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NITROGEN REMOVAL

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WEFTEC 2015 Trade Show Preview

DC Facility Employs High-Capacity Pump Station for Nitrogen Removal

Optimization of the selected submersible propeller pumps saved the facility up to $200,000 per year.

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Covering more than 150 acres and serving an area of 725 square miles, the Blue Plains Advanced Wastewater Treatment Plant (AWTP) in Washington D.C. is one of the largest advanced wastewater treatment plants in the world. Blue Plains has a design capacity to treat up to 370 million gallons per day (mgd), meeting the needs of the metro-D.C. area's wastewater and collection treatment needs. Because the treated effluent is discharged into the Potomac River, the plant must meet some of the most stringent nitrogen standards in the world. The District of Columbia Water and Sewer Authority, also known as DC Water, has implemented a $3.8 billion, 10-year capital investment program for all its capital projects. Part of this program has been the construction of the Enhanced Nitrogen Removal Facility (ENRF). Submersible wastewater pumps are central to the operation of this facility.

Image 1. One of five submersible propeller pumps for The Blue Plains Water Treatment Facility in Washington, D.C. (*Images courtesy of KSB*)

Reducing Nitrogen

Nitrogen is an odorless, tasteless, colorless non-metallic chemical element that occurs naturally in the earth and atmosphere. It is a vital component of life for many organisms, but too much nitrogen can be harmful. In waterways, excessive nitrogen can deplete the oxygen that fish and other aquatic life need to thrive.

The latest ENRF process expansion of Blue Plains was designed to reduce nitrogen levels before the water is discharged into the Potomac River. The goal was to meet or exceed the new U.S. Environmental Protection Agency (EPA) requirement to reduce effluent nitrogen production to 4 million pounds per year.

Nitrogen removal at Blue Plains is a two-stage process that involves nitrifying secondary effluent within the existing 12 nitrification/denitrification reactors. Complete denitrification occurs in the newly constructed ENRF tanks.

Pump Station Requirements

A key element of the new ENRF process was the addition of a new high-capacity pump station. The design specifications mandated 24/7 operation, with a planned life span of at least 20 years. The selected pumps had to be robust and have a high degree of reliability. Blue Plains chose several submersible propeller pumps designed specifically for this type of application.

The selected pumps were factory-tested in accordance with the operating conditions, and they had to pass a stringent set of criteria. The pumps were optimized specifically for the project, using the most suitable motors for the application and hydraulics that exactly matched project requirements.

The selected pumps are ideal for the wastewater-treatment and water-supply sectors and operate in some of the most challenging water industry applications worldwide. At Blue Plains AWTP, seven submersible pumps are located at various locations in the denitrification return sludge gallery sumps and are used for pumping drainage, washdown, and potentially sludge and chemicals if a pipe breaks. Four other submersible pumps are located at two dewatering stations in the denitrification return sludge gallery and are used for liquor, pumping groundwater, pump/floor washdown drainage and wet weather run-off duties.

In the Alternate Carbon Building, two submersible pumps are used for sump pumping eyewash station drainage, laboratory sink drainage, pump/floor washdown drainage and potentially carbon chemicals if a pipe or pump leaks. Portable submersible units can be moved to various locations in the denitrification reactors and post-aeration tanks to handle mixed liquor. Their primary function is to dewater the denitrification reactors and post-aeration tanks when they are taken out of service.

DC Water's new submersible motor denitrification pumps are typically used for industrial and agricultural water supply, stormwater and flood prevention stations, and water and wastewater treatment. It is a close-coupled, wet-installed, single-entry axial propeller pump with the propeller located in a tubular casing immersed in the water. To satisfy project requirements, the pump manufacturer adjusted the pitch angle of the propellers and specially wound the motors. Each of the seven pumps has a maximum flow capacity of up to 179 mgd and a maximum head of 12 meters (m). Together they deliver a total of 895 mgd. Low vibration hydraulics and a vortex-free flow resulting from the inlet ribs and wide bellmouth ensure the pumps are hydraulically optimized. The slim motor that minimizes discharge tube flow losses provides improved operating efficiency.

Image 2. The largest submersible propeller pumps produced by the project's pump manufacturer.

For maximum versatility/flexibility, this type of pump is available in a wide range of materials. Specially adapted hydraulic systems with high operational reliability resulting from wide free passages provide optimum economic transport of all types of liquids. Unlike the water supply pumps, the pumps used for the handing of untreated and treated effluent operate all day long, which places them under a considerable workload.

Adapting to System Needs

Having chosen these high-capacity pumps for this unique application, DC Water took advantage of alternative configurations. Optimizing the configuration resulted in considerable power savings—as much as $200,000—that could be achieved every year. The manufacturer also has the engineering resources to assist design engineers in optimizing the design of the pump station. Reducing the number of pumps also reduced the overall pump station footprint. Less excavation, less concrete, less rebar and fewer control panels contributed to lower operating, capital and construction costs. Extensive hydraulic calculations were also performed to develop a pump curve required at various speeds. ■

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