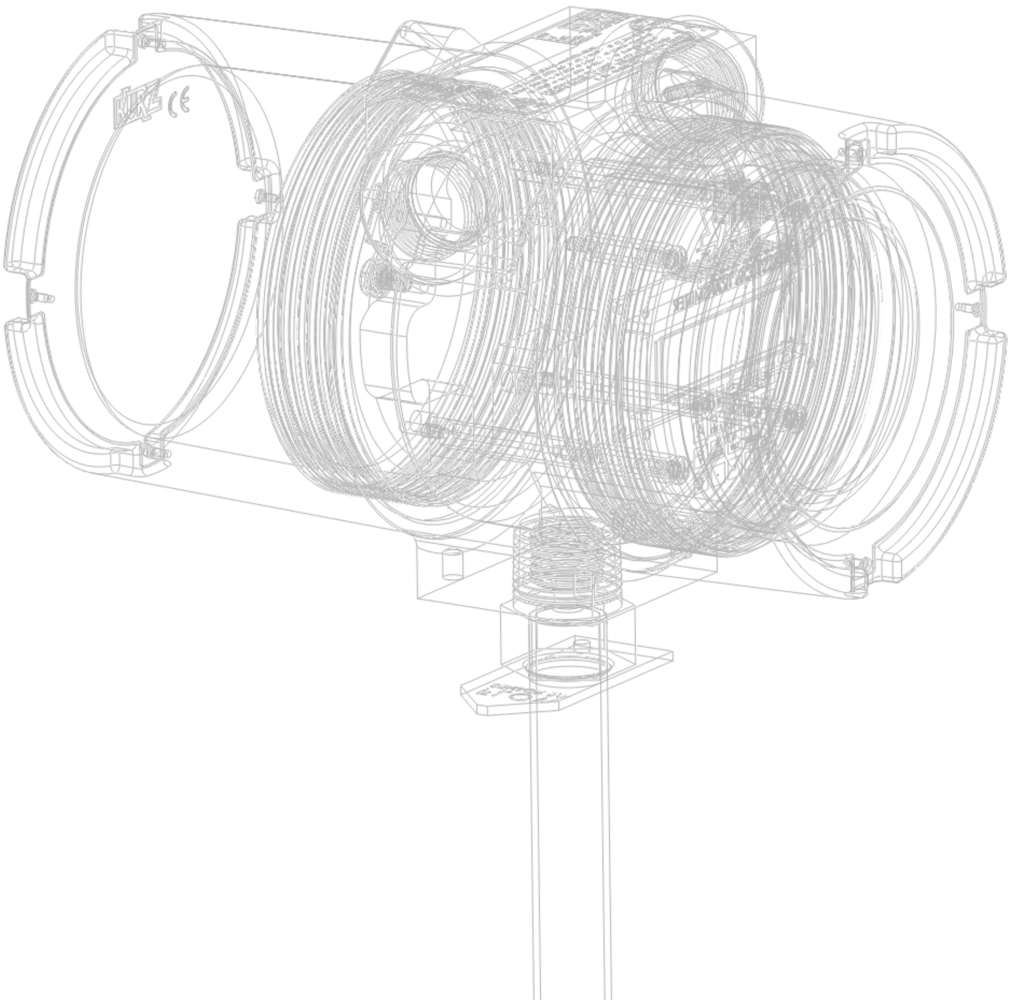
Profile

Three Wastewater Plants
One Solution



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Digester Health & Energy Production

Digester process management involves carefully balancing the quality and quantity of sludge going into the digester and the health of the micro-organisms – an imbalance can result in a poor quality or quantity of biogas production (too much or too little), a digester upset, or foaming.

- Consistent gas production is essential for operating a modern cogeneration unit. Gas-fired engines do not like variations in the quality or quantity of gas. It is particularly hard on an engine that is operating at a rated power only to have it shut down due to a fuel flow interruption.
- Foaming can occur due to inadequate or inconsistent sludge mixing, feed fluctuations that cause acid-forming organisms to compete with biogas-forming micro-organisms, or when there is an imbalance in any of the fats, oils, grease, polymers, or dewatering components. At the minimum, a foaming incident requires shutting down a digester and extensive costly clean-up. It can also result in the catastrophic failure of a digester or holding tank roof, plug flame arrestors, and effect level indicators (due to entrained foam).

Monitoring biogas production is a complex endeavor. Not only is it affected by the sludge and micro-organisms, but as a condensing gas, daily and seasonal temperature variations change the amount of liquid present in the biogas.

- Warm temperatures reduce the amount and size of liquid droplets and provide a stable gas flow measurement.
- Cooler temperatures increase the amount and size of liquid droplets, typically confusing the computer system that tracks methane production. The excess liquid is recorded as additional biogas, which then triggers a diversion of methane away from the generator and causes the generator to run inefficiently or abruptly shut down.

Today's wastewater treatment plants (WWTPs) and publicly owned treatment works (POTWs) must operate 24/7 in order to meet treatment demands from domestic and industrial sources. Wastewater plants follow stringent EPA guidelines while using technology to speed up processes that mimic the natural water cycle.

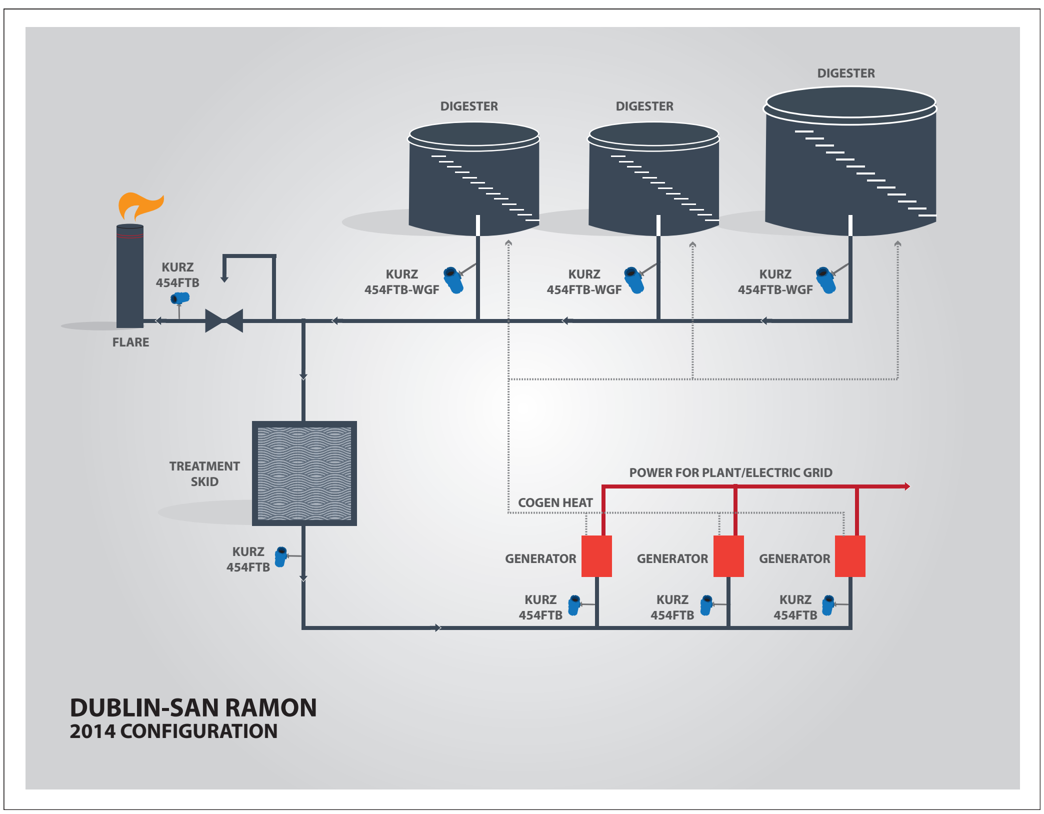
The ability to collect and use the biogas created during the wastewater process, and the increasing awareness of greenhouse gases, has an increasing number of these water resource recovery facilities (WRRFs) using the biogas to generate electricity and heat used for plant operation. Many plants have the opportunity to sell excess energy back to local utilities, but the goal is to burn as little unused or excess biogas at a flare because it must be reported to local air quality boards.

Dublin-San Ramon Services District

The wastewater plant for the Dublin San Ramon Services District (DSRSD) provides services for over 140,000 residential, commercial, industrial, and institutional customers in Dublin, Pleasanton, and southern San Ramon. From the beginning, the DSRSD wastewater plant invested in a system design that supports an environmentally friendly strategy for increasing the quality and quantity of recycled wastewater. Additionally, the plant's resource recovery efforts include capturing digester gas to generate energy for the facility. Expansion and upgrades to the plant included increasing capacity from 9 to 11.5 million gallons per day (MGD) in 1985, and then increasing capacity up to 17 MGD in 2000.

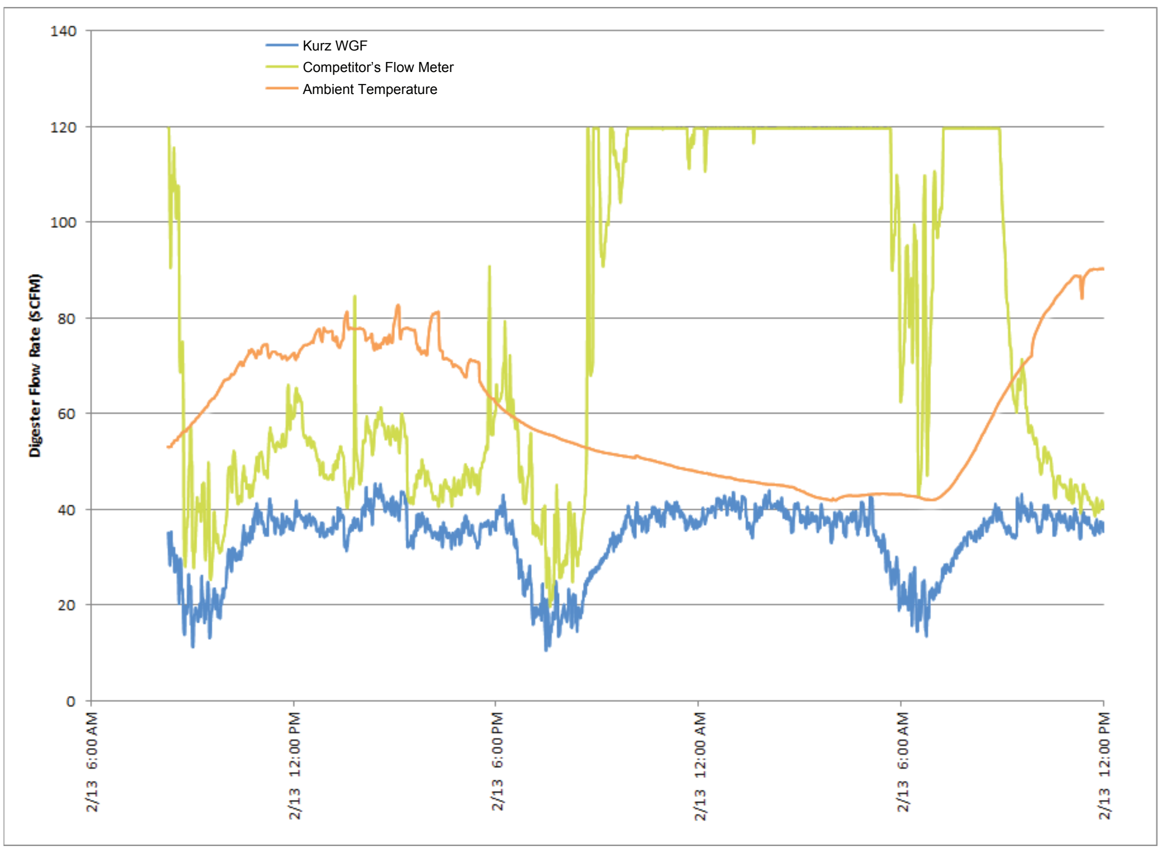
The plant has three digesters that are used to stabilize the solids from the average 10 MGD flow generated by the surrounding communities. The biogas captured from the digesters is sent to three generators that produce electricity used at the plant. The waste heat from the generators is used to keep the digesters warm.

During a plant upgrade, a variety of gas flow meters were installed to measure the rate of biogas production from the digesters. At the time, traditional thermal technology was known to be deficient in condensing gas flows although it remained the most frequently used, cost-effective option in the wastewater industry. As a result, the digester measurements were known to be reporting more biogas production (because of the varying condensation levels due to daily and seasonal temperature changes) than was being used by the cogeneration system.



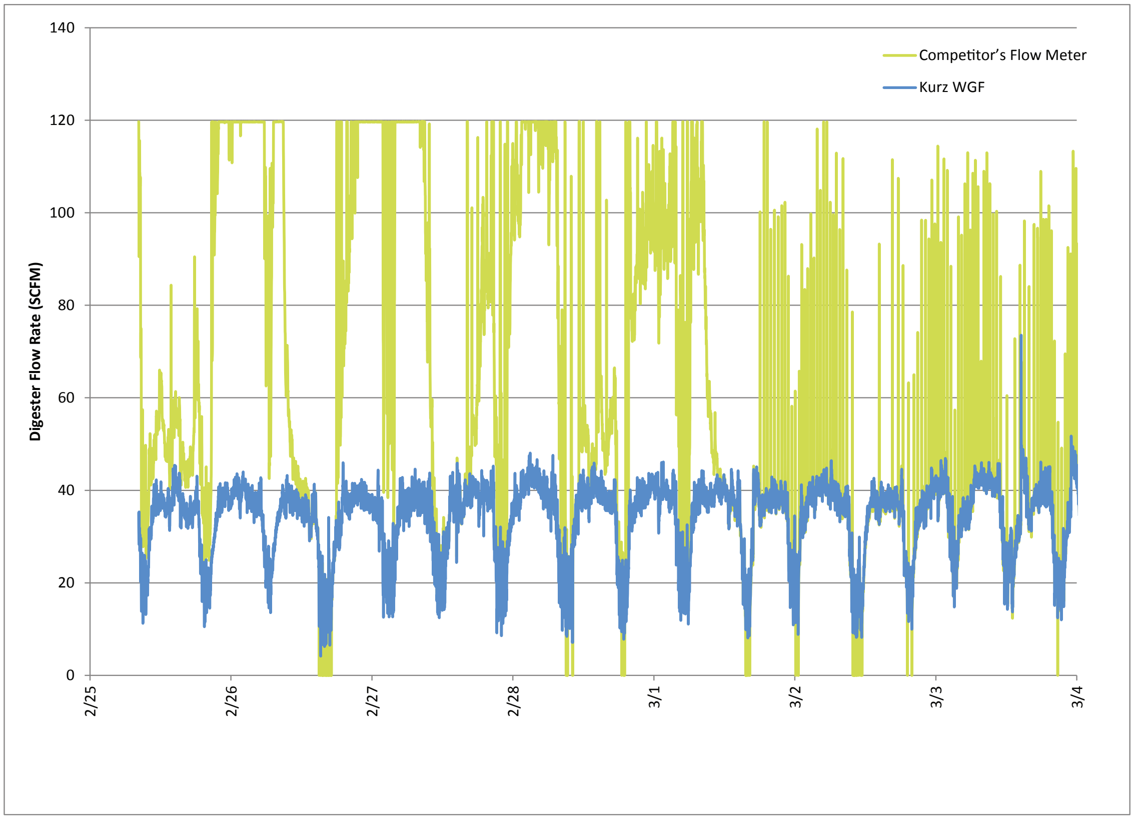
Prior to the installation of the Kurz meters biogas flow measurements remained erratic. The measurements for treated dry gas only matched overall biogas production during the heat of the day. The relationship of temperature changes, especially colder weather, affecting condensation levels and flow measurements was not fully understood at the time.

Kurz Instruments approached the Dublin-San Ramon plant with an offer to use their facility as a test site for new biogas instrumentation. Kurz was aware that condensation in a gas flow stream caused erratic reading problems for thermal flow meters, and had designed an instrument that effectively ignores the liquid. In June 2012, the preliminary results from the test provided impressive improvements so the test was expanded to all raw biogas ports. There was already suspicion that the original flow meters were not working correctly and the expectation was that expanding the test would validate the long-standing discrepancy between gas production and gas consumption. One of the first comparison tests on Digester 1 is shown in the following graph.

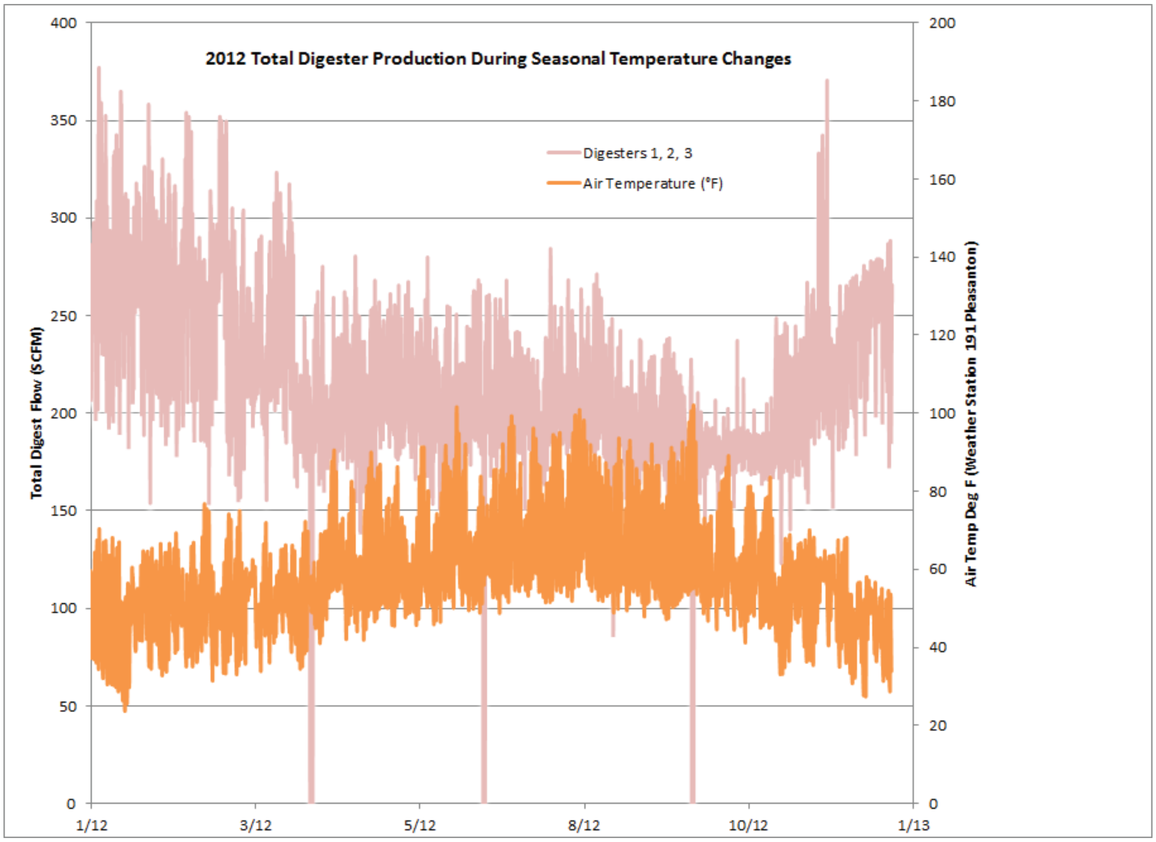


As shown in the graph, when the ambient temperature is cool (in this case, evening and early morning), the original competitor's flow meter reports false high readings and takes some time to respond to digester changes in cooler weather. As the outside temperatures rise, the readings from the competitor's flow meter began to agree with the Kurz WGF.

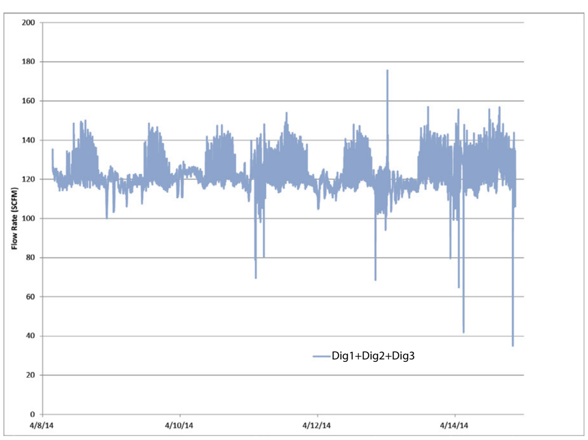
A week's worth of data (as shown in the following graph) shows that the digester dosing (the rate of sludge feeding) is consistent, the competitor's flow meter is consistently erratic, and the Kurz WGF is consistently accurate.

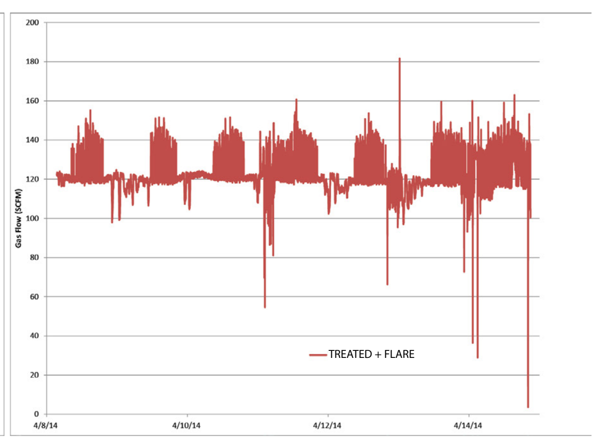


The SCADA system supports summing the data from all three digesters for 2012, when the original flow meters were reporting flow. The graph clearly shows the over-reporting of gas production is related to seasonal changes in ambient temperature, with almost twice as much gas production being reported than was being consumed by the generators.



By 2014, a Kurz WGF flow meter was installed on each horizontal exit pipe on the top of each digester. The graph on the left shows the sum of the three digesters related to sludge collection. The graph on the right shows sum of gas consumption sent to the cogeneration engines and flare. The short spikes in the consumption graph for the 20-30 SCFM range are caused by the flare control scheme for biogas pressure above 15 inches of H_2O. As shown, total biogas production closely matches biogas consumption.





The ability to resolve the long-standing discrepancy between gas measurement and actual energy recovery supported the criteria to find instrumentation capable of functioning in a condensing gas flow. Individual digester data revealed a cyclical production pattern created by the sludge doser timer setting. The ability of the Kurz WGF flow meter to show a rapid responsiveness of digester gas to sludge feeding supported the desired behavior that had not been achievable until now.

Installing a flow meter that is designed specifically for condensing gas applications on each digester provided the plant with the means to accurately monitor biogas gas production regardless of changing condensation levels. The Kurz WGF flow meter ignores liquid droplets and reports the true dry gas flow rate. The new biogas monitoring system provides not only reliable flow measurements, but also supports system-wide troubleshooting because the production and consumption add up.

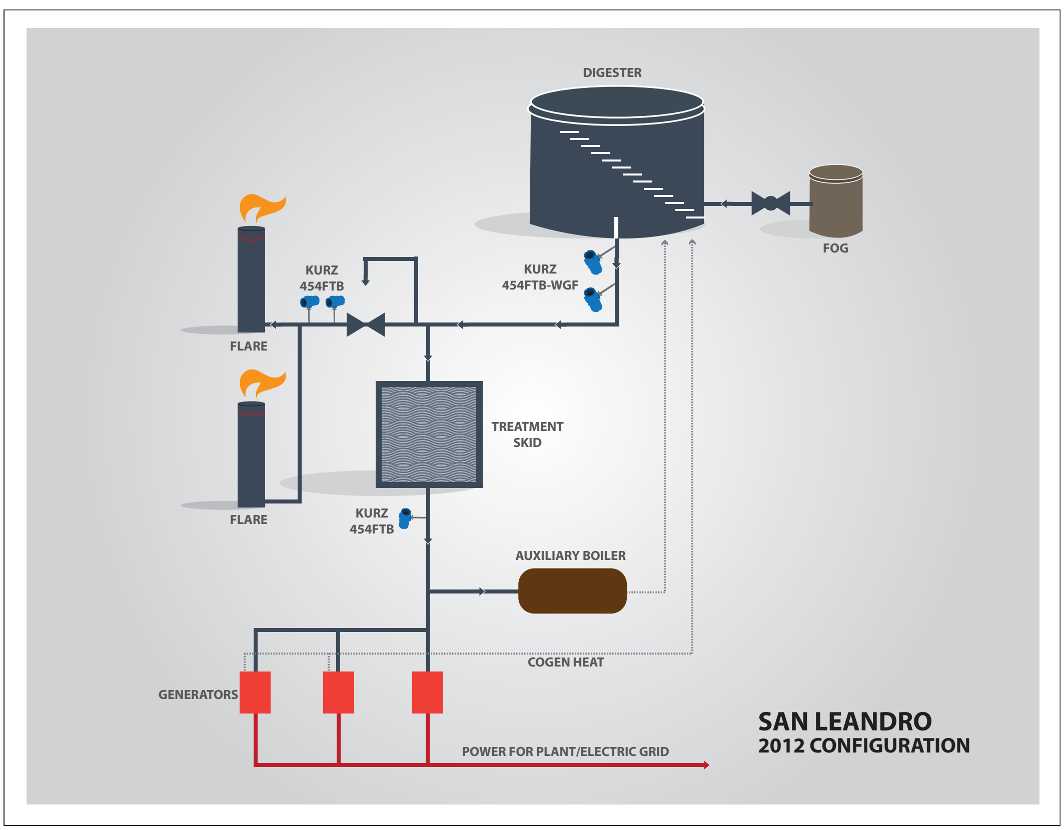
San Leandro Wastewater Treatment Division

The San Leandro Water Pollution Control Plant provides services for more than 50,000 residents, in addition to businesses, commercial, and industrial customers for the northern two-thirds of San Leandro. One of the primary directives is to protect the San Francisco Bay while serving the community.

The plant has three digesters in service to treat the solids from 5 MGD flow. Extensive renovations included in the $50 million upgrade involve supporting a maximum dry weather flow capacity of 7.6 MGD and spikes up to 23 MGD. The treatment plant removes approximately 6 million pounds of solids from wastewater each year.

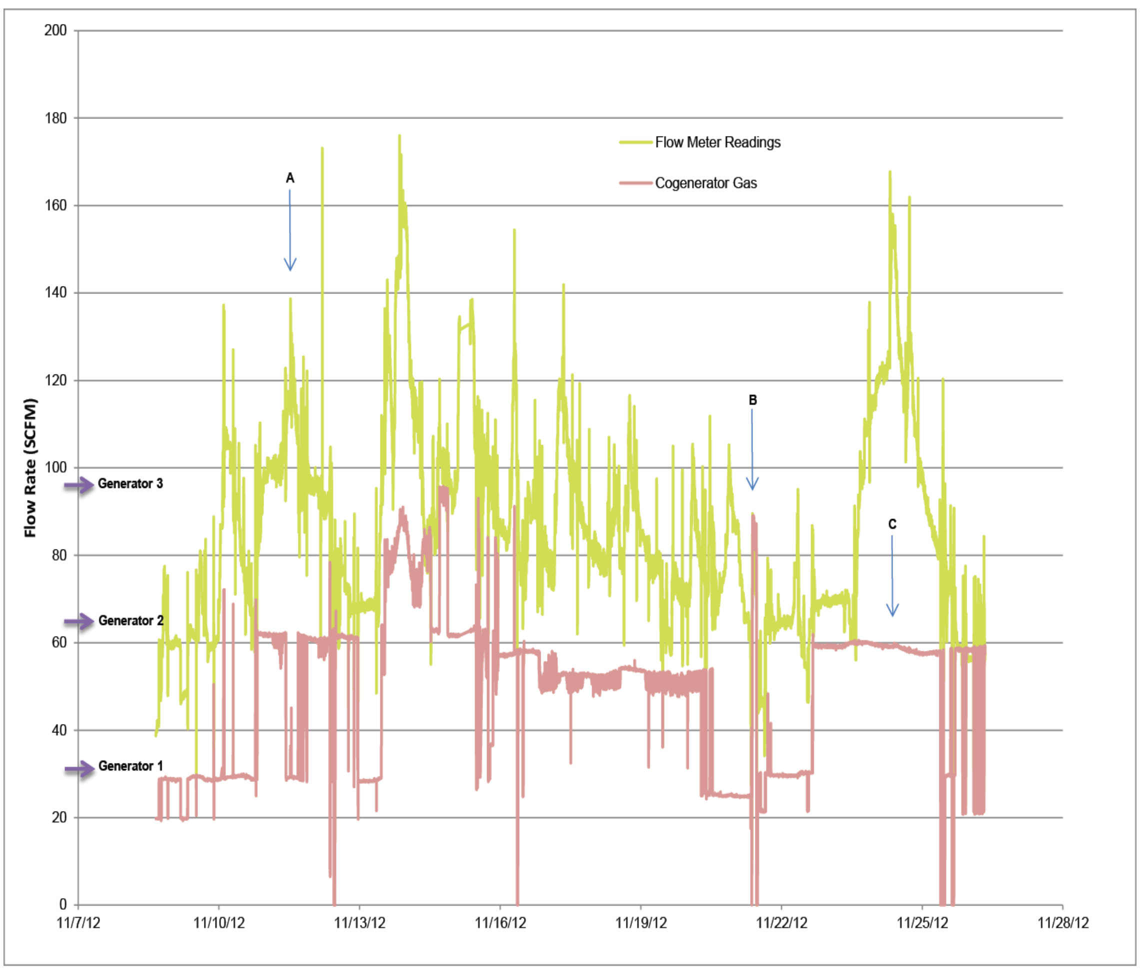
San Leandro's cogeneration units produce heat from three 110kW cogenerators fueled by three digesters. The plant has a FOG (fats, oils, and grease) receiving station. The FOG station provides a method for users to ensure FOG is not poured into drains where it can clog pipes. The FOG is used as feedstock for only one of the digesters.

San Leandro's cogeneration system is unique in that is was built with a guaranteed performance for heat and electricity based on gas production, so both San Leandro and the design firm had a vested interest in accurate gas flow measurements. San Leandro also discovered that gas flow fluctuations caused havoc with the cogeneration system by creating unsteady performance with the engine generators.



Managing overall digester health and effectively monitoring the stability within each digester has traditionally focused on testing the volatile acids-to-alkalinity ratios, pH, and the percentages of biogas and CO2. While the tests provide a basic level of monitoring for a specific time of day, unanticipated changes in sludge quantity or content can create an imbalance. For example, while community use is typically within expected seasonal ranges, the plant also receives varying levels of sewage from a local milk products processing facility and a soda bottling facility. The biochemical oxygen demand (BOD) of this sewage is high (450 mg/l) and results in highly variable gas production each day.

The biogas mix of CH4 and CO2 is 65% and 35%, respectively. Each cogenerator requires approximately 32 SCFM of biogas to come online (that is, 32 SCFM for one generator, 64 SCFM for two generators, and 96 SCFM for three generators). Historically, a mismatch in biogas production readings and mistrust in the flow meter accuracy resulted in the cogenerators not being turned on when there was sufficient fuel (A and C) and being turned on when there was insufficient fuel (B). For example, the generators would shut down due to a loss of gas pressure even though the measurements for the biogas indicated sufficient flow. Once the generator went offline, gas pressure would build up and the biogas would be redirected to the flare. With this much improved monitoring system, San Leandro expects to reduce maintenance by eliminating costly stops and starts of the cogenerators.



Installing the new technology Kurz WGF flow meter on the digester and additional flow meters at the flare and cogenerators, allows gas production and consumption and overall system integrity to be more easily tracked. The cogeneration control strategy became more accurate, leading to much steadier performance. The gas production from FOG dosing is quick and fairly predictable; making it practical to install a pump feed control system so the cogenerators can stay above the minimum gas requirements. This maximizes energy recovery, minimizes potential flaring, and reduces potential fines as greenhouse gas regulations become increasingly stringent.

Installing a flow meter capable of rapid response to changing biogas production levels provides the fastest indicator of digester health. The varying levels of condensation mixed with the biogas leaving the digester change daily and seasonally, and this causes most thermal flow meters to errantly over-report biogas production. The wrong information can lead to the wrong solution. For the San Leandro Wastewater Treatment Division, the Kurz WGF flow meter provided the right solution by removing the ambiguity from the recorded gas flows, and eliminating false spikes and drops.

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Inland Empire Utilities Agency

The Inland Empire Utilities Agency (IEUA) operates and maintains four water recycling facilities and two biosolids treatment facilities. The four water reclamation facilities are designed to reclaim wastewater received from the five member agencies and have a total combined design treatment capacity of 84 million gallons per day (MGD). Regional Water Recycling Plant No. 1 (RP-1) in Ontario, California, was originally commissioned in 1948 and has undergone several expansions to increase the design wastewater treatment capacity to the current 44.0 million gallons per day (MGD) and biosolids treatment capacity equivalent to a wastewater flow rate of 60.0 MGD. The major treatment processes include preliminary and primary treatment, primary effluent flow equalization and diversion, secondary treatment, tertiary treatment, and biosolids treatment.

The RP-1 wastewater treatment plant is a progressive plant that has been using multistage anaerobic digestion since 2000 to improve the efficiency of the facility. A multistage system separates a single digester process into temperature-based anaerobic digestion (TPAD) phases using multiple digesters. In the case of RP-1, the first stage digesters operates at 90º – 104ºF (32º – 40ºC), the second stage digesters operate at 122º – 127ºF (50º – 52ºC), and the third stage digesters operate at 108º – 110ºF (42º – 48ºC).

IEUA technical staff gave a presentation on an acid phase upset that was partially attributed to the inability of thermal flow meters to respond effectively to changing gas production when impacted by liquid condensation from the digester. After meeting with Kurz Instruments and learning of the capabilities of the 454FTB-WGF flow meter, IEUA agreed to test the Kurz WGF.

After a month of testing, operators questioned what appeared to them to be noise generated by the new flow meter. After several experiments, it was determined that the meter was actually measuring the gas burping through the scum mat floating on the digester. This provided the first example of the responsive measurement capabilities of the Kurz WGF.

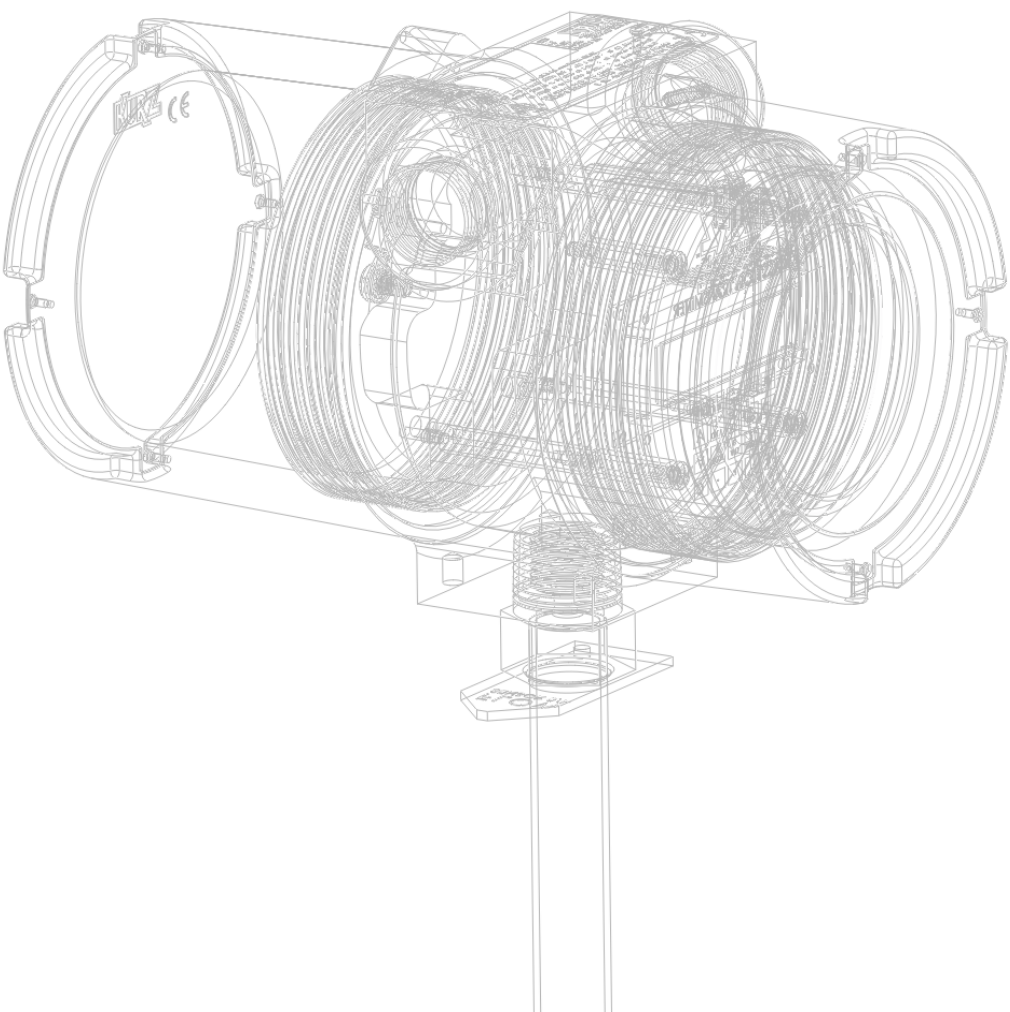
The second example occurred when the operators were able to prevent an upset due to vivianite buildup in the heat exchanger. As the digester temperature began to drop, gas production was immediately affected. The fast response time of the Kurz WGF allowed operators to take corrective action to prevent a situation that would have otherwise required extensive maintenance and cleanup. The previous thermal flow meter would not recognize the changing gas production but would instead rail out from the excess moisture, which made it impossible to prevent the impending upset.

Conclusion

The Dublin-San Ramon Services District, San Leandro Wastewater Treatment Division, and Inland Empire Utilities Agency have invested in green efforts and recognize the benefits of utilizing digester gas. These large investments were thwarted by poor performing gas flow instrumentation. Each plant had a different issue that was resolved using the same instrumentation from the same manufacturer. The Kurz WGF flow meter is a low-cost alternative to other condensing gas flow meter technologies. Its ability to provide a consistent dry gas flow regardless of varying levels of liquid make the Kurz WGF a unique instrument among the available options.

The Kurz 454FTB-WGF flow meter operates at an overheat that vaporizes any droplets contacting the sensor. This allows the WGF to provide a quick response for the true dry gas flow measurement within a condensing gas environment. Other thermal meters specified for wet gas environments have a sensor overheat that is incapable of stopping droplet contact with the sensor, which then requires substantial time to dry out. The varying degrees of continuous condensation make it impossible for other thermal meters to retain accuracy in digester applications.

For all three wastewater treatment plants, using the correct instrumentation for the biogas flow system supports their efforts with environmental stewardship. In addition to installing a flow meter on each digester as an indicator of digester health and gas production, installing a flow meter at each generator and at the flare allows a plant to easily match biogas production (digesters) with biogas use (generators) and waste (flares). Any imbalance between the three provides a quick indicator of a situation in the system, such as a leak or blockage, so corrective action can take place. The end result is efficient biogas use, improved system performance, reduced flaring, eliminating venting, and accurate biogas measurement to ensure regulatory compliance.



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