Formerly World Water & Environmental Engineering

world water

Volume 34 / Issue 1
January / February 2011

Economy sparks creative solutions

wef publishing uk ltd.

A Supporting Publication of weftec the water quality event™

Can wastewater treatment plants achieve energy self-sufficiency? **Marc Roehl**, global product manager of biosolids technologies for Siemens Water Technologies, answers this question in an interview conducted by **Pamela Wolfe** of *World Water*. He explained how available solutions, energy management strategies, and innovations can reduce energy use in wastewater treatment plants.

Achieving net-zero energy in the future

Energy self-sufficiency is not a realistic goal for 99.9 percent of municipal wastewater plants. But in a few years, Marc Roehl of Siemens Water Technologies anticipates that practical solutions will be available for many treatment plants to achieve nearly net-zero energy consumption. Meanwhile, he says wastewater treatment plant operators could reduce energy consumption by 25 percent by optimizing process efficiency and greatly improving energy recovery with available technologies. Ultimately, however, innovation is key to closing the gap.

Wastewater treatment accounts for 30 to 40 percent of municipal energy usage. In a wastewater treatment plant, energy costs are the second largest operations and maintenance (O&M) expense after labor. Biological processes, depending on plant design and processes, account for 55 to 70 percent of O&M energy use.

Under economic pressures, municipal governments are increasingly investigating ways to reduce energy costs, but these savings are not cost-free. Convincing public officials to approve purchases of new, innovative technologies even in good financial times is difficult. Roehl contends that treatment plants could invest in many energy-efficient steps, such as installing technologies and incorporating best practices, which could quickly result in attractive investment returns. Aging infrastructure offers an opportunity to retrofit and upgrade inefficient systems with newer, energy-saving technologies that increase capacity and shrink energy footprints.

For example, aeration uses 54.1 percent of total energy consumed at municipal wastewater treatment plants, according to the Water Environment Federation Energy Conservation Task Force. Roehl said: "Energy-efficient blowers can reduce power use by 10 to 20 percent. More energy-efficient diffusers are available now than years ago at some of these plants with older equipment installed. Dissolved oxygen control systems can greatly reduce the amount of energy put into aeration systems by fine-tuning the amount of air, and thus energy, put into the treatment system, based on the actual flows and loads coming into the plant at a given time."

"Plants could also improve control systems and add variable frequency drives on motors, especially higher horsepower motors, to allow motors to be dialed in to meet the demands rather than running at rates higher than necessary and wasting energy," he said.

For example, the Siemens BioFlowsheet℠ Solution biological process optimization program evaluates specific cost factors such as energy use, labor, and disposal. To reduce energy costs, the program integrates several key wastewater operations, including biological, solids separation, solids treatment, and controls. Using this approach, a California wastewater treatment plant reduced biosolids production by 70 percent, and reduced aeration demands from the aerobic digester by more than 90 percent after installing the Siemens Cannibal® solids reduction system.

Control and telemetry systems increase the efficiency of a plant's entire operations. All plant processes can be integrated under a unified control system that maximizes the energy efficiency of treatment technologies and allows operators a single point of responsibility in coordinating the control strategy and operation. The Siemens Link2Site® Flex system is a wireless-to-web remote monitoring and control system that can be added to equipment or processes to optimize operations by reducing maintenance and service expenses, according to Siemens literature. Another approach developed by Siemens is to combine its vertical loop reactor (VLR®) system with the MemPulse™ membrane

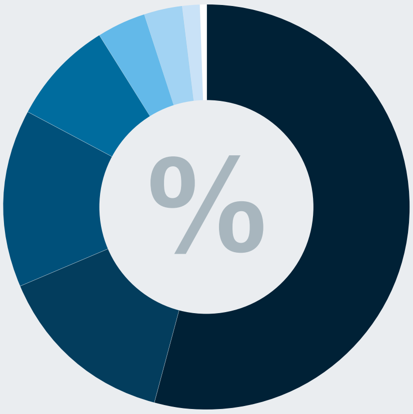
The Dystor® system is a digester gas-holder design that uses a dome-shaped, engineered membrane system to prevent odors and store methane gas and sludge. The system includes two durable membranes. The outer membrane is cable-restrained and remains inflated in a fixed position. The inner membrane moves freely as it stores or releases gas generated from the anaerobic digestion process.

Closing the energy gap

"The future of energy management lies in being able to close the gap between what we can help customers achieve today and achieving net-zero energy in the future," says Marc Roehl, global product manager for biosolids technologies at Siemens Water Technologies. "We know that the energy value of municipal wastewater is 10 times greater than the energy required to treat it, but we only reuse a fraction of that energy. We're working to change that."

A Siemens technology undergoing pilot testing in Singapore is a "green" treatment process that extracts energy from municipal wastewater, resulting in a 30 percent lower solids yield. Energy content in wastewater is harvested as biogas and converted to energy to create a nearly energy-independent treatment plant. The process is scheduled for commercial introduction in 2012.

Figure 1: Energy usage at municipal wastewater treatment plants



Water Environment Federation Energy Conservation Task Force. *Energy Conservation in Wastewater Treatment Facilities. 1997*

bioreactor system to reduce energy consumption by 30 percent.

Siemens reports that a US Midwestern city reduced operating costs by upgrading its outdated, conventional wastewater treatment plant. Its municipal client abandoned its primary clarifiers, converted its fine-bubble aeration tanks to VLR systems and replaced the anaerobic digesters with the Cannibal solids reduction system. They also added two new VLR tanks and three new 80-foot (24.4m) diameter final clarifiers with Tow-Bro clarifier suction removal mechanisms. The upgrade reduced the plant's aeration power costs and solids volume while improving effluent quality, Roehl said.

Energy recovery

For a typical wastewater treatment plant, savings of 20 to 30 percent on overall power use are possible by improving process efficiency. Energy recovery solutions can increase those savings even more by converting biogas, produced through anaerobic digestion of wastewater sludge, to electrical energy. Biogas is composed of about 65 percent methane and 35 percent carbon dioxide. Roehl explained that the combustible methane gas can be used for heating, boilers, and energy generation in a cogeneration system. Internal combustion engines, microturbines, and fuel cells can convert biogas into electrical energy.

Many wastewater treatment plants in Europe and the United States have been recovering energy in this way for decades. Roehl commented: "In general, European countries are ahead of the curve. Energy costs tend to be higher in Europe, so there's been greater attention to energy recovery than in the USA historically, but that's really changing. We're seeing more and more plants considering cogeneration systems to recover this energy and reuse it on site."

In North America, many plants recover biogas energy to heat the anaerobic digester, while allowing significant amounts to be flared as a waste product. An engine generator system can recover approximately 20 to 35 percent of the plant's power needs by capturing, storing, and processing biogas.

Much of the research and development (R&D) taking place is focused on finding creative ways to reduce reliance on aerobic treatment processes and improve biogas production and energy recovery. Roehl explained that one of Siemens' R&D initiatives is to focus on improving anaerobic digester performance "by essentially conditioning the solids going into the digester so that they're more degradable and produce more biogas." The Crown® sludge disintegration system is one such technology, which uses cell lysis to break down sludge at the cellular level. The system ruptures the cell structure to increase the gas yield from the anaerobic digester by up to 30 percent. It also reduces sludge for disposal by up to 20 percent.

Another focus of R&D is improved efficiency of energy generation when burning biogas. "We're investigating a process, which is really a modification of a conventional treatment plant that addresses the issue of improving the efficiency of energy usage and our ability to produce and recover energy from biogas." Roehl continues, "For the past 12-18 months, the company has been working on a low-energy wastewater treatment system at its global R&D center in Singapore. We started off with some very simple bench-scale tests to validate the computer model that we had run. Those tests were successful, so we went into lab-scale testing on small, pilot-scale systems in the lab. Those results have been very promising, and we're now moving on to a larger-scale demonstration at a local treatment plant in Singapore. It's still an R&D project, and not yet ready for commercialization, but it's exciting because it's an opportunity to tap the energy contained in the wastewater that is being wasted at most treatment facilities. Recovering this energy for reuse would essentially get us to the point where our plants are close to being energy self-sufficient."

Summary

So how close can available technologies help wastewater treatment plants achieve energy self-sufficiency? During a presentation on this topic at WEFTEC 2010 in New Orleans, USA last October, Roehl explained that a net energy reduction of 40 to 60 percent is feasible with cogeneration and improved process efficiency, but that "Net-Zero" energy is not yet possible for most wastewater treatment plants. Innovations could close the gap to energy self-sufficiency, Roehl claims, by enabling treatment plants to unlock the energy stored in wastewater, reducing reliance on aerobic processes, and improving biogas production. Innovation is the key.

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