The Right Water Treatment Makes the Difference for Power Plant Cooling Towers

SIEMENS

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Power plants need a consistent, reliable source of water for cooling tower make-up that is also cost effective and sustainable. In many cases, cooling tower make-up water must be treated to soften, or remove solids, and in some cases deal with organics. With properly treated water, the potential for scaling in the cooling tower is significantly reduced. This reduces cooling circuit cleaning requirements, extends the life of the cooling equipment and reduces the cooling tower blowdown flow to the environment.

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Table 1 shows typical water parameters and product water requirements in cooling tower make-up influent.

Parameter	Units	Influent Range	Typical Product Water Requirements
pH		2-13	6-9
Total Hardness	Mg/L as $CaCO_3$	100-1,500	<100
Total Suspended Solids	Mg/L	5-500	<10
Silica	Mg/L	5-100	<15
Total Organic Carbon	Mg/L	0-50	<10

Table 1

For treating cooling tower blowdown, systems that remove silica, hardness and other suspended solids are used. Additional technologies can be implemented to further treat the water before it is returned to the cooling towers, thus significantly reducing wastewater and sludge volume.

Choosing the Right Technologies

The choice of technologies and the specific treatment train depends on the raw feed water quality, the desired make-up water quality and the flow requirement. Another consideration is the target cycles of concentration for the cooling tower. The target blowdown flow from the cooling tower and the discharge limits are also factors to consider, as is the sludge treatment/disposal method. Additional factors such as improved effluent quality, reduced waste production to meet regulations, efficient use of space and reduced chemical usage, can have a positive impact on capital and operating costs during the life cycle of the power plant.

Treatment technologies for cooling tower make-up can include clarification and softening systems. However, traditional clarifiers rely on long detention times and rise rates of 0.5 to 1.5 gallons per minute (gpm) per square foot to deliver the required effluent quality. These systems typically include a solids contact clarifier or a mixer/clarifier/flocculation tank and a sludge thickener for waste handling. Since these steps can use separate basins, the system has a large footprint -- approximately 1gpm/ft^2 or less in some applications. These systems also take longer to produce usable water from start-up, due to longer basin retention times, which can be a disadvantage to peaker plants.

High-Rate Clarification Technology

Technologies have been introduced that allow higher rate systems with reduced detention times and waste volume. These include rise rates up to 6-8 gpm/ft^2 and even higher in some stages of the process treatment train, while maintaining excellent effluent levels. One such unit is a high rate clarifier incorporating a thickening process (the Contrafast® system, Siemens Water Technologies).

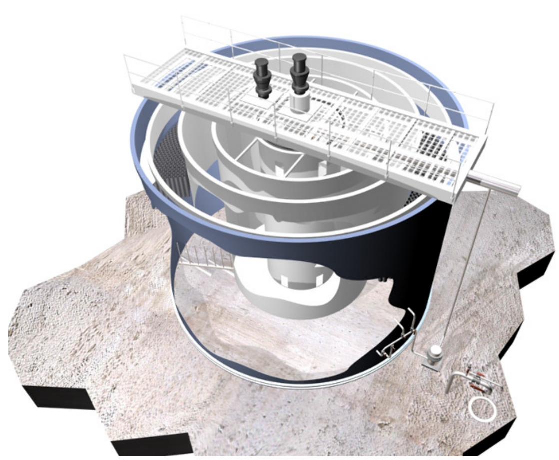

Figure 1

Besides providing high effluent quality, this system also has a smaller footprint and reduced waste production. While traditional clarification systems use separate basins for the different process steps, the high-rate clarifier consists of a solids contact reaction chamber, clarifier with tube settler and gravity thickening in a single process train or unit. This allows up to an 80 percent reduction in footprint and as much as 10 times higher sludge concentration. For flow rates up to 1.0 MGD, the high-rate unit is contained in a single, round, steel basin; for larger flows, a concrete process train is used. The footprint reduction is important for power plants with limited space for expanding their existing water treatment systems.

Power plants that need rapid increases in water during peak demand require a system that can quickly provide sustained quality levels for water use. The high-rate clarifier, due to its process, provides this ability. It is also capable of continuous operation for sustained demands. It uses a simple controller that does not require a programmable logic controller (PLC) unless chemical feed systems and/or sludge dewatering systems are added. The clarifier only requires limited operator monitoring once an appropriate sludge level is developed in the reactor. It enhances suspended solids removal, can provide softening and heavy metals removal. The high quality effluent water produced may not require additional filtering before the water can be used or discharged. The high-rate process uses lower chemical doses compared to traditional clarifiers, thus reducing operating costs.

When raw water enters the process train, it is treated with a coagulant and a polymer to facilitate floc formation. Softening will require lime or caustic addition. The high-rate clarifier's reaction chamber has a flow rate approximately 10 times that of the influent flow. The combination of high shear mixing in this chamber and floc dewatering allows for higher settling rates of the sludge material, and increased sludge densification. The clarifier produces a sludge density of approximately10% without having to use a thickener basin, whereas a conventional clarifier produces a sludge density of only around 1-2%. Although greater densities from the high-rate clarifier are possible, this can result in excessive wear and increased power consumption on the sludge handling and discharge system.

In a properly designed and operated high-rate clarifier system, effluent water consistently contains less than 5 true color units, and turbidity levels of less than 2 NTU. The system can be used ahead of a filter, but the operator should pay attention to the amount of polymer carry-over that may occur. Excessive levels of coagulant carry-over can result in reduced filter run times, increasing the wastewater amount.

Packaged Treatment Systems

When lime softening is not required, but the plant's source water quality varies significantly, packaged water treatment systems that incorporate a multi-barrier design are ideal. One packaged system, the Trident® HS system, uses a two-stage clarification process followed by a mixed media filter to successfully treat raw water with high turbidity levels (up to 400 NTU and peak values up to 1,000 NTU).

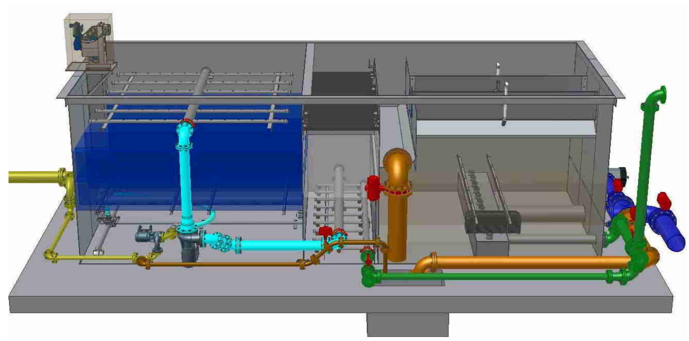

Figure 2

In the Trident HS system, coagulant and polymer is added in the first stage to aid flocculation. The dosed water is forced up through settling tubes where large floc particles settle to the bottom of the tank. Periodically, a sludge blowdown is performed. In the second stage, the water is pumped through a buoyant media – the Adsorption Clarifier®. Because buoyant media is used, this type of clarification cannot be used for lime softening, due to the scaling effects. However, it is excellent for solids removal, particularly in cold water environments, as the solids do not need to settle to the bottom of a basin.

The first stage reduces the turbidity level in the water by approximately 95%, while the secondary clarifier traps and retains smaller floc particles and reduces the effluent from this stage by an additional 95%. In general, systems recirculate around 10% of the sludge collected in the first clarification stage. By recirculating a percentage of the separated sludge into the influent stream, large and/or rapid changes in raw water turbidity result in small changes seen by the treatment system. This process results in efficient use of chemicals and improved floc formation and retention in the clarification stage. For example, the water coming from a river may be 100 NTU, but by adding sludge from the first stage, the incoming turbidity is elevated to around 300 NTU. Now, if the level in the water rises to 150, the amount of sludge is reduced to maintain the turbidity around 300. Also, because the sludge that is re-circulated has already been doused with chemicals, any unused amount will be reused in the second pass and also enhance floc formation.

After the water passes through the clarification stages, it is filtered through a mixed media gravity filter. The media is tailored to meet the effluent requirements, based on raw water conditions. The filter must be periodically backwashed to waste, typically once every 24-48 hours, to remove contaminants trapped by the filter. When further polishing of the water is not required, the filter can be removed from the system and the unit will still deliver quality water.

The packaged system provides a net water production above 95% while removing up to 70% TOC and generating low total waste volume. For flow rates below 3 MGD, complete fabricated steel packages are available. For larger flows, a concrete process train is typically used.

In many cases, this high-effluent quality water can be combined with raw source water and still meet applicable limits. The package plant can be used for process water or tertiary wastewater applications, for large or small flows on new or retrofit projects.

Return on Investment

Initial capital equipment costs may be higher for high-rate water treatment systems; however, these systems provide reduced installation costs since major assembles are pre-fabricated before being transported to the site. They provide advanced, automated methods for reducing phosphorus, true color, suspended solids, BOD, and COD from surface or ground water. What's more, they provide a fast return on investment with their higher loading rates, reduced footprint and waste disposal costs.

A Case Study Example: Cooling Tower Blowdown Treatment in Hobbs, NM

Disposal costs can be a critical factor in implementing wastewater treatment at a site. At a power plant in Hobbs, New Mexico, wastewater was collected in holding ponds and then pumped out and trucked away for disposal. The wastewater was generated from several sources at the site, with the primary being cooling tower blowdown. An equalization tank is used to collect the waste sources prior to introduction. The tank is used to prevent rapid changes in influent conditions and to maintain a consistent flow to the clarifier even as waste flows vary. A high-rate solids contact clarifier was installed to treat the water for reuse at the site, and the high solids concentration sludge is disposed of. The clarifier removes silica and other solids, and softens the water. The effluent from the clarifier is returned to filters and then reused in the cooling towers. This environmentally friendly solution reduces demand for supply water and saves money on waste disposal costs.

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