evaporation of water the dissolved solid content increase which increases the conductivity and corrosion potential. Therefore, in addition, to chemical treatment, blowdown is important to minimize corrosion.

Control of biological growth

Algae (green moss) and slime (gelatinous organic material) may develop in the cooling tower and result in loss of cooling efficiencies. Various proprietary algaecide and slimicide compounds are available from water treatment companies.

Foaming

Foaming sometimes occurs, in new systems it may subside after a short period and use of blowdown method, persistent foaming caused by contamination of the circulation water requires added foam depressant chemicals.

Control of suspended impurities

Various contaminants brought into the system from the air or from incoming water sources are best removed by continuous filtration. Oils and fats are removed from the circulation water by

means of a skimmer. In case of abnormally dusty areas where sedimentation tanks are used as part of the filtration system, the oils and other particulates whose tendency is to float could be skimmed off by means of an overflow weir.

Tower location and orientation

To minimize pickup of contamination from air as well as for the proper functioning of the tower, proper location at the site and orientation to prevailing wind, amongst the myriad of other factors, is most important. The placement at site is best determined by cooling tower consultants.