Plant Adds Submerged Membrane Filtration System To Expand Capacity

Erie, Colorado's water treatment plant is the first municipal drinking water facility in the country to use both pressure and submerged microfiltration membrane filtration systems. A recent expansion using submerged membrane technology effectively doubled the plant's treatment capacity in roughly half its already small footprint.

Erie, Colo., with a population of 11,725, lies among the suburbs of North Denver, ideally situated in the heart of Colorado's major businesses and population centers. It's a rapidly growing community, with the town projecting a population of more than 30,000 within the next 15 years.

Erie's Lynn R. Morgan Water Treatment Facility began full operations in March 2000, replacing the town's former 1970s-era plant and significantly improving drinking water quality. But with continuous, rapid development in the area, the town soon realized it was quickly outgrowing its new plant. An expansion project was completed in 2005, increasing the capacity of the facility from 4.5 million gallons per day (mgd) to 9.9 mgd to meet the needs of Erie's current and future residential, business and commercial water customers.

The original portion of the plant uses positive pressure membrane filtration to achieve high quality finished water. The recently completed expansion project added submerged membrane filtration, which effectively doubled the plant's treatment capacity in roughly half the footprint of the existing pressurized membranes. The Erie, Colo., plant is the first municipal drinking water treatment facility in the country to use both pressure and submerged membrane filtration systems.

Varying Raw Water Quality

Erie's water sources are Colorado-Big Thompson River (from Northern Colorado Conservancy District) and South Boulder Creek. Big Thompson water, the town's primary water source, is delivered to the Erie plant via an underground pipeline from Carter Lake, approximately 30 miles away. South Boulder Creek water is delivered to three small local reservoirs via the South Boulder Canyon Ditch.

Raw feed water quality varies widely by source. The Carter Lake water is very good quality, with average turbidities of around 2 NTU and total organic carbon (TOC) of about 3.6 mg/L. Water from the three local reservoirs, however, each have different characteristics – with turbidity ranging from 2 to 7 NTU and total organic carbon (TOC) as high as 10 mg/L.

When designing the original portion of the plant, the town and its engineers determined that the most effective method of achieving treatment goals would be a process treatment train that includes coagulation, flocculation,sedimentation through plate settlers, followed by membrane filtration. The town selected a Memcor pressurized system.

The Erie plant's system operates six skids, with a pressurized feed distributed among 90 modules in each of the four original skids. Two additional skids with 108 modules in each were added to boost capacity a year later.

"Organics removal is our primary focus, operations-wise," Joe Kleffner, chief water operator for the Erie plant, says. "We need to keep TOCs below 2.9 mg/L at all times. High levels of soluble organics can bring taste and odor issues, cause membranes to foul, and increase the potential for exceeding our trihalomethanes (THMs) limits. Knowing we can meet all other parameters, we run the plant based primarily on TOC removal because that's where we need to optimize our operations."

Water flows in an outside-in pattern across the membrane fibers from the shell side to the internal area, called the lumen. Any particle larger than 0.04 microns is retained on the fiber surface. The membranes are able to achieve greater than 6-log removal of bacteria and produce turbidity levels of less than 0.1 NTU , regardless of changing feed water conditions. Organic and color reduction of 10 percent is possible with no chemical addition; 50 percent is possible with chemical addition.

"We can oftentimes utilize the pressure of the Carter Lake water coming in and get finished water TOC below 2.9 mg/L without doing very much pretreatment," Kleffner says. "This way we can save on energy costs because we don't have to turn on the pumps."

Kleffner operated the town's 1970s-era drinking water treatment facility before it was replaced with the new membrane filtration plant in early 2000. He says the difference in performance between the two plants has been like night and day.

"We used to really struggle for a log reduction on our MPA (microscopic particulate analysis) tests -- and we were lucky to get a 3-log removal. As operator in charge, it really has eased my mind knowing we have a positive barrier and excellent log reduction."

Expanding Capacity With Submerged Membranes

In 2005, the plant's treatment capacity was expanded from 4.5 MGD to 9.9 MGD, and a peak capacity of 12.2 MGD. The project included adding a 1.7 million gallon concrete clearwell, 10 MGD pretreatment building, and expanding the treatment building to house a new submerged membrane system providing 6.75 MGD of additional capacity. The project, designed by Burns & McDonnell under a design-build approach, allowed for design and construction to be completed in approximately 14 months.

For the expansion, the town selected the Memcor CS Submerged Membrane System from Siemens Water Technologies to provide added capacity and flexibility while further optimizing facility performance. The town selected the submerged system because of its small footprint and flexibility to implement treatment process changes without significantly affecting the existing membranes.

"The submerged membrane system treats slightly more water and has about half the footprint of our pressure membrane system," Kleffner says. "This really cut down on the capital expense of the building and all that goes with it, such as heating costs."

In addition, the submerged configuration of the membranes substantially reduces the number of automatic valves required when compared to the pressurized membrane system, further simplifying operation and maintenance.

Kleffner says that another reason the town selected the submerged system was for more optimization when dealing with future source waters. In late 2007 or early 2008 the plant will begin receiving water from a new source, Boulder Reservoir.

"We aren't sure what contaminants may show up in our permit once we start receiving this new water. Manganese is one of the new contaminants we may have to deal with, and we can't use oxidants with our pressure membrane system. Our submerged membranes, however, are polyvinylidenefluoride (PVDF) and are resistant to oxidants, so with these we will be able to add potassium permanganate in our treatment for manganese control. We also can run chlorine dioxide or chlorine through the submerged membranes with no problems."

The new submerged membrane system at the Erie plant consists of three cells, with 256 modules per cell. Each cell will treat 2.25 MGD, for a total capacity of 6.75. A low vacuum is applied, drawing water through the membrane fibers with a 0.04-micron pore size.

"When treating Carter Lake water, we're often able to effectively reduce TOC from 3.6 mg/L to below 3.0 mg/L without using any coagulant in our pretreatment," Kleffner says.

The high log removal values offered by the membranes have the added benefit of reducing required disinfection dosages and allowing the system to meet regulatory limits for disinfection by-products.

"This is important because our TTHM and HAA5 (haloacetic acids)requirements are the two parameters that really drive us to reduce our organics as much as possible," adds Kleffner.

Automated Process Control

The treatment facility is equipped with a programmable logic controller (PLC) and a SCADA workstation, giving operators precise control over the plant's membrane systems. Integrity testing is conducted automatically every 24 hours. . Both the pressurized and submerged membrane systems provide unique in-situ integrity testing, which validates removal down to two-tenths of a micron.

An Effective, Economical Solution

Erie, once home to coal mines, railroads and agriculture, today is a vibrant, rapidly growing community. Utilizing state-of-the-art microfiltration membrane technology to protect against microbial contaminants has provided the town with a highly effective and economical solution for its drinking water treatment. Expanding its existing membrane plant with a submerged membrane system has further provided for highly effective treatment with reduced plant footprint, chemicals and power consumption, while providing greater flexibility in implementing treatment process changes to deal with future source waters. Plus, the facility has future expandability from 9.9 to 16.65 MGD with additional submerged membranes.

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