Enhancing Reliability

By Ray Heulitt & Art Womack

Wastewater plant uses thermal flowmeter for blended-gas cogeneration process

The Rahway Valley Sewerage Authority (RVSA), which operates a large wastewater treatment plant in New Jersey, embarked on a green cogeneration waste-to-energy project to power a portion of its operations. The plant performs primary, secondary, tertiary and sludge treatment processes in serving more than 250,000 residential customers and 3,000 industrial and commercial customers in a 40-plus-sq-mile region. A maximum peak flow of 105 million-gal-per-day (mgd) can be processed daily.

RVSA's management team became interested in pursuing the gas-to-energy power cogeneration system for both environmental and cost reasons. The treatment facility installed four large 1.5-MW cogeneration production engines, which would be fueled in part by the site's production of digester gas and generate onsite power for the facility.

These large gas-reciprocating engines are well suited to co-gen waste-to-energy applications. They have generally high electrical efficiency rates with relatively low environmental impact. A number of manufacturers design gas reciprocating engines especially for use in wastewater treatment and landfill plants. By providing energy directly from the load source for use in the plant, there is very little energy loss due to transportation and distribution.

To sustain the BTU levels the engines required in the event that digester gas production was too low, the engines also were to be powered by natural gas. The blended waste gas and natural gas system was necessary because the plant did not always produce enough waste gas to operate at least two of the four co-gen engines at 70% of the load needed for plant operations.

The co-gen energy was in part designated to help power a new ultraviolet (UV) disinfection system. This system was installed to help meet environmental regulations requiring effluent treatment before water was discharged from the plant. UV disinfection systems require continuous power in order to disinfect wastewater effectively during the treatment cycle.

UV disinfection utilizes short-wavelength UV-C ultraviolet light to kill microorganisms in wastewater effluent prior to discharge back into the water system. It attacks bacteria, viruses, molds and other pathogens. It frequently is used in conjunction with other disinfection technologies to ensure effectiveness.

UV lamps for water treatment typically are mercury vapor lamps that produce UV radiation at 200 to 254 nm, depending on the type of lamp. The lamps never touch the water and are housed in glass sleeves inside the water chamber or mounted externally. As water flows through the chamber, the water is exposed to the UV rays that are absorbed by the suspended solids in the flow stream.

Flowmeter Criteria

The co-gen engines' control system required independent flow measurement of both the digester gas and the natural gas lines in order to blend the mixed gas properly. To minimize training and service/support costs, RVSA plant staff wanted to use the same flowmeter technology from a common vendor for the digester gas and natural gas lines. The flowmeters had to measure accurately and be unaffected by continuous engine vibration in a dirty environment.

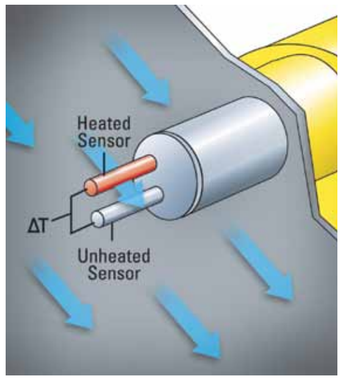
The plant staff specified that the flowmeters would be required to measure a mixed composition of both digester gas (Methane [CH_4] 60% + carbon dioxide [CO_2] 40%) and natural gas (Methane [CH_4] 90% + ethane [C_2H_6] 10%). They had to be installed on 4- and 6-in. lines (DN100 and DN150) and measure a flow rate of up to 500 standard cu ft per minute (14 NCMM). Temperature conditions ranged from 50 to 100°F at a pressure of 60 psig. The flowmeters needed to work accurately at a pipe straight-run of 120 pipe diameters.

Thermal Sensing Technology Design

RVSA wastewater treatment plant staff already had a relationship with Fluid Components Intl. (FCI), having utilized its flow instruments for several decades. Engineers at the plant were satisfied with approximately 40 FCI flowmeters that already were installed, mainly in the aeration system where they monitor the air blowers.

With this history, RVSA engineers at the plant wanted to discuss their co-gen project measurement needs with the manufacturer. After consulting with the company's applications team, the treatment plant engineers chose the Model ST98 thermal mass flowmeters. The mass flowmeters were installed on both the digester gas and the natural gas lines at the plant.

These thermal mass flowmeters combine equal mass thermal dispersion flow-sensing elements, precision electronics and exacting fluid calibrations,



Thermal mass flow principle of operation

The waste and natural gas blended system was necessary because the plant did not always produce enough waste gas for engine operation.

packaged within industrial enclosures. They deliver a gas flow measurement solution that meets performance specifications in demanding plant applications, including wastewater treatment, and need no scheduled maintenance.

The plant staff installed an insertion-type ST98 flowmeter on the 4-in. (DN100) and 6-in lines (DN150). These meters are designed with a no-moving-parts flow element that provides direct mass flow measurement with a single process penetration. They also are not susceptible to the heavy vibration caused by the co-gen engines because of their construction.

The plant staff recognized the advantages of the flowmeter's thermal sensing technology design, which saves space and eliminates unnecessary component installation expenses and performance degradation.

The thermal dispersion sensing technology provides direct mass flow measurement. It places two thermowell-protected platinum resistance temperature detector (RTD) sensors in the process stream. One RTD is heated, while the other senses the actual process temperature. The temperature difference between these sensors generates a voltage output, which is proportional to the media cooling affect and can be used to calculate the mass flow rate.

With this direct mass flow sensor technology, the meter also includes built-in temperature compensation to ensure repeatable and reliable measurement even in extreme environments, such as those found in outdoor wastewater treatment plants. This automatic temperature compensation technology adjusts automatically for accuracy to changes in seasonal temperatures, such as cold winters, hot summers and periods of high humidity.

With no moving parts to plug or foul, the meter delivered future cost savings for the co-gen power application at the wastewater treatment plant. This meter now provides the accurate gas flow measurements essential for dependable and safe plant operation at the lowest lifecycle cost for the gas-fed co-gen engines.

RVSA plant staff were satisfied with the meter's accuracy of ±1% of reading, 0.5% of full scale, with repeatability of ±0.5% of reading. The meter includes a NEMA 4X/IP66-rated enclosure and is agency approved for installation in hazardous gas locations involving combustible biogas and natural gas. The flowmeter's standard 4-20 mA analog output of flow rate was wired into the wastewater treatment plant's four-engine control system.

RVSA's wastewater treatment plant's engineers and managers have been pleased with the results that they have obtained from their flowmeters. The ability to measure both digester and natural gas with the same meter has allowed for significant cost savings. The co-gen system is now running at its highest level of efficiency. WWD

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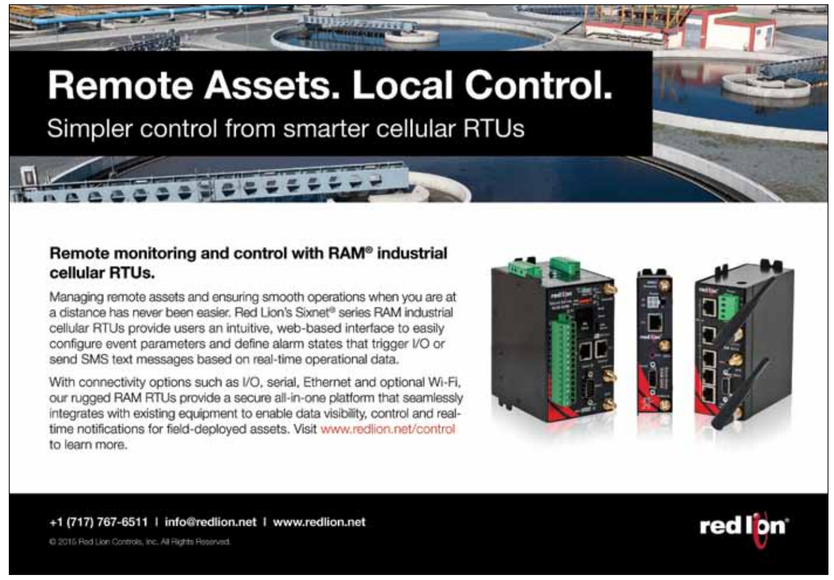

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