Retrofit for a Community

Manitowoc chose a new submerged membrane water plant that was retrofitted to an old sand filter plant.

By Robert Michaelson

Converting a 10-mgd filter building into a 40-mgd submerged membrane system

The team completed Manitowoc's new submerged membrane wastewater plant in 24 months.

ARTICLE SUMMARY

Challenge: A Wisconsin utility needed to expand its water treatment facility in limited space.

Solution: The city retrofitted a new submerged membrane water treatment plant in a decommissioned sand filter plant.

Conclusion: Repurposing an old facility is cost-effective and utilizes unused space.

Manitowoc Public Utilities (MPU) provides potable water service to the city of Manitowoc, Wis., which has a population of approximately 34,000. The primary raw water supply is obtained from Lake Michigan. In 1999, MPU replaced the conventional sand filter water treatment plant (WTP) with state-of-the-art membrane filtration: microfiltration (MF). This pressurized hollow-fiber membrane technology could provide up to 11 million gal per day (mgd) of treated water capacity to MPU's customers.

This left the conventional sand filter plant in a decommissioned state, and most of the equipment was removed. Incidentally, MPU also is the largest municipally owned power plant in the state of Wisconsin. This power generation provides the added benefit of warming Lake Michigan water through the power plant steam condensers. The ability to provide a minimum water temperature of 45˚F to the membranes enabled MPU to appropriately size the membrane plant regardless of the cold water temperatures.

In 2004, MPU began discussions with the Central Brown County Water Authority (CBCWA) to provide high-quality water to CBCWA member communities.

CBCWA History

As Brown County experienced accelerated growth in the 1960s and 1970s, concerns began to develop about the ability of the groundwater aquifer to meet the long-term drinking water needs of Brown County municipalities. The county commissioned a 1976 water study by engineering firm Donohue & Associates. The Brown County Water Plan indicated that the St. Peters Sandstone Aquifer, which provides the water for all municipal wells in Brown County, would not be able to meet the long-term drinking water needs of the municipalities in the Green Bay area.

The Brown County Planning Commission Potable Water Study Committee, made up of municipalities within Brown County, subsequently was formed to investigate drinking water solutions for Brown County and to recommend a course of action. In 1992, Consoer, Townsend & Associates performed a second independent water quality and quantity study. The report confirmed the results of the first study, concluding that groundwater cannot supply the long-term needs of the Green Bay-area communities, and recommended that a Lake Michigan water source be pursued.

In 1998, the Central Brown County Water Commission introduced state legislation allowing the formation of joint water authorities. With that, Wisconsin municipalities could combine efforts to tackle water problems. The commission was formally established under the new state law in 1999 as the Central Brown County Water Authority (CBCWA). The six current members of the CBCWA are the village of Allouez, the village of Bellevue, the city of DePere, the village of Howard, the town of Lawrence and the town of Ledgeview.

Prior to CBCWA's existence, charter members relied exclusively on groundwater supplies. But, in response to the state's requirement that communities mitigate water quality concerns related to radium and other contaminants, the charter members—along with various other entities—first united in 1998 to act as a wholesaler of Lake Michigan surface water.

After reviewing various options, the authority decided to purchase water from the city of Manitowoc and Manitowoc Public Utilities (MPU) as the best choice for the member communities and their residents. The agreement was signed by Manitowoc and MPU in July 2004. CBCWA constructed a 65-mile water transmission main from Manitowoc to Brown County, and MPU assumed responsibility for the WTP expansion.

WTP Expansion

With the signing of the Wholesale Water Agreement in 2004, MPU initiated the expansion of the water treatment facilities. The city of Manitowoc's water demands totaled approximately 8 mgd, and the existing pressurized MF plant could not meet both the Manitowoc and CBCWA water demands of approximately 18 mgd.

In 2005, MPU signed an engineering design contract with CDM-Chicago to design a new submerged MF plant that would retrofit into the decommissioned sand filter water plant. Other projects requiring completion in order to provide an adequate water supply to the CBCWA included a new lake intake pipe, raw water pump station, and finished water reservoir and pump station.

Due to the enforcement of the U.S. Environmental Protection Agency's radium rule, the groundwater wells that served the CBCWA member communities would be noncompliant in December 2006. It was imperative that the new WTP be able to serve the CBCWA by December 2006, leaving a short project window of 24 months.

Design Limitations

Due to limited space on the MPU property, there were several design factors that needed to be considered, including:

- Choosing a membrane manufacturer that could retrofit into the existing sand filter plant, including the required footprint of the membrane plant, the type of membrane, the easy access to perform maintenance of the

membrane, and allowing enough room to expand in the future.
- Moving the other equipment into the "old" plant, including strainers, pumps, drives, motors, air compressors, blowers and chemical clean-in-place equipment. Finding paths for the associated wiring and piping for the above appurtenances also proved to be a challenge.
- The new membrane plant was to be built in the sand filter water plant area, which was over the original water plant clearwell. It was determined that there was not adequate support for the membrane equipment, so additional columns needed to be installed in the clearwell.

Construction Challenges

The new submerged membrane water plant was to be built within the existing four walls and ceiling of the decommissioned sand filter plant. This revealed a number of challenges, including:

- The construction of the submerged membrane water plant was one of four projects occurring concurrently. Finding ample space for the general contractors and their subcontractors became a challenge that had to be resolved.
- Selective demolition of several concrete walls while maintaining the integrity of the exterior walls, floor and ceiling, was required. Some of the concrete walls and floors were left in place, and new concrete walls were poured up to them. When leaks occurred, the contractor would claim that the leak was coming through the old rather than new concrete.
- The use of a concrete additive was implemented in some of the new concrete pours, providing an integral nonsoluble crystalline structure. This essentially made the new concrete waterproof and self-healing.
- The design engineer based the retrofit construction on the best available as-built plans (circa 1938 and 1970), and the contractor found various discrepancies between the design drawings and the field. This resulted in some rework and change orders.
- The new submerged plant required substantial upgrades to the electrical system, which required some electrical shutdowns for the entire WTP and pumping stations.
- The original water treatment building was built in 1938 and expanded in 1970. It was determined that significant amounts of asbestos were present in various areas of the plant and that they needed to be abated or removed. Lead paint also was found. The contractor would stop work and notify MPU of any asbestos and lead findings, and leave the jobsite until they were safely removed. Because this was not anticipated in the general construction specifications, various levels of delay and costs arose.
- Part of the roof was removed and replaced to permit the installation of large mechanical equipment. Work on or around the roof resulted in some leaks, and it was difficult to determine whether a leak was pre-existing or the result of contractor's work.

While Manitowoc's new plant was retrofitted, several old concrete walls had to be demolished.

Lessons Learned

MPU identified the need to increase its water treatment capacity and determined that retrofitting a new submerged membrane WTP in a decommissioned sand filter plant was a cost-effective means of expanding the treatment capacity while utilizing unused space. Designing the membrane equipment and related mechanical equipment into the existing space required some creative ideas from the membrane equipment supplier, engineer and utility operations, and maintenance staff.

There were many lessons learned from the retrofit project, including:

- Perform value engineering with the general contractor before work commences to determine whether any changes may result in a cost savings or a better finished product.
- Consider the detailed condition of the original building—from the concrete to the roof to the electrical. There may be more cost in making this work rather than starting anew.
- Retrofitting into an existing space does not result in the optimal environment to access and/or maintain mechanical equipment. Oftentimes the equipment is located in a space that can accommodate it, but that provides limited access.
- There is an unquantifiable cost to retrofitting into an existing space. The cost of selective demolition vs. total demolition and constructing a new building may eliminate the limitations and challenges related to the condition of the building, space limitations and the design and construction issues that will arise. WWD

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