WATER & WASTES DIGEST

Keeping it Cool

By Bobbie Montagno, August 23, 2018

Optimizing cooling tower performance with metering pumps

The growth of upstream activities in the Permian Basin and throughout the Middle East has increased demand at refineries and petrochemical plants, which are two of the largest water users on the planet.

Every 50,000 barrels of oil refined generates 1 trillion BTUs of heat per hour, which is removed by water that evaporates in cooling towers. Large refineries can use more than 10,000 gal per minute. The recent uptick in activity is increasing demand for a finite resource, which prompts a simple question: Has the time come for refineries to re-evaluate their water acquisition strategies and increase their investments in chemical treatment and water reuse?

The answer to this question is driven by economics and geography. Refineries in landlocked places such as Saskatchewan and Kansas have fewer choices for incoming water. As a result, they have become innovators with respect to treating and reusing municipal wastewater.

One way to reuse water in refineries starts with monitoring the levels of precipitated particles in cooling towers. A refinery's incoming water can vary depending on its source: River or lake water has fewer dissolved minerals, which can be corrosive to pipe, while well water typically contains more minerals, which can create scaling issues.

As cooling towers transfer heat from evaporating water to ambient air, dissolved solids such as calcium, magnesium, chloride and silica remain in the cooling tower. Over time, the concentration of solids increases to a point where it can diminish thermal efficiency and cause corrosion. To prevent this, the concentrated water is removed from the tower in what is referred to as "blowdown." Once removed, additional "makeup" water must be added to the cooling tower from the plant's original source.

The frequency of water replenishment in cooling towers is measured by "cycles of concentration." This term compares the level of solids in cooling tower water to the level of solids in the original raw makeup water. If the circulating water contains four times as many solids as the source or makeup water, then the cycles are four.

Cooling towers can operate within a range of two to seven concentration cycles before eliminating water via blowdown. Older refineries and plants with poor-quality source water have to flush their cooling towers after just two or three concentration cycles, and this is where the majority of water is wasted in refineries. The ability to maximize cycles in cooling towers is one of the most effective ways to save water, as an increase from three to six cycles reduces cooling tower blowdown by 50%.

Chemical Metering Pumps in Industrial Water Treatment

Although a variety of water treatment applications exist (membrane bioreactor technology, reverse osmosis, ultraviolet purification, etc.), industrial water treatment in refineries and chemical plants often involves the use of hydraulically actuated diaphragm (HAD) metering pumps to deliver specific doses of chemicals for disinfection applications and pH control, and to deliver scale inhibitors to protect plant equipment.

Disinfection applications. These are administered by dosing specific quantities of high-concentration sodium hypochlorite (bleach). When sodium hypochlorite comes in contact with bacteria, it oxidizes molecules in the cells of the germs and kills them. Even though this simple but harsh chemical has been used for more than 100 years, it is prone to causing problems for pumps by "off-gassing." To solve this issue, the pumps used to deliver it must be able to pass the gas bubbles without locking or clogging the pump.

One of the primary goals for disinfection applications in cooling towers is to prevent the growth of Legionella, a ubiquitous organism that can appear in almost all sources of water. Numerous studies have found cases of Legionella in up to 60% of cooling towers around the globe. Disinfection is important to protect plant personnel because the bacteria can spread via water droplets or mist, causing respiratory infections. The organism can

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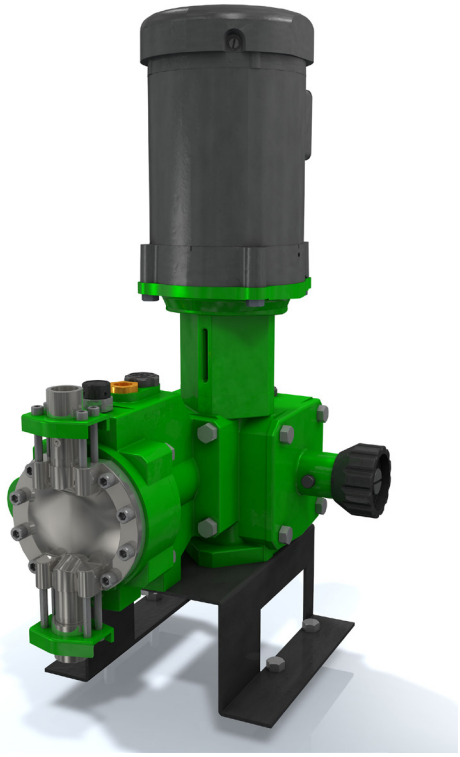
be resistant to some chemical treatments, but treatment specialists have developed tailored chemical combinations specific to the type, age and setup of a given cooling tower to properly address Legionella.

pH adjustment. While municipal water treatments typically strive to bring pH levels to neutral (7), some halogens used in refineries, such as bromine, work more effectively at higher pH levels (8.5 to 9). Metering pumps are commonly used in industrial plants to dose the exact volume of caustics needed to raise alkalinity and create the optimal conditions for halogens to work effectively. Metering pumps also are used to dose specific concentrations of sulfuric acid into alkaline water to lower pH during the disinfection phase.

pH control in industrial water treatment applications can feature multiple rounds (nested within each other) to treat water for the required application. It concludes with a final round of adjustment in the plant's wastewater facility to bring pH levels back to neutral prior to discharge. During this final pH adjustment, many plants also use flocculation basins to dose additional polymers and chemicals that aggregate precipitated particles and make them easier to filter out.



PulsaPro pumps offer the accuracy, longevity, and reliability needed for industrial water treatment applications.

Cooling tower water also must be treated to avoid scale and corrosion that could damage or impede the plant's performance. Cooling towers and other plant equipment are protected by metering pumps that dose precise volumes of corrosion inhibitors.

Additional Requirements for Metering Pumps

The flow rates required for metering pumps used in refineries to treat water typically range from just a few liters per hour to as much as 200 liters per hour, with pressures that range from less than 10 bar up to approximately 40 bar. Most of the metering pumps sold into refineries should be API 675-compliant, because metering pumps are not just used to render water treatment chemicals, but also are used to dose specific volumes of chemical catalysts at higher pressures as required by the refining process. As such, metering pumps used in refineries should feature:

- **Flexible configurations.** Different materials, including 316 stainless steel, Alloy 20 and PVDF should be available to address different chemicals, polymers and corrosion inhibitors that possess different characteristics. The ability to leverage a single pump family that can be configured with different materials helps suppliers meet a refinery's delivery deadlines.

- **Accuracy.** Metering pumps should provide 1,000-to-1 turndown capabilities with steady state accuracy down to +/- 0.5%. This is critical because chemical costs are among the larger expenses for refineries. The chemicals used are procured in concentration, and they must be metered accurately—not only to save money, but also to ensure that overdosing does not occur, as acid overdoses can severely damage a cooling tower.

- **Longevity and reliability.** Most refineries run continuous operations, and downtime is to be avoided at all costs. The metering pumps used for the water treatment applications should feature hydraulically actuated double diaphragms with leak detection capabilities. HAD pumps operate with equal pressure between the hydraulic and process fluids, which eliminate diaphragm stress because the pressure is equally balanced on both sides at all times. This balance provides longevity for HAD pumps and enables them to operate for 20 years or more, with minimal maintenance.

The use of these water treatment techniques administered by highly accurate metering pumps enable cooling towers to run at higher cycles of concentration, which enables refineries to limit blowdown activities and save water.

Plant-wide water treatments also open the door for alternative sources of water, such as process water, to be used for cooling tower makeup, which is particularly useful for plants with limited access to source water.

The more effectively a plant treats water, the more cycles it can get from it. These treatments also provide the added benefit of inhibiting scaling and corrosion, which protects pumping and piping infrastructure while ensuring continuous plant uptime.

The effective management of water and wastewater investments can save plants 1% to 2% annually, which adds up to hundreds of millions of dollars each year for larger refineries and chemical manufacturers.

While these benefits may never equal the financial advantages of "once-through" cooling processes, they do enable plants to use significantly less water. This puts refineries and chemical plants on a more flexible path to address potential changes in regulations, it makes them better environmental stewards, and it puts them on a path to more predictable, sustainable operations.

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