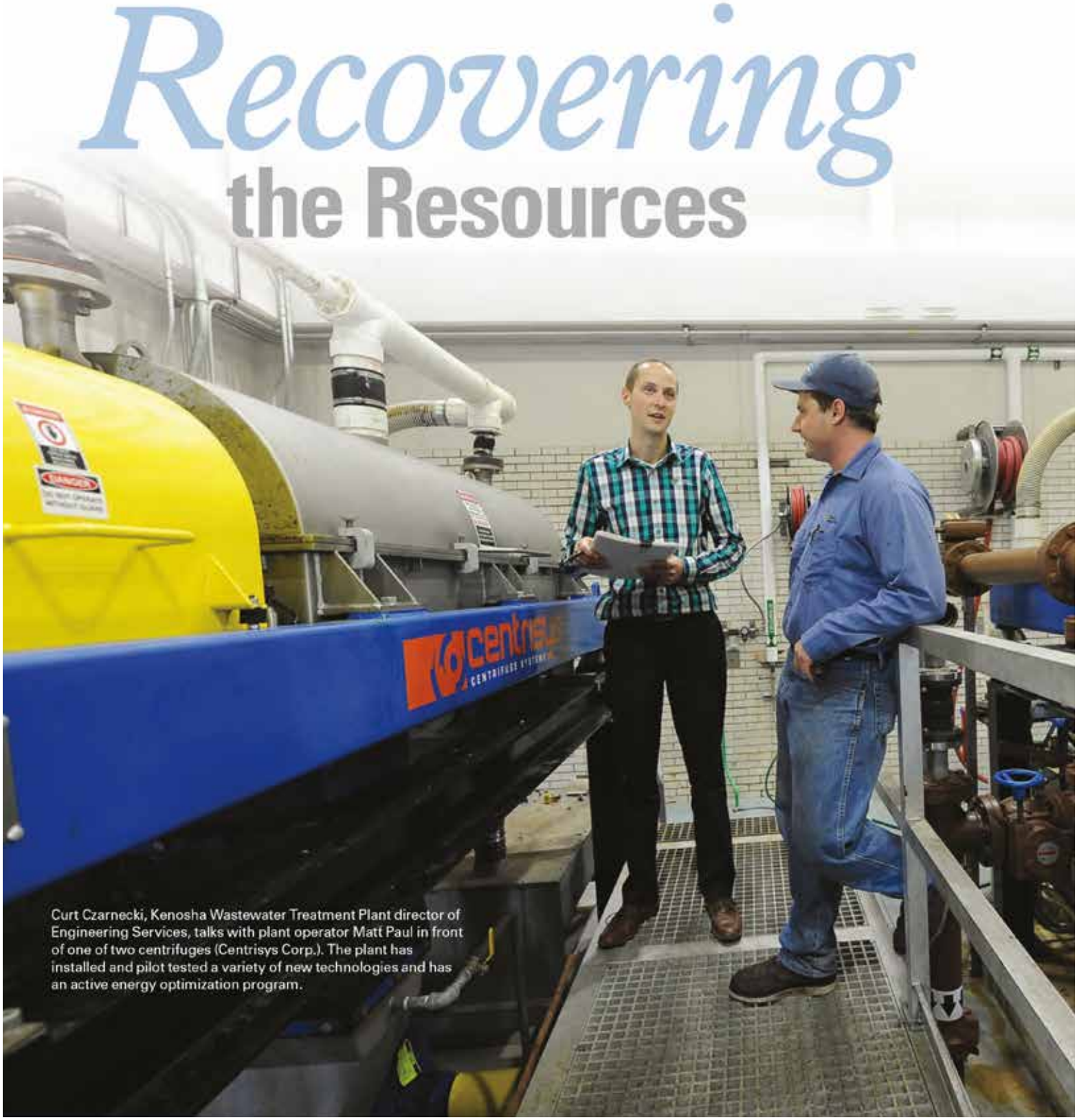
top performer
wastewater: PLANT

Recovering the Resources



Curt Czarnecki, Kenosha Wastewater Treatment Plant director of Engineering Services, talks with plant operator Matt Paul in front of one of two centrifuges (Centrisys Corp.). The plant has installed and pilot tested a variety of new technologies and has an active energy optimization program.

A PLANT ON LAKE MICHIGAN'S SHORE USES A MIX OF INNOVATIVE TECHNOLOGIES TO MAKE THE MOST OF NUTRIENTS AND ENERGY CARRIED IN WASTEWATER

STORY: **Jim Force**
PHOTOGRAPHY: **Michael McLoone**

DRIVEN BY A PASSION FOR INNOVATION, THE KENOSHA Wastewater Treatment Plant team has converted a messy, inefficient biosolids process into a state-of-the-art resource recovery and energy production system.

The technology includes thickening centrifuges; thermal-chemical hydrolysis; high-solids anaerobic digestion with mechanical hydraulic mixing; biogas conditioning, dewatering and drying; and combined heat and power generation. The system has been humming along for just under two years, generating all the electricity and heat required for biosolids handling, and surplus electricity for about one-third of other treatment plant needs.

Humming is the right word. It's clean and quiet as Curt Czarnecki, director of engineering services, shows off the new units in the old dewatering building. Ear protection isn't required as he explains how the new system has improved sludge consistency and reduced the number of digesters needed, while producing a 90 percent solids Class A end product that has cut biosolids landfilling costs by at least two-thirds, based on volume reduction alone.

> "We wanted to increase our biogas production, generate electricity and use waste heat as our primary thermal energy supply."
> **CURT CZARNECKI, P.E.**

"We like to be on the cutting edge of technology," Czarnecki says. "Our general manager, Ed St. Peter, takes a lot of pride in being an industry leader." Kenosha gets good value because equipment manufacturers are eager to demonstrate new technology at the plant and make sure it functions as designed. Since training and technical assistance are important, it helps to have local suppliers. Centrisys Corporation of Kenosha supplied the thickening and dewatering centrifuges.

CONVENTIONAL TREATMENT

The 22 mgd (average) Kenosha treatment plant occupies 29 acres on Wisconsin's Lake Michigan shore just south of the city center. Permitted average is about 28 mgd. The liquid end is straightforward: headworks screening and grit removal, primary settling tanks, secondary aeration and settling, gas chlorination and discharge to the lake. BOD removal averages 92 percent, TSS 96 percent, ammonia 89 percent, and phosphorus 84 percent. The plant serves about 110,000 people along with many industries in the 86-square-mile urban area.

Previously, the plant's solids handling process included dissolved air flotation thickening, which brought the solids content of waste activated sludge from 1 percent to 3.5 to 4 percent.

The thickened sludge was digested in four primary and two secondary digesters, operated in batch runs. Then it was conditioned with lime and ferric chloride, and dewatered in batches in plate-and-frame presses. The cake was trucked to a landfill.

In 2009, with the old equipment needing repair or replacement and energy and landfill costs rising, the utility replaced the plate-and-frame presses with a Centrisys CS21-4HC dewatering centrifuge. The new units reduced dewatering costs, but the utility was still spending some $340,000 a year in landfill tipping fees.

NEW LOOK

The plant team continued to upgrade the biosolids process in 2011, when

The operations team at the Kenosha plant includes, from left, Wayne Greisen, George Morgan, Rich Kositzky, Don Kordecki and Garrett Gilbertson.

Kenosha (Wisconsin) Wastewater Treatment Plant

BUILT: |	**1939; expanded 1967, 1985, 2015**
FLOWS: |	**28 mgd design, 22 mgd average**
SERVICE AREA: |	**City of Kenosha and surroundings**
POPULATION SERVED: |	**110,000**
TREATMENT LEVEL: |	**Secondary**
TREATMENT PROCESS: |	**Activated sludge**
RECEIVING WATER: |	**Lake Michigan**
BIOSOLIDS PROCESS: |	**Thermal drying**
BIOSOLIDS USE: |	**Landfilled (land application pending)**
ANNUAL BUDGET: |	**$7.7 million**
WEBSITE: |	**www.kenosha.org**
GPS COORDINATES: |	**Latitude: 42°33'31.98"N; longitude: 87°48'55.10"W**

Centrisys completed a full-scale pilot test of a THK 200 centrifuge for waste activated sludge thickening. Next, the utility entered a design-build contract with Centrisys to provide a system able to tap the full energy potential locked in the biosolids waste stream.

"We wanted to increase our biogas production, generate electricity and use waste heat as our primary thermal energy supply," Czarnecki says. The utility also aimed to produce Class A biosolids while maintaining or reducing noise, odors and particulate emissions.

Important to the system is a PONDUS thermochemical hydrolysis process provided by CNP Technology Water and Biosolids Corporation (a division of Centrisys). The unit breaks down the cell walls of the thickened waste activated sludge before digestion. Through a hot-water heat exchanger, the thickened material (6 to 7 percent solids) is heated to about 155 degrees F, ideal for the hydrolysis process.

Caustic soda is added to adjust pH. Then, at atmospheric pressure, the solids circulate in the PONDUS reactor for 2 to 2.5 hours. New material is added to the reactor periodically at a ratio of one part new solids to three parts circulating solids. "The process releases internal organic acids, which brings pH of the stream back to neutral," says Czarnecki. "After hydrolysis, the pH is 6.8 to 7, and no more chemical addition is necessary before digestion." A second Centrisys THK 200 centrifuge thickens primary sludge from 3.1 to 6.1 percent solids.

EFFICIENT DIGESTION

The primary thickened solids join the hydrolyzed solids and are pumped to the two primary digesters and then to the single secondary digester. Digester contents are fully mixed using a Rotamix unit (Vaughan Company). "The system consists of a chopper pump, internal piping and six nozzles per digester," Czarnecki says. "We get even heating of the contents, improved volatile solids reduction and increased gas production." As opposed to the previous batch operation, the process is continuous feed and draw.

The composition of the biosolids is critical. New perforated plate band screens improve removal rates at the headworks, important to downstream

solids processing. "The capture rate has been fantastic," says Czarnecki. "The difference is night and day." The screens are manufactured by Envirocare, just south of Kenosha in Gurnee, Illinois.

After digestion, the solids are dewatered on a CS21-4HC Centrisys centrifuge to 26 to 29 percent solids. The cake is fed to a compact SÜLZLE KLEIN GmbH belt dryer (distributed by Centrisys) operating at 185 degrees F and achieving all the requirements for Class A biosolids. While the 90 percent solids granules are being landfilled (at far lower volume and expense), Kenosha has verbal approval of the material as a Class A product from the state Department of Natural Resources, clearing the way for land application.

ENERGY RECOVERY

Smooth operation and a Class A end product are only part of the story. Energy recovery was a major objective and is being realized big-time. "Our energy costs have been going up 2 to 3 percent every year," says Czarnecki. "Plus we wanted to reduce our dependence on natural gas and electrical energy from the local utility. The utility prides itself on keeping rates low. We're among the lowest-cost operations in the state."

In the old plant, biogas from the six digesters was only used to heat the plant with boilers or to fuel the raw water pump engines. In summer most of the biogas was flared. "We couldn't use all our biogas unless it was really cold," says Czarnecki.

That has changed. Two new engine-generators, manufactured by f.u.n.k.e. Senergie GmbH and supplied by Kraft Power Corporation, use 100 percent of the biogas, first compressed and cleaned in a gas conditioning unit (Unison Solutions). Heat captured from the 330 kW generator meets the needs of the PONDUS system, and a dryer provides most of the heat for the digesters.

One generator operated at full load and the second at less than capacity, for a total of about 500 to 550 kW at current biogas production levels. "We're not entirely off the grid, but about half the power we generate is exported back to the main switchgear at the treatment plant," Czarnecki says.

ABOVE: The Kenosha plant, on 29 acres along Lake Michigan, treats an average of 22 mgd and has a design capacity of 28 mgd. BELOW: The grit basins and primary clarifiers.

BANG FOR THE BUCK

For the size of the payback in energy recovery, facilities usage, and biosolids handling costs, Kenosha gets a lot for its money. The solids project was implemented on a design-build basis at a cost of $5.4 million.

"The state allows design-build for energy recovery projects," says Curt Czarnecki, director of engineering services. "We worked with Centrisys as our design-build partner." The contract called for design, assistance with permits, procurement, construction and installation, integration with the existing SCADA system, startup and commissioning, operation and maintenance manuals and warrantees.

Czarnecki believes working with local manufacturers on a cutting-edge project added to the savings. "Manufacturers want to get the new technologies installed and operating successfully," he says. "They guaranteed cost savings." He calculates savings of up to 50 cents on the dollar.

Using existing buildings and reducing space and the number of facilities also saved on costs. The new thickening centrifuges occupy about 50 square feet each, while the old dissolved air flotation system required 10,000 square feet.

The city secured a $500,000 grant from Wisconsin Focus on Energy and a smaller grant for LED lighting in the solids handling building. One provision of the Focus on Energy grant was that the work be completed by the end of 2015. To meet that date, the team had to move the dewatering equipment out of the building and operate outside in winter until the new equipment was installed.

New technology at the plant goes hand-in-hand with basic maintenance. From left, Brian Lequia, Centrisys field technician; Curt Czarnecki and Matt Paul, operator.

Kenosha Wastewater Treatment Plant
PERMIT AND PERFORMANCE

	INFLUENT	EFFLUENT	PERMIT
BOD	180 mg/L	13 mg/L	30 mg/L monthly avg. 45 mg/L weekly avg.
TSS	180 mg/L	8 mg/L	30 mg/L monthly avg. 45 mg/L weekly avg.
Ammonia	27 mg/L	3 mg/L	16.2 mg/L daily max.
Phosphorus	3 mg/L	0.5 mg/L	1.0 mg/L initial limit 0.6 mg/L final interim limit

He suggests that even more power could be exported if the plant began accepting high-strength waste — and the utility is considering doing so. Hydrogen sulfide odors are not a problem with the new system. A KWT 1000/3000 chemical scrubber (SÜLZLE KLEIN GmbH) uses water, caustic soda and sulfuric acid to cool the exhaust and remove moisture, particulates, ammonia and sulfur compounds.

SIMPLE OPERATIONS

As robust as the new system is, it is relatively easy to operate. The operations team includes Mat Paul, Rich Kositzky, Don Kordecki, Ray Granado, Dustin Stockwill, Bill Peters, Darrick McCarthy and George Morgan (Mike Christel recently retired).

Paul says the process is simple even though all the process elements are integrated and must work together: "With the new equipment, everything is

Curt Czarnecki, director of Engineering Services

easier. We've had just a couple of hiccups. And Centrisys, being local, is here nearly every day to check on operations."

The new technology has not added to the staff requirements. The process is fully automated, requiring just one operator during the first shift. On second and third shift, the process is simply monitored by an operator who is responsible for the entire plant as well as satellite operations.

Operator input was important during the design phase. Czarnecki says plant staff was involved in such decisions as valve location and placement of pumps: "It was not your typical design-build. Our operators provided feedback, ensured redundancy and shared performance criteria. We've kept the operators and mechanics involved throughout installation and startup. As a result, we have a system that's easily maintained. Overall, it has been a very positive project."

The utility has been able to keep the staff level the same while recovering energy, saving on operations, and keeping wastewater rates as low as possible, Czarnecki observes: "It's a green project. It's in everybody's best interests." tpo