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MAXH2O Desalter Helps Minimize Water Usage in Power Plants

IDE offers a new technology, MAXH_2O DESALTER, that meets business, operational, regulatory, and environmental requirements.

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Abstract

Electric power plants use a significant amount of water. However, due to the water shortage, regulations on water discharge and cost of water, power plants require to minimize their water usage and water discharge, and reuse as much of the water as possible. To save water and reduce the amount of effluent discharge from the power plant, the amount of makeup water and blowdown from the cooling tower must be reduced. One alternative is to treat water to enable its reuse as cooling tower makeup, or elsewhere in the plant. IDE offers a new technology, MAXH_2O DESALTER, that allows achieving exactly this.

Overview

The primary demand for water in a power plant is for condenser cooling. The methods used for condenser cooling in the power plant are once-through, evaporative cooling, and dry cooling. The quantity of water required for a cooling tower is determined by a parameter known as the cycles of concentration (COC). Therefore, one of the ways to save water is to increase the number of COC. Unfortunately, this increases the potential for scaling and corrosion because of the resulting higher levels of dissolved solids.

This paper addresses:

- Methods used for cooling in power plants
- Challenges with cooling tower blowdown
- Solutions

Methods Used For Cooling In Power Plants

A significant amount of water is used in almost all power plants. The water volume required for power generation depends on several factors such as electricity generation technology, type of cooling applied and site operating conditions. The main water consumers in a power plant are cooling water, flue gas desulfurization and boiler makeup. The total water consumption in a power plant varies between 370 gal/MWhr (1.4 m3/MWhr) for natural gas combined cycle power plants, to 714 gal/MWhr (2.7 m3/MWhr) for pulverized coal power plants [1].

The main demand for water in a power plant is for condenser cooling. A power plant typically converts the energy of a fuel source (coal, gas, nuclear or biomass) to steam, which is then used to drive a steam turbine generator. After the steam is exhausted from the turbine, it is condensed and recycled for use in the production of steam again. Since the condensate must be cooled as much as possible to reduce backpressure on the turbine, this recycling of the steam is a critical process in the efficiency of the plant.

The methods used for condenser cooling in the power plant can be divided into three types: once-through, evaporative cooling and dry cooling. In once-through cooling, water is withdrawn from a lake, river, sea, or ocean, pumped through the condenser, and returned to the source at the same rate but at a higher temperature. Evaporative cooling is often used when a power plant does not have abundant water availability. The recirculating water is cooled either in a cooling tower, on site cooling pond or canal, and then recycled back to the condenser. In dry cooling, the steam is ducted to an air cooled heat exchanger where it is condensed (direct dry cooling), or condensed in a traditional condenser by cooling water that is then pumped to an air cooled heat exchanger (indirect dry cooling).

Once-through cooling is used wherever possible, since this method is very cost effective and energy efficient. Dry cooling is the most expensive cooling method and, therefore, this method is used where water is unavailable or the water cost and/or the wastewater discharge cost are significantly high. Far from the shore and other water sources, the most useful cooling method is evaporative cooling by cooling towers, since the use of ponds or canals requires significant real estate and might not be feasible for other reasons.

The most common cooling system employed in modern power plants is closed loop cooling by cooling towers. The water from the cooling tower is recirculated to the steam condenser and then back to a cooling tower. In the cooling tower, recirculated water is sprayed over the tower fill while ambient air is forced from the bottom of the tower upwards. As ambient air passes through the warm water, part of the water evaporates, cooling the remaining flow. The cooled water is collected in the bottom of the tower and pumped back to the steam condenser. To prevent the accumulation of salts in the water, part of the water is drained from the tower - the blowdown. The quantity of blowdown and makeup required for a cooling tower is determined by a parameter known as the cycles of concentration (COC), which is the ratio of dissolved solids in the recirculating water to that in the makeup water. To compensate water losses (evaporation, blowdown, drift, and leaks), fresh water, makeup, is added to the cooling tower.

Challenges With Cooling Tower Blowdown

Due to the water shortage, regulations on water discharge and cost of water, power plants require to minimize their water usage and water discharge, and reuse as much of the water as possible. To save water and reduce the amount of effluent discharge from the power plant, the amount of makeup water and blowdown from the cooling tower must be reduced. One of the ways to save the water is to increase the number of COC, which saves water as essentially it means that water is recycled longer before it is discharged as blowdown. Unfortunately, the potential for scaling, biofouling and corrosion increases significantly because of the resulting higher levels of dissolved solids and organics

An alternative is to treat blowdown to enable its reuse in the cooling tower as makeup, or elsewhere in the plant. Blowdown treatment becomes essential when blowdown discharge from the power plant is either too expensive, or in places where industrial water discharges are limited due to environmental regulation. The blowdown stream is often mixed and blended with effluents from other systems (RO/EDI/IX) in the power plant and characterized by high scaling potential of sparingly soluble salts such as silica, calcium carbonate, and calcium sulfate. Thus, conventional reverse osmosis (RO) treatment is limited in its capabilities and does not offer a cost effective solution that can reach high water recoveries and high rate of water reuse. To be able to treat the blowdown in a conventional RO, it has to go through an extensive pretreatment, such as conventional lime clarifier, to precipitate the sparingly soluble salts before the stream is fed to RO and/or downstream ZLD (Zero liquid discharge) systems such as an evaporator and Crystallizer.

Due to the challenging chemistry of the blowdown, such conventional systems, that attempt to treat blowdown, usually suffer from very high OPEX and technical difficulties which prevents them from reaching high recovery and offer a sustainable solution for treatment the blowdown.

Solutions

IDE offers a new technology, MAXH_2O DESALTER, which allows overcoming the above challenge. The technology contains a single stage reverse osmosis system, with an integrated salt precipitation unit, making it possible to treat and reuse the blowdown stream as makeup water in the cooling tower at high recovery rates and in a cost-effective way.

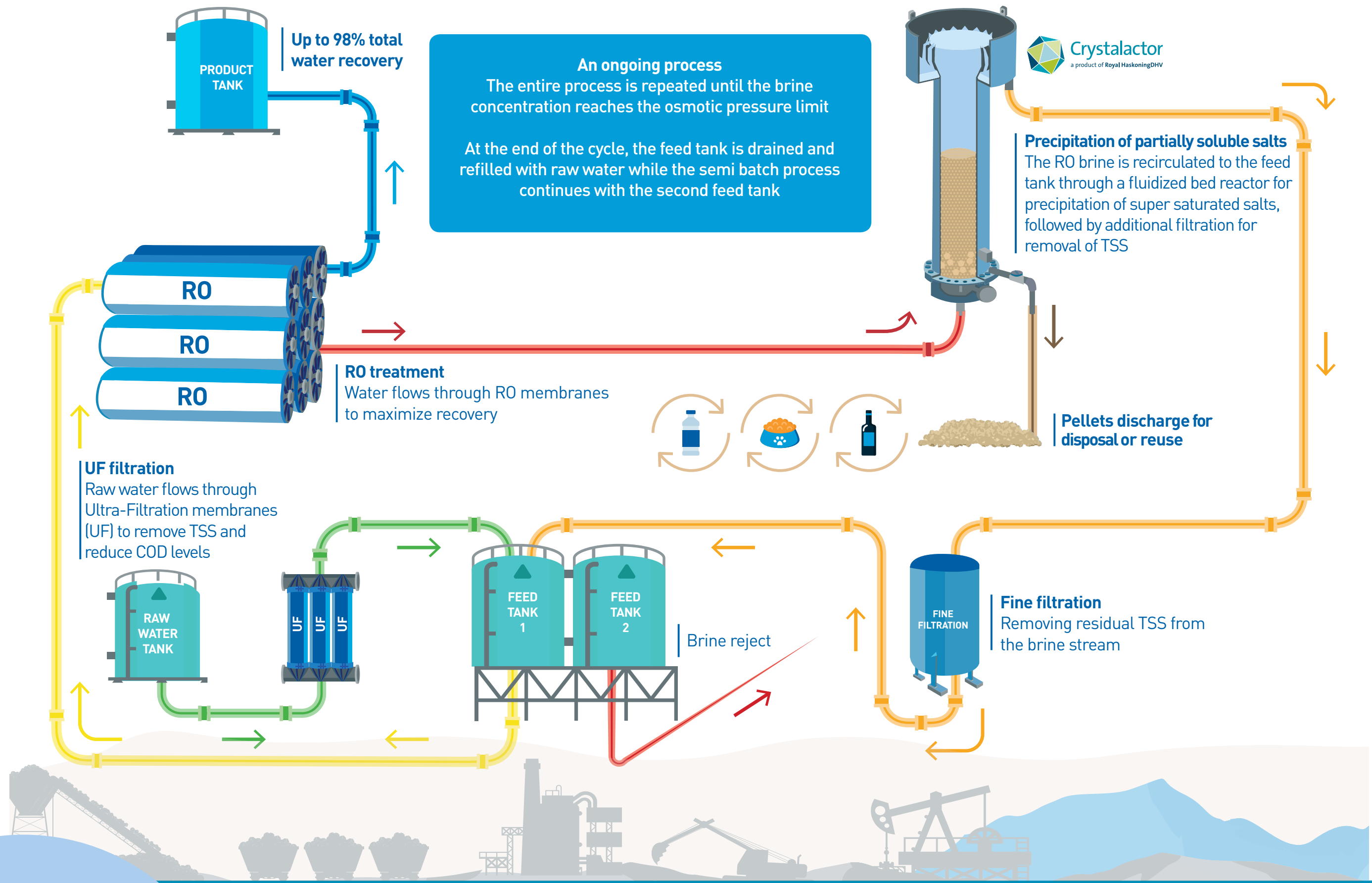
The MAXH_2O DESALTER operates by recirculating treated water through the RO system at high shear velocity, and continuously precipitating supersaturated salts from the recirculated brine. This significantly reduces the salt concentration build up near the wall of the RO membrane, and prevents the precipitation of sparingly soluble salts on the membranes. The salt precipitation unit downstream reduces the saturation of sparingly soluble salts in the recirculated brine. This allows continuous cycles through the RO system until maximum brine osmotic pressure is reached.

This solution overcomes the inability to handle variant changes in feed flow and composition, and operates at very high recoveries without compromising membrane service life, while pushing the limits for the precipitation of silica, calcium carbonate and calcium sulfate.

The system operates without the addition of chemicals other than antiscalant and calcium carbonate seeds, and produces pellets with more than 90% dry solids content, eliminating the need for further sludge dewatering treatment.

MAXH2O Desalter

Industrial Effluent Treatment & Brine Minimization



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The operational principles of this new technology are:

Recirculation of treated water through the RO system at high shear velocity, and continuous precipitation of supersaturated salts from the recirculated brine. This significantly reduces the salt concentration built up near the RO membrane wall, and prevents the precipitation of sparingly soluble salts and bio fouling on the membranes.

Brine flows through the salt precipitation unit downstream, where it reduces the saturation of sparingly soluble salts, enabling continuous cycles through the RO system until the maximal brine osmotic pressure is reached.

The fluidized bed reactor is partially filled with suitable 0.2-0.5 mm seed particles; RO brine is pumped upward through the bed of particles to maintain a state of fluidization. Seed particles are used as crystallization sites, providing a high surface area that lowers the energy required for precipitation.

The antiscalant that prevents scaling in the RO elements, together with sparingly soluble salts, adsorb and precipitate on the seed particles, creating salt-coated crystals. As the crystals become progressively heavier, they gradually sink towards the bottom of the bed.

Periodically, without interrupting operation of the reactor, the lower portion of the bed, containing 0.8-1.0 mm size crystals, is discharged and fresh seed material is introduced.

No filter or other mechanical dewatering equipment is required. The high content of dry solids (over 90%) in the obtained crystals can be easily disposed to a landfill or used for soil neutralization, road building, animal food additives, cement making and other applications.

The ability of this technology to practically eliminate the recovery limitation of water chemistry by gradually precipitating sparingly soluble salts on pellets, while operating the RO membranes at high velocity with inherently high shear forces, allows the RO unit to meet its maximal production and recovery potential, overcome chronic scaling and bio-fouling issues in RO and drive operational efficiency.

Conclusion

Power plants are one of the most significant industrial water users, with most water used for cooling purposes. Therefore, considering options to reduce water use is vital to remain in operation. With its ability to operate at a very high recovery rate without compromising membrane service life, the IDE MAXH_2O DESALTER is an optimal treatment for cooling tower blowdown, which meets business, operational, regulatory, and environmental requirements.

For more information on IDE Water Technologies' comprehensive water solutions >>

REFERENCES
"Power Plant Water Usage and Loss Study", United States Department of Energy, National Energy Technology Laboratory, 2005