The Journey Toward A Sustainable Biosolids Handling Process

A Kenosha, WI wastewater treatment plant leveraged innovative upgrades to become more sustainable – and save $750,000 per year.

By Ed St. Peter and Michael Kopper

The Kenosha Water Utility has long been a forward thinker for sustainable technology and solutions in the water and wastewater industry — in fact, on the very leading edge. In 1997 it installed what was then the largest water microfiltration purification system in the world. The installation put Kenosha ahead of regulatory requirements concerning surface water and disinfection byproducts without the use of pretreatment chemicals.

Like many plants in the U.S., Kenosha's collective wastewater infrastructure was also aging. The plant first went online in 1940, with the addition of secondary treatment in 1967 and upgrades to expand capacity in 1987. More recently, due to aging infrastructure as well as an effort to combat ever-rising natural gas and electric utility costs and landfill disposal fees, the Kenosha Water Utility began to explore emerging technologies as a means of becoming more energy independent by looking to transform "waste to energy" while also reducing the volume of biosolids in need of disposal. When it came time to make critical upgrades, Kenosha set out with the confidence to venture into a state-of-the-art wastewater treatment process. That decision is already paying off.

Meeting Complex Integration Challenges

In all, the project would have to deliver a cost-effective and eco-friendly solution to biosolids handling, processing, and disposal. But the task was anything but simple. The biosolids handling process was to be the biggest project at the plant since the 1980s and called for a range of new technologies and their integration to:

- Increase the generation of methane gas from the anaerobic digestion of sludge.
- Generate electricity from the methane gas to produce greater than 500 kW of continuous power for the plant.
- Use the electricity generated to offset peak energy pricing during high-demand periods.
- Use electric and thermal energies to dry the biosolids to reduce the volume of biosolid cakes to 90 percent.
- Reduce the volume and cost of biosolids that are land filled.
- Produce high-quality biosolids that meet the criteria for Class A Biosolids for beneficial reuse.
- Recover and utilize waste heat as the main thermal energy supply for the facility.

At the same time, the new process and individual technologies would have to maintain the existing effluent quality and not increase the ambient noise level, odor, or particulates beyond the area of the plant.

Steps To Becoming More Sustainable

Over the years, initial portions of the biosolids handling process underwent rebuilds or upgrades. These included the grit system in 2009, bar screens in 2010, and three of four final clarifier drive units with the final tank being completely rebuilt in 2015. As is typical for municipal contracts, a design-bid-build model was used to complete these upgrades. But to meet the goal of becoming energy efficient while drastically reducing biosolids disposal, a design-build approach was solicited for the latest major biosolids overhaul due to the complexity of the project and varying technologies necessary to accomplish the monumental task at hand.

In the request for proposal (RFP), the design/builder was tasked with preparing of the design, assisting Kenosha with all necessary permits, procuring, constructing, and installing all components, integrating of the new system with the existing plant supervisory and control data acquisition (SCADA) network, and startup and commissioning. Centrisys, a U.S. manufacturer of decanter and thickening centrifuges and dewatering systems, was awarded the contract along with J.F. Ahern, CD Smith, and Pieper as the contractors, and Donohue & Associates as the consulting engineer.

The proposed plan would incorporate some technologies never before used in North America. One of the biggest challenges was procuring and integrating the varying technologies. Also adding to the complexity was the need to generate enough biogas production to meet energy-resource needs. While some biogas would be recovered through primary sludge, Centrisys offered a solution to generate additional biogas needed through waste-activated sludge (WAS). The solution came by way of sister company

The centrifuge room at the Kenosha Water Utility

CNP-Technology Water and Biosolids Corporation's PONDUS thermo-chemical hydrolysis process (TCHP), which uses chemicals and thermal energy to hydrolyze the WAS stream to achieve biogas production.

Another critical step was the addition of a second THK 200 thickening centrifuge — one for primary sludge thickening to complement the one already installed (in 2013) for WAS thickening. Combined, the thickening technology would work to reduce the liquid volume within the sludge stream and thicken the sludge before entering the primary anaerobic digesters. This thickening technology would yield a concentration of 7 percent solids compared to the 3 to 4 percent solids produced by the older dissolved air flotation thickening (DAFT) system. With thicker sludge, less water would be sent to the digesters, reducing the number of tanks needed from six to three, lowering heat and energy costs.

Combining these technologies, a pair of combined heat and power (CHP) cogeneration units from Kraft Power Corporation is powered by the biogas. Prior, the electricity needed to run the equipment at the treatment plant was purchased exclusively from the local utility. Any heat needed for the operations had to be provided by boilers using either natural gas or biogas as a fuel source. With the generators, each unit is capable of producing 330 kW of electrical energy and 422 kW of thermal energy. The electricity produced is being used to power the new system and supply excess electricity to the main plant power network for use elsewhere throughout the plant. Based on the design, the new system will eventually consume approximately 340 kW of electricity, leaving the remaining balance of 320 kW for reuse elsewhere at the plant and moving toward a longer-term goal of providing supplemental power to the rest of the plant.

The thermal energy will feed the TCHP, the belt dryer, and the central plant's heating loop. Based on current plant loadings, the TCHP will consume 245 kW of thermal energy, while the dryer will consume 590 kW, leaving the remaining balance of roughly 10 kW for the central plant's heating loop. The goal through optimization is that the dryer will consume less than the rated 590 kW of thermal energy, leaving additional heat for the central plant's heating loop.

Meanwhile, a biogas conditioning system was brought in to reduce maintenance and increase the longevity of the combined heat and power cogeneration units. This technology removes moisture and siloxane from methane gas in the digestion stage in preparation to fuel the CHP system.

The other major goal at hand for achieving greater sustainability was to realize an eco-friendly Class A Biosolids designation while lowering disposal volume. Prior to the overhaul, dewatered biosolids were manually loaded into a truck and disposed of at a local landfill. To meet this goal, a compact belt dryer by Sülzle-Klein was also installed. With the new dryer, dewatered material leaving a dewatering centrifuge is dried using the waste heat from the cogeneration units as the thermal supply. The dryer achieves all the requirements of Class A material, including temperature, duration, and moisture content.

A Greener Tomorrow

While each technology plays a critical role individually, it is their unique integration that has worked to bring this forward-thinking project to life. The additions and upgrades are in the midst of a year-long optimization process. With the additions and upgrades finished in the fall of 2015, the optimization period is targeted for a fall 2016 completion.

Today, the plant stands to save $750,000 annually with an anticipated return on investment of just eight years. The majority of those savings are attributed to energy reuse. Kenosha is currently pursuing options for the beneficial reuse of its biosolids, which potentially include land application on local farm fields, additive to the city's yard-waste compost product, fuel supplement at a local coal-fired power plant or other incineration process, or contract operations with an outside firm for distribution. The city is currently in the process of getting the final biosolids product reclassified as Class A Biosolids with the Wisconsin Department of Natural Resources.

"We're proud to take a stance in the management of our wastewater treatment facilities that is fiscally responsible to our ratepayers but also supports long-term sustainability for ecological balance," said General Manager Ed St. Peter. "It goes to show that with the right critical thinking, commitment, and steps, sustainability can be achieved cost-effectively. We're very proud that the Kenosha treatment system demonstrates such a balance." ■

About The Authors

Ed St. Peter is general manager of the Kenosha Water Utility (Kenosha, WI), and has been with the utility for his entire 45-year career. Along with being a leader in the municipal water and wastewater field, Ed believes his greatest accomplishment is the exceptional staff with which he has surrounded himself.

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