Thermal Protection

For the Santa Cruz Wastewater Treatment Facility (WWTF), dependability matters. Since 1989, this state-of-the-art WWTF, nestled in a shallow canyon in the coastal city of Santa Cruz, Calif., has been leading the way for renewable energy programs and environmental protection in the West. Santa Cruz WWTF generates its own electric power by using internal combustion engines that burn a mixture of methane gas produced by the sewage digestion process and purchased natural gas, producing 7.4 million kWh of electric power per year.

By Scott Rouse

WWTF gets ahead of the curve with thermal mass flowmeters

Using its new thermal technology, the WWTF can measure true mass flow with 40:1 rangeability.

ARTICLE SUMMARY

Challenge: Santa Cruz WWTF depends on gas meters to make operational adjustments to its digesters.

Solution: The facility installed immersible thermal mass flowmeters, as they create virtually no pressure drop and accurately measure the low flow rates of the digester gas applications.

Conclusion: The thermal meters optimize overall efficiency and reliably troubleshoot engine problems.

Historically, WWTFs around the globe have used differential pressure devices for gas measurements. In the late 1980s, Santa Cruz WWTF made the switch from these costly, maintenance-ridden differential pressure devices to thermal technology, which measures true mass flow directly with one instrument and provides turndown and accuracy at low flows, as well as a lower cost of ownership.

Valuing responsive customer service and low maintenance costs, in spring 2002, Santa Cruz WWTF decided to change vendors, ultimately choosing Sierra Instruments. By 2007, the WWTF had replaced all of its meters with the company's immersible thermal mass flowmeters.

Capturing Biogas

The cornerstone of Santa Cruz WWTF's renewable energy program is producing abundant, healthy amounts of biogas each day in its digesters. Acting like a large stomach, the solids from the wastewater treatment process are "digested" in four large, domed digesters heated to 98°F for optimal digester gas production.

When methane-forming bacteria breaks down the acids in the digester, a large amount of anaerobic digester gas made up of 60% methane and 40% carbon dioxide (CO_2) is produced. Facility operators, the "brains" of this stomach, use their SCADA computer system to check that each digester is producing optimal amounts of digester gas. If the digester gas readings are low, the stomach is upset, so the operators will check various process parameters (e.g., pH levels, alkalinity ratios, temperatures and feed rates) to increase the production of digester gas.

"We are not able to make operational adjustments if we don't have the right accuracy of our gas meters," said Senior Plant Operator Dave Meyers. "These gas readings are the first indicator of the health of the stomach."

Because digester gas applications operate at relatively low pressures, it is essential that instrumentation has the ability to remain accurate at these low pressures. Immersible thermal mass flowmeters create virtually no pressure drop and accurately measure low flow rates, whereas orifice plates could not be used at all. Santa Cruz WWTF now can measure true mass flow directly while enjoying 40:1 rangeability and an accuracy of ±1% of reading, plus 0.5% full scale and repeatability of ±0.2% of full scale.

Fueling Cogeneration System Engines

According to Al Locatelli, co-gen and standby generator specialist, preparing this raw biogas into fuel for internal combustion engines is no simple task, but it is what makes Santa Cruz WWTF unique. Its Waukesha 7042 GLD 820-kW engine, coined Cogeneration 1, burns a mixture of digester gas and purchased natural gas that is mixed with air to lower the BTU levels closer to those of digester gas. This biogas enters a manifold system, goes through a scrubber to remove the hydrogen sulfide (a harmful greenhouse gas) and enters a chiller unit to remove the moisture from the gas.

Compressed from 7 in. of water column to 3 psi, the gas enters a second carbon scrubber to remove siloxanes, which can harm the engines. In the plant's static inline mixer, this cleaned and compressed biogas is mixed with the diluted natural gas to maintain the optimal blend of 80% digester gas and 20% purchased natural gas. If the mass flow rate of digester gas decreases, more diluted natural gas enters the blend, ensuring that little digester gas has to be flared off.

After passing through a particle filter, this mixed gas is ready to fuel up the Waukesha 7042 GLD engine. To improve engine performance, a high-BTU shot of natural gas is injected into the precombustion engine chamber using admission valves to ignite the lean fuel mixture in the cylinders.

By reusing its methane, Santa Cruz WWTF prevents 41 tons of CO_2 emissions from polluting our atmosphere. At times, however, especially when Cogeneration 1 is down, the plant must flare off extra biogas that needs to be measured.

Energy Cost Savings

By using the sophisticated SCADA system and the ION meter, which automatically calculates the WWTF's monthly energy bill, Meyers makes important energy-saving decisions each day. Using about 1.3 MW, the plant cannot run solely on the 820 kW produced by Cogeneration 1.

Between noon and 6 p.m., Monday through Friday, from May to October, energy rates jump from 11 cents per kWh to $11 per kWh, which includes on-peak demand charges. To break these peak demand times, at 11:30 a.m., Meyers and other operators fire up their Waukesha 3521 GLD lean-burn engine, coined Cogeneration 2. It produces 440 kW of energy but runs solely on purchased natural gas at 14 cents per kwH.

Meyers and other operators save Santa Cruz WWTF money on energy by choosing to pay for the natural gas to run Cogeneration 2 during peak demand times rather than importing expensive energy. "The bottom line for us is power," Meyers said. "It's an energy savings balancing act."

Solutions in Action

With millions of dollars in instrumentation systems in place, nothing pleases operators more than to hear nothing about their instrumentation. With its cogeneration system, photovoltaic solar panels and heat-recovery system used to heat the digesters, Santa Cruz WWTF is one step ahead of the green curve, striving to optimize energy usage, decrease its carbon footprint, and improve energy production and savings. WWD

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