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Producing Clean Water for Isolated Steel Mill Cooling Towers

Technology purifies the only feasible water source for mill.

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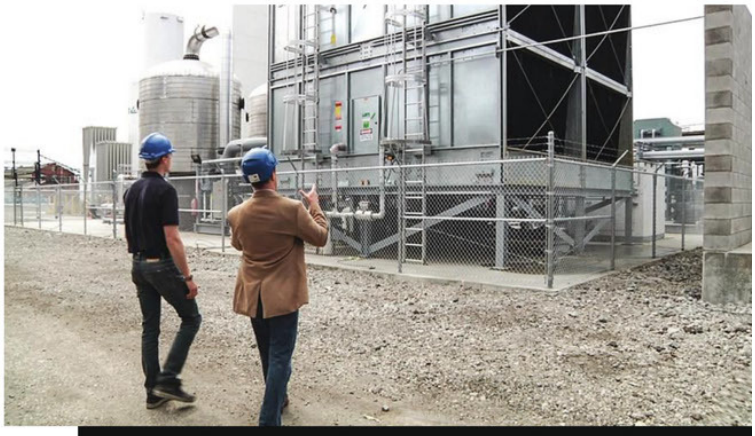

Image 1. Membrane capacitive deionization experts evaluating cooling towers at the steel mill *(Images courtesy of Voltea)*

High-quality water is vital for many industry applications, from cooling towers at a manufacturing plant to irrigation systems at a large agricultural operation.

Most commercial businesses and industrial plants pull water from the local municipality to power appliances and equipment, feed lawns and provide drinking water on-site. However, the municipal water source is not always the most feasible or easily accessible option, forcing business owners and consultants to look for other ways to get the water required.

Steel Mill Challenge

A steel mill in Lorain, Ohio, had recently installed a new gasification system on-site at the 600-acre facility along the Black River. The gasification system required the use of a cooling tower for operation. This cooling tower, however, was far away from the main water line, and the cost to connect the two was quoted at $1.2 million. Due to this high cost, the mill needed to consider other options.

Given the location of the steel mill, the nearby Black River became the only feasible water source for the cooling needs of this new gasification system. However, the Black River presented new problems. Raw river water would require significant treatment before it could be suitable as a feedwater source for the cooling tower.

Controlling Scaling & Corrosion

Most cooling towers are designed to remove heat from the manufacturing process through evaporation and will provide cooled water across a broad range of applications. Due to evaporative losses, the water remaining in the cooling tower becomes concentrated with dissolved solids like calcium, bicarbonate, chloride and sulfate that will lead to scaling and corrosion. This buildup can affect overall performance and even shorten the equipment life span.

The traditional methods of scale and corrosion control are through dosing chemicals and blowdown—the act of discharging water at a high total dissolved solids (TDS) level. This operation results in high volumes of water and chemicals being discharged to the environment. The quality of the water introduced to the cooling tower system is key to process efficiency and the frequency of preventive maintenance intervals.

Treating River Water

Seasonal weather fluctuations, the presence of silica, suspended solids and high levels of hardness are a few challenges faced when attempting to treat raw river water.

The Black River, which runs through parts of northern Ohio, is one of many Lake Erie tributaries. This area is known for heavy snowfall, icy conditions and substantial winds in the winter and early spring, with summer bringing warmer weather and some rain.

These conditions tend to cause higher turbidity in local rivers due to deicing processes and surface runoff. This can be a major challenge for treating river water due to the high fluctuations in TDS and other hardness minerals in the water. For this steel mill, the spring runoff of road salts from the winter season in the local area resulted in the Black River conductivity varying between 400 and 1,400 micro-Siemens per centimeter (µS/cm), corresponding to 23 to 180 parts per million (ppm) chlorides with turbidity spiking up to 800 nephelometric turbidity units (NTU). Consequently, finding a water treatment system that can self-adjust to these naturally occurring fluctuations can be a challenge.

Delivering High-Quality Water with Electro-Deionization

There are few options available to treat river water, such as from the Black River, and to purify it to the required standards of the steel mill and its cooling tower needs.

Traditional treatment methods such as reverse osmosis (RO) were investigated as options for the treatment of the river water, but they required expensive pretreatment and ongoing high operating expenses due to the heavy level of treatment needed. The chemicals also needed to keep this equipment operational required special permitting from the Ohio Department of Environmental Quality.

Image 2. Water quality of the feedwater to the cooling tower

Parameter	Avg. Black River	Requirements	Product Water
Chloride (ppm)	98.5	<50	22.5
Sulfate (ppm)	97.5	<50	32.5
Phosphate (ppm)	0.3	<0.2	0.1
Conductivity (µS/cm)	800.0	N/A	305.0
Hardness (ppm as CaCO3)	132.5	N/A	29.2

A newer, disruptive water treatment technology known as membrane capacitive deionization was also examined as a possible treatment option for the river water. This technology was an attractive solution for two reasons:

- It had relatively simple pretreatment requirements.
- No special permitting was necessary because the technology does not use chemicals.

Membrane capacitive deionization technology removes TDS from water sources with minimal pretreatment requirements.

It eliminates dissolved salts and other minerals via direct current (DC), or electro-deionization, where oppositely charged salt ions are attracted to electrodes, leaving pure water flowing out of the cells in a two-step process of purification and regeneration.

A major difference between this technology and other systems is its "tunability" feature. This means customers can choose the specific level of dissolved salts that are removed—salt removal is thus "tunable." Not all applications require the same removal rate, which eliminates any remineralization needed from using traditional desalination and softening technologies.

The steel mill selected this electro-deionization technology because it can require minimal pretreatment, lower expected energy consumption, minimal intervention and may not require any special permitting. In addition, the forecasted operational costs included with the assessment were acceptable to the steel mill.

The need for high-quality water (lowest controlled TDS level) prompted the selection and use of the electro-deionization technology as a solution to treat the Black River water as the feed source at this location.

Installed at the beginning of the spring season, the electro-deionization system experienced extreme fluctuations in feedwater quality. Despite seasonal fluctuations, the system operated with a simple conventional multimedia filtration.

Once the system was installed, the salinity level of the feedwater to the cooling tower met the requirements of the manufacturer, as shown in Image 2.

The Black River, previously deemed unfit for cooling tower applications using traditional desalination technologies, was now a reliable feedwater source thanks to the implementation of the electro-deionization technology.

The chemical-free process also enabled the site to discharge the concentrated effluent of the system directly back into the river without having to secure an additional site permit for disposal. ■

Bryan Brister joined Voltea in January 2014 as COO before transitioning to CEO in October 2014. Brister has a bachelor's degree in biochemistry and a doctorate degree in polymer science and engineering. He may be reached at bryan.brister@voltea.com. For more information, visit voltea.com.