Cooling Tower Blowdown

Water and wastewater reclamation and reuse in industrial applications has become a growing trend in the past decade due to rising water demand and scarcity. In fact, water treatment including the use of RO is estimated at more than 30 percent of all industrial water treatment sales globally. RO is now used to treat recycled cooling tower blowdown in zero-liquid discharge (ZLD) applications as well as to purify boiler feed water.

Many industrial plants use cooling towers as an efficient means to remove large amounts of heat from hot equipment. Cooling these plants requires a considerable amount of water—typically 80% or even up to 90% of the plant's total water needs. To treat and reuse this water instead of using fresh water, membrane technology was introduced.

COOLING TOWER BLOWDOWN PROCESS

Cool water circulating through a plant absorbs heat from the equipment and becomes warmer. When this now-hot water is circulated back to the cooling tower, some of the water is lost due to evaporation or the misting effect (when water is lost by drifting into the air). As pure water evaporates from the system, some of the dissolved solids (TDS) are left behind, causing the remaining TDS in the water to become more concentrated. If this process is continued, the dissolved minerals concentrate to a point where they no longer remain in solution. Less soluble minerals such as calcium, magnesium and silica may precipitate to form insoluble salts that may scale in the tower or within plant equipment. For these reasons, cooling towers must be operated in ways that keep dissolved minerals in solution. Often, this is accomplished by bleeding a small amount of concentrated cooling tower water to drain while replacing the water lost by evaporation and bleed with fresh cooling tower make-up water.

Most cooling towers use potable water as their make-up supply. However, as fresh water supplies dwindle and the cost per gallon rises, plants are increasingly forced to use alternative sources such as reclaimed water from municipal or industrial wastewater treatment plants or, instead of discharging water and replacing it with new fresh water, the cooling tower blowdown may be treated for reuse. Many industries are relying on reusing cooling tower blowdown to reduce their operating costs. Although using reclaimed water reduces the use of fresh water, treatment of the wastewater may be required to make it suitable for use in the cooling tower.

ULTRAFILTRATION

Whether municipal water, industrial wastewater or reclaimed cooling tower blowdown is used as make-up supply, ultrafiltration membrane modules may be used to remove suspended solids, viruses and bacteria, silica and any large organic molecules before sending the water to reverse osmosis (RO) membranes for further treatment. /Sep™ 500 UF modules and SpiraSep™ 960 UF modules may be used for feed waters with high concentrations of suspended solids (up to 1,000 mg/L TSS). These modules are vacuum-driven, backwashable, spiral-wound membrane modules designed to operate at high yields and provide a more consistent quality effluent despite changes in raw water quality. Both modules are available with a durable 0.03 micron PVDF membrane.

In one case study, a power plant aimed to reduce the amount of cooling tower blowdown water discharged to their evaporation ponds without implementing expensive brine concentrating systems such as evaporators or crystallizers. Instead, the power plant implemented electric coagulation (EC) to precipitate sparingly soluble salts, particularly silica, alkalinity and hardness. SpiraSep™ 960 UF modules followed the EC process and removed all total suspended solids prior to the RO system. This treatment approach enabled the power plant to recover close to 90% of the cooling tower blowdown water.

REVERSE OSMOSIS

Reverse osmosis is typically used after ultrafiltration to produce high purity water for the cooling towers. By removing a high percentage of dissolved solids including calcium, magnesium and silica from the cooling tower blowdown, RO reduces scale build-up within the cooling tower and scaling of the heat exchanger equipment may result in a loss in productivity on the process side of the facility. By removing these ions with reverse osmosis (RO) membrane elements, the cooling tower can run at higher cycles of concentration, and ultimately reduces the amount of blowdown and fresh make-up water required.

TRISEP® X-20™ low-fouling RO elements are highly recommended if organics are still present in the UF effluent or RO feed. The X-20 membrane is a fouling-resistant membrane with a unique, proprietary formulation that results in low-fouling characteristics. The unique barrier layer chemistry does not degrade over time like some competitive “fouling resistant” membranes that are simply “modified” or “coated” standard membranes. X-20 membrane elements are extremely durable and offer consistent high salt rejection while lowering cleaning frequency and extending membrane life.

MICRODYN RO elements may be used if most of the organics have been removed prior to the RO system. MICRODYN BW RO elements have a high rejection brackish water RO membrane suitable for water purification where high solute rejection is required. MICRODYN LE RO elements are ideal for water purification applications where reduced energy consumption is required. These elements feature our low energy membrane for directly replacing competitive RO products and operate at low pressure conditions.

ZERO-LIQUID DISCHARGE

Zero-liquid discharge (ZLD) systems often use primary and secondary RO systems to treat wastewater for make-up water. Often times, wastewater from cooling tower and boiler blow downs is first sent to a pretreatment system or an ultrafiltration system using /Sep™ 500 UF or SpiraSep™ 960 UF modules. The effluent from the pretreatment or ultrafiltration system is then sent to a primary RO system (which may consist of MICRODYN RO elements). The permeate from the primary RO is sent to the cooling tower for use while the reject is sent to a secondary RO system for further treatment and water recovery.

Because reject from the primary RO system is typically very high in TDS concentration, the secondary RO is made up of seawater RO elements. The reject from the secondary RO is then sent to a brine concentrator and crystallizer. The secondary RO system reduces the load on the brine concentrator significantly, meaning a smaller brine concentrator may be used. By using a smaller brine concentrator, capital costs are dramatically reduced.

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