Two Wastewater Plants
Two Problems
One Solution

By **Jerry Miller** & **Dean Wilson**

Dublin San Ramon Services District
Water, wastewater, recycled water

h2o works
san leandro wastewater treatment
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The Purpose of Wastewater Treatment

Wastewater treatment plants (formerly called “sewage plants”) are a thriving source for resource recovery, which is the reason they are also called water resource recovery facilities (WRRFs). Typical resources include:

- Providing recycled or reclaimed water for landscape irrigation (such as parks, greenbelts, roadway medians, schools, and office complexes), industrial processes, wildlife habitat augmentation, and recharging groundwater basins.
- Separating the water from solids in the wastewater reduces the impact to receiving waters, and also produces valuable biosolids for beneficial uses.
- Producing biogas from the wastewater to generate electricity and heat used for plant operation, with excess energy being sold back to local utilities.

Today’s wastewater treatment plants (WWTPs) or publicly owned treatment works (POTWs) must operate 24/7 in order to meet treatment demands from domestic and industrial sources. The sewage contains a variety of domestic and industrial wastes including dissolved and suspended solids, chemical compounds, pathogens, and inorganic and organic materials.

Treated wastewater can be engineered for safety and reliability, often creating a water source that is more predictable than existing surface or groundwater sources. Wastewater plants follow stringent EPA guidelines while using technology to speed up processes that mimic the natural water cycle. Treating the wastewater is important because it:

- Protects public health

  Untreated wastewater is the leading cause of death in third world countries.

- Ensures a good quality of life

  Untreated sewage must be kept from bays, lakes, and rivers.

- Protects the environment

  Each gallon of untreated wastewater potentially pollutes between 20 to 45 gallons of lake or stream water and 40 to 90 gallons of bay/ocean water.

Treating wastewater so it is safe to release into receiving water sources requires removing all solids and disinfection, both of which are accomplished by several processes.

Wastewater Treatment Plant Basics

Treating wastewater involves pretreatment, primary treatment, and secondary treatment. Many plants start with a pretreatment that screens large items to protect the pumps and equipment. Pretreatment can also include a grit chamber that removes materials such as gravel. Primary treatment uses a clarifier, which commonly looks like a round, above ground swimming pool. The clarifier allows materials to either settle on the bottom where it is suctioned out or float on the surface where it is skimmed off.

Secondary processes are used to turn the remaining material into sludge. The sludge is sent to a digester, the “heart” of wastewater treatment. A digester is a large tank containing micro-organisms that feed on the sludge, with the intent of converting the volatile solids into a nonhazardous material. During the process, a substantial amount of digester gas (also called methane or biogas) is released. Accurately monitoring everything going into and out of the digester is critical in managing and maintaining optimal sludge processing and digester health, as well as benefitting the environment of the surrounding community.

The wastewater plant reclaims the digester gas to generate electricity, heat hot water to maintain the digester temperature for optimum efficiency, and heating or cooling the buildings. The cogeneration of heat and electricity recovers about 2/3 of the energy from the biogas. Every person served by the wastewater plant helps generate approximately 2 cubic feet of digester gas per day.

Digester Health & Energy Production

The biogas captured from a digester should never be vented directly into the atmosphere because raw biogas is a harmful greenhouse gas pollutant. Biogas is typically utilized as an energy source or flared. As an energy source, biogas can be used to fuel a boiler for plant heating needs or sent to cogeneration engines that produce heat and electricity used at the plant. Heat is used to keep the digesters at the correct temperature, and electricity is used for all plant processes, especially for the pumps that generate air in the aeration basin (which account for up to 60% of electricity used at the plant).

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 dry gas flow.

- 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.

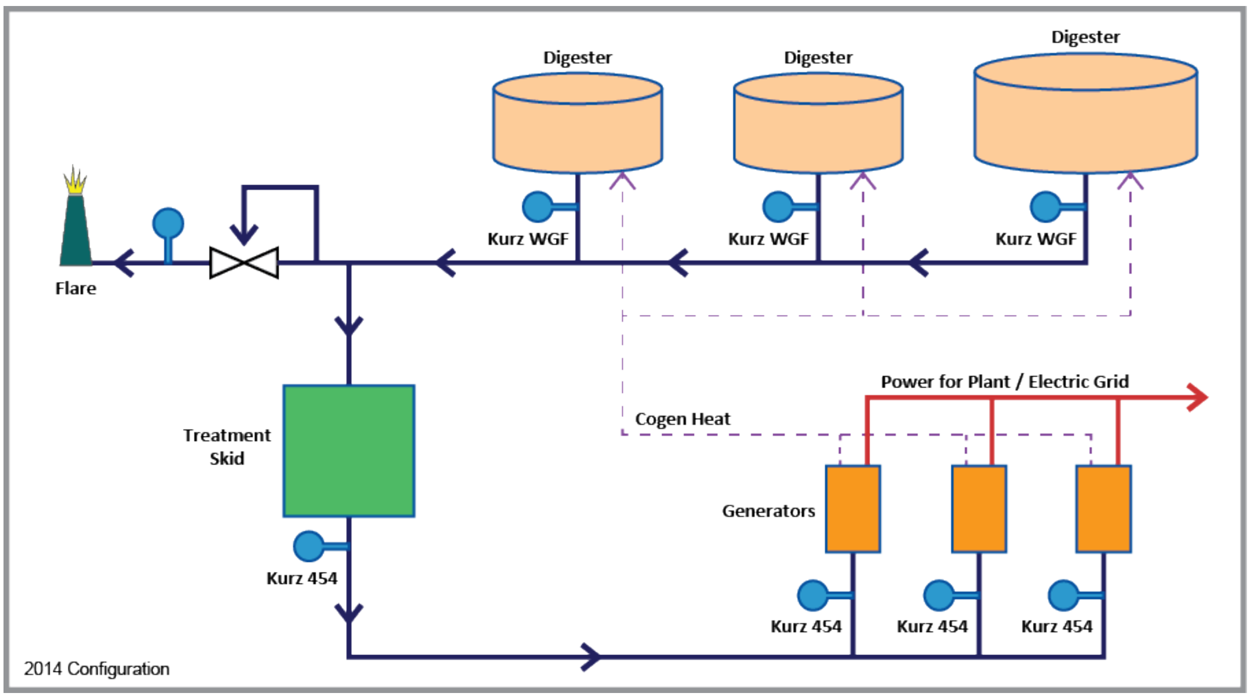
The increasing awareness of greenhouse gases has WWTPs and POTWs in the U.S. burning unused or excess methane gas at a flare, which is reported to local air quality boards.

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.

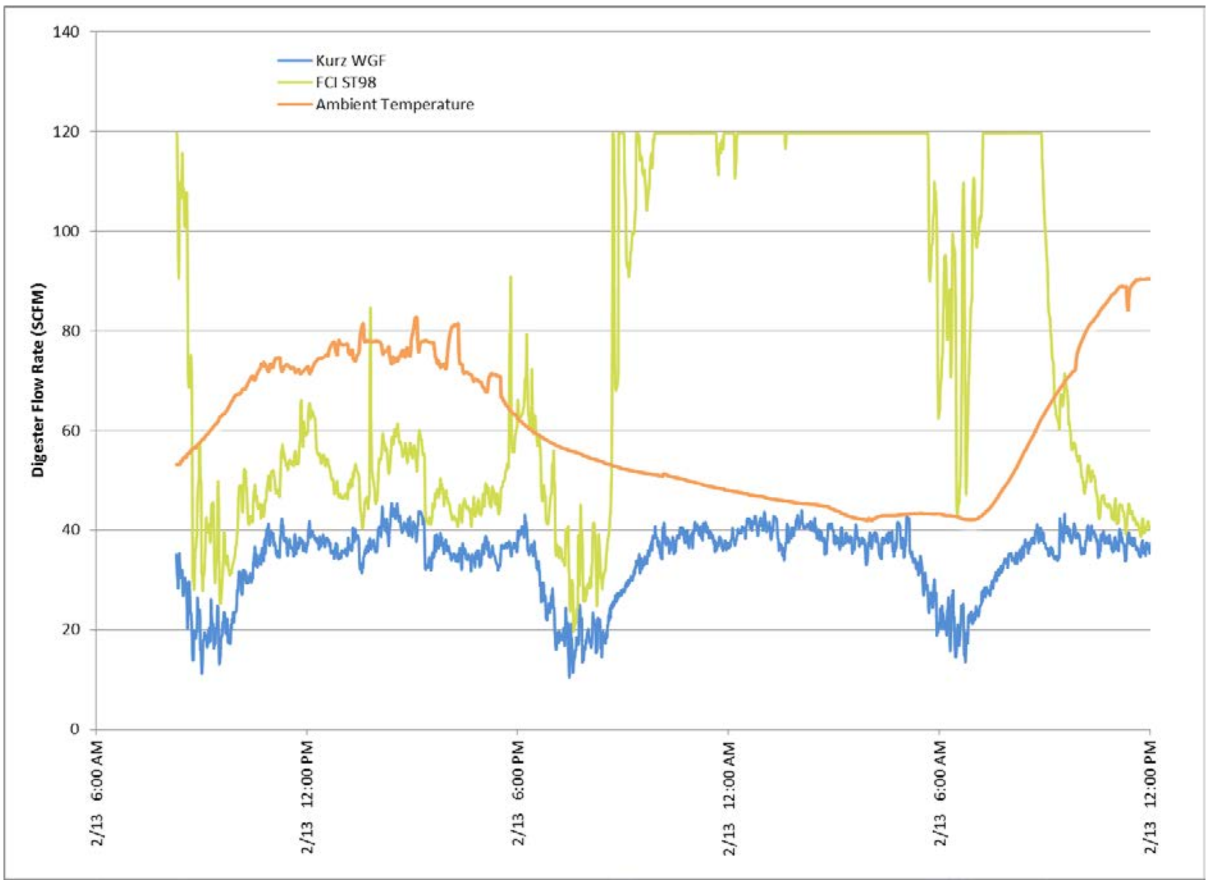
The plant has three digesters that are used to stabilize the solids from the 10 MGD flow generated by the surrounding communities. The biogas captured from the digesters is sent to three generators that produce electricity used at the plant. The waste heat from the generators is used to keep the digesters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

During a plant upgrade, a variety of FCI 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.



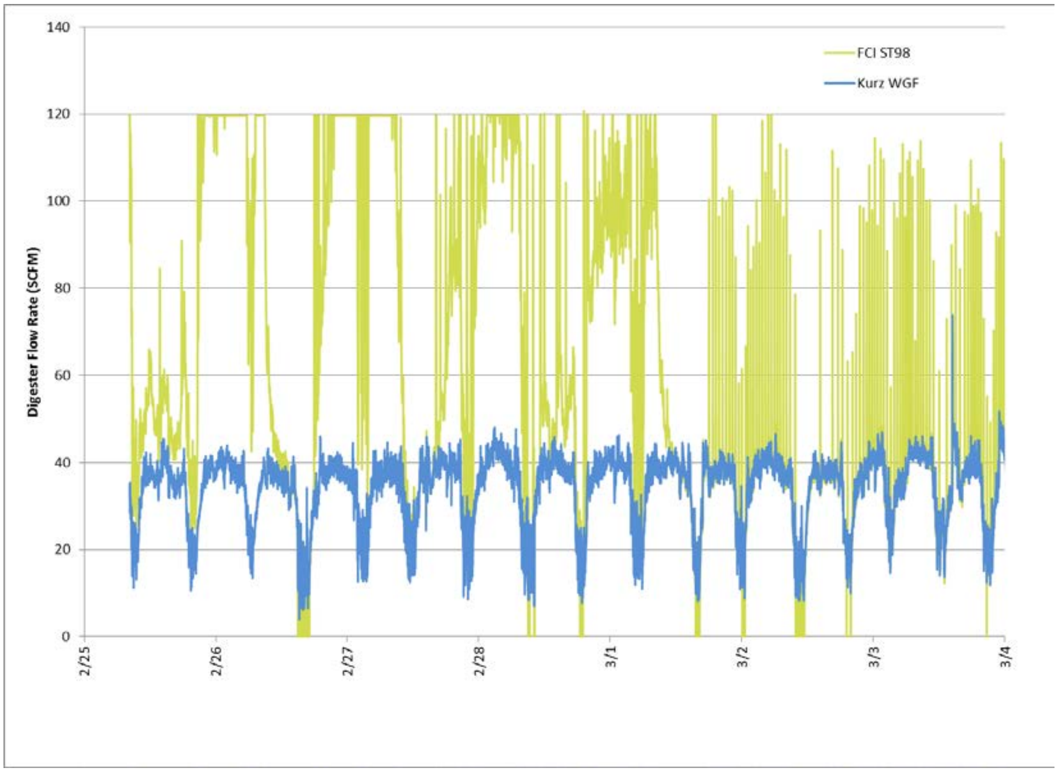
Prior to the installation of the Kurz meters biogas flow measurements remained erratic.
The measurements for treated dry gas only matched overall biogas production during the heat of the day. The relationship of temperature changes, especially colder weather, affecting condensation levels and flow measurements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

We were approached by Kurz Instruments with an offer to use our 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 they had designed an instrument that effectively ignores the liquid. In June 2012, the preliminary results from the test provided impressive improvements so we expanded the test to all raw biogas ports. We long suspected that our original flow meters were not working correctly and hoped 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.

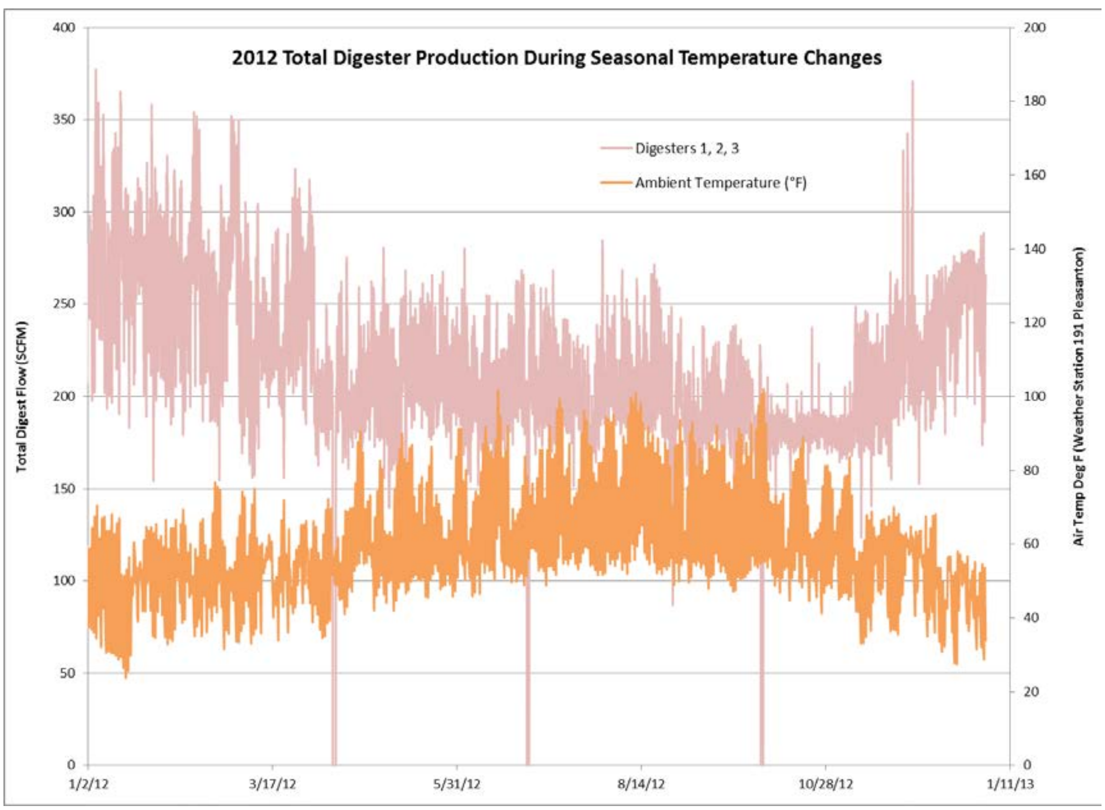


As shown in the graph, when the ambient temperature is cool (in this case, evening and early morning), the FCI ST98 flow meter reports false high readings and takes some time to respond to digester changes in cooler weather. As the outside temperatures rise, the readings from the FCI ST98 began to agree with the Kurz WGF.

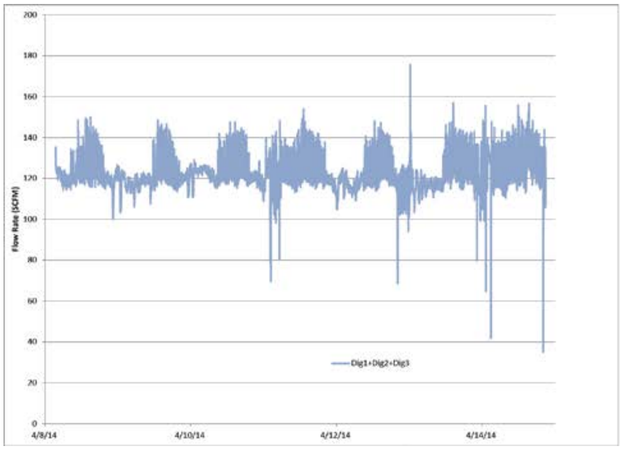
A week's worth of data shows that the digester dosing (the rate of sludge feeding) is consistent, the FCI ST98 is consistently erratic, and the Kurz WGF is consistently accurate.

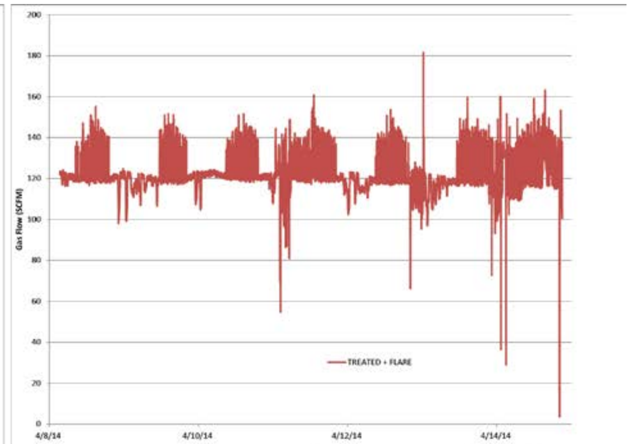


The SCADA system supports summing the data from all three digesters for 2012, when the original FCI ST98 flow meters were reporting flow. The graph clearly shows the over-reporting of gas production is related to seasonal changes in ambient temperature, with almost twice as much gas production being reported than was being consumed by the generators.



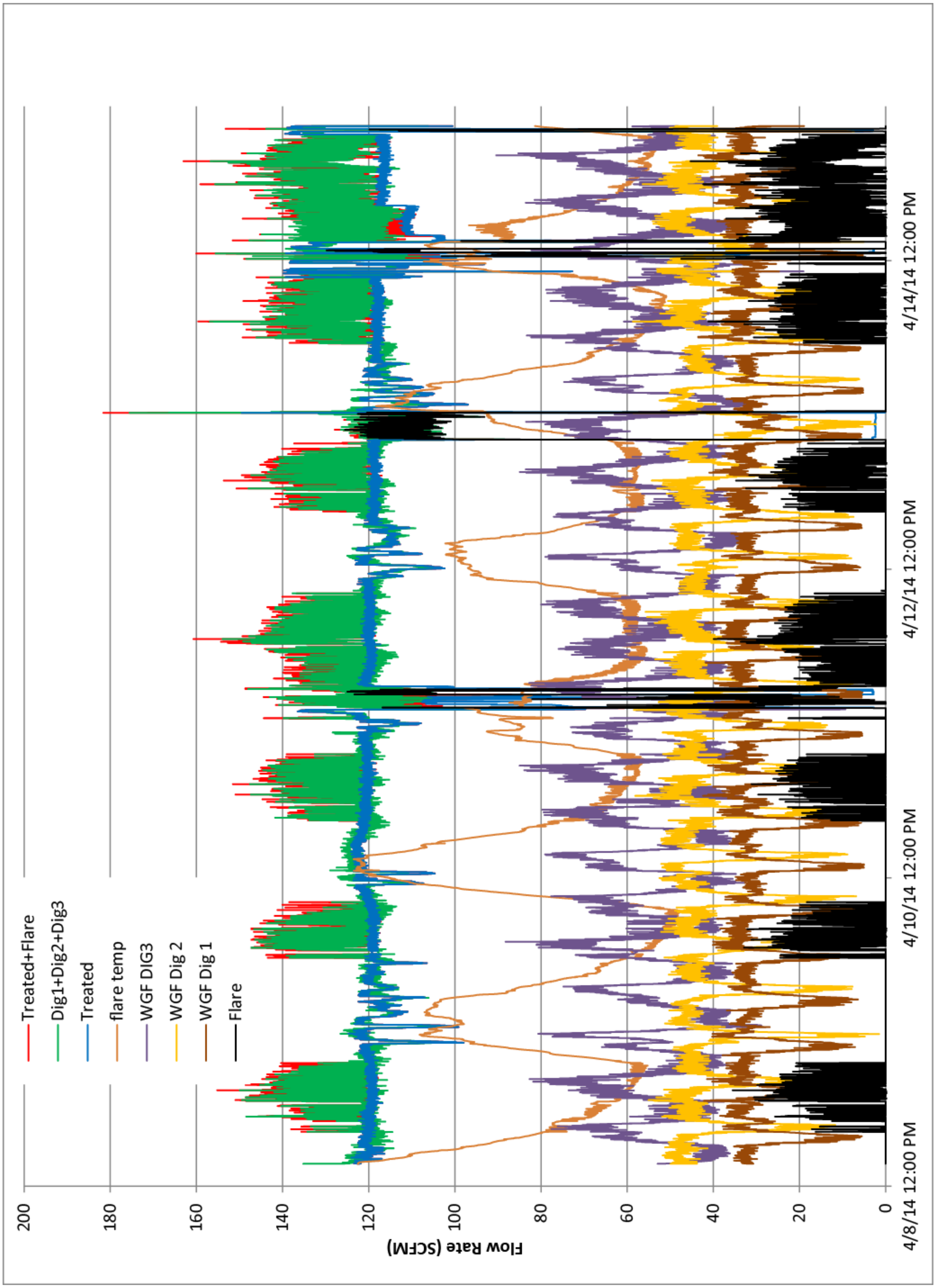
By 2014, a Kurz WGF flow meter was installed on each horizontal exit pipe on the top of each digester. The graph on the left shows the sum of the three digesters related to sludge collection. The graph on the right shows sum of gas consumption sent to the cogeneration engines and flare. The short spikes in the consumption graph for the 20-30 SCFM range are caused by the flare control scheme for biogas pressure above 15 inches of H2O. As shown, total biogas production closely matches biogas consumption.





The ability to relate 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 our sludge doser timer setting. The ability of the Kurz WGF flow meter to show the responsiveness of digester gas to sludge feeding support the behavior we expected to see but had not been able to achieve 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.


Treated+Flare
Dig1+Dig2+Dig3
Treated
flare temp
WGF DIG3
WGF Dig 2
WGF Dig 1
Flare
Flow Rate (SCFM)
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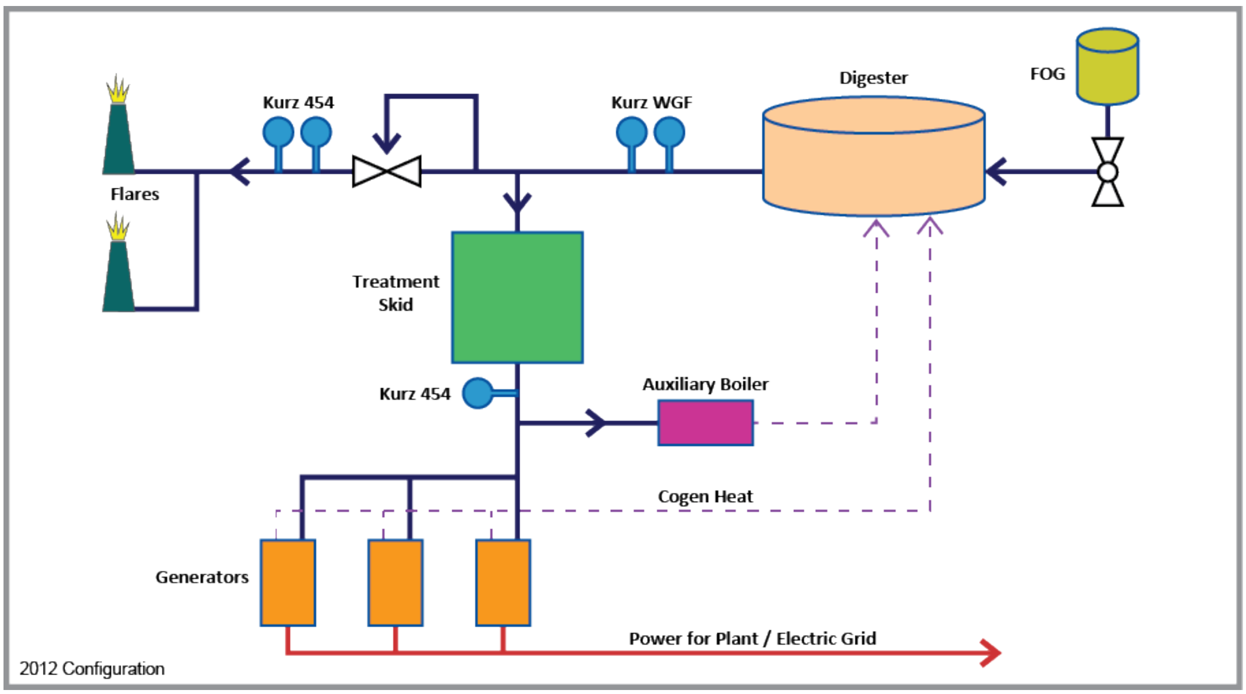
San Leandro Wastewater Treatment Division

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.

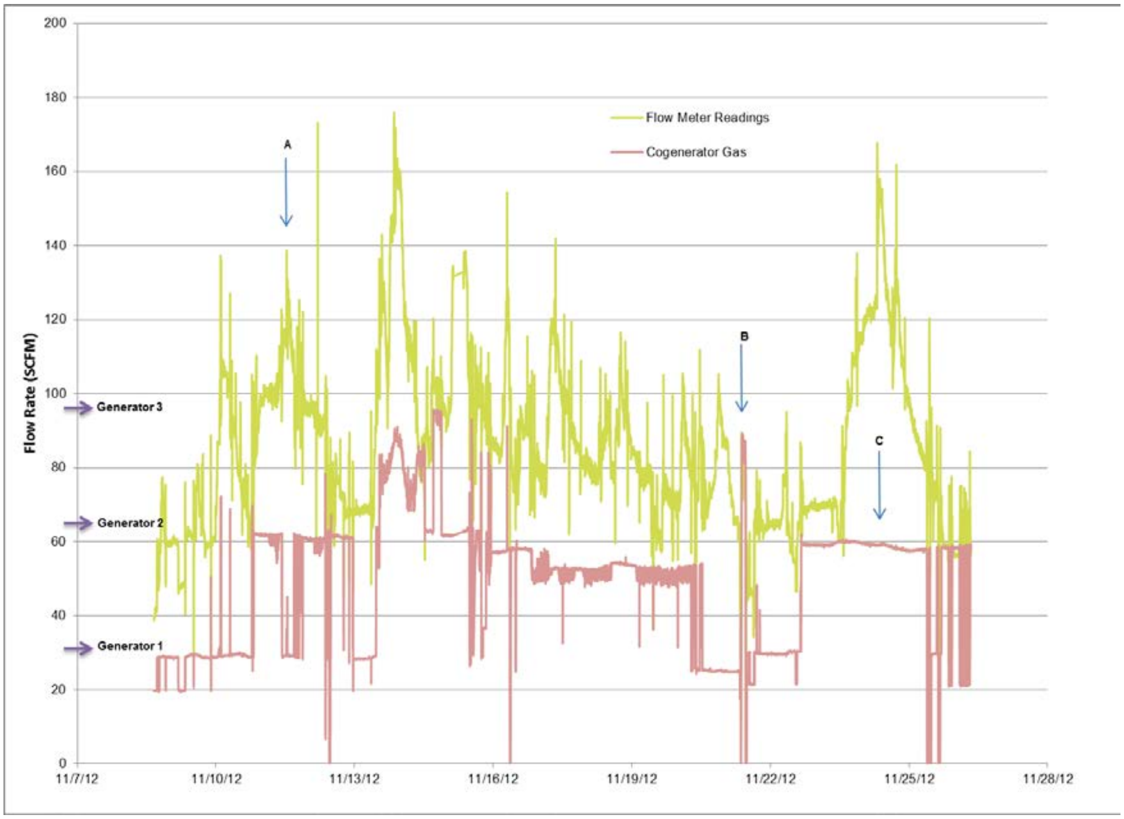
San Leandro's cogeneration units produce heat from three 110kW cogenerators fueled by three digesters. The plant has a FOG (fats, oils, and grease) receiving station. The FOG station provides a method for users to ensure FOG is not poured into drains where it can clog pipes. The FOG is used as feedstock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

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 eliminated false spikes and drops.

Conclusion

The Dublin-San Ramon Services District and San Leandro Wastewater Treatment Division 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.

For both DSRSD and San Leandro wastewater treatment plants, using the correct instrumentation for the biogas flow system supports our 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.

About the Authors

Jerry Miller is currently the Senior Instrumentation and Controls Technician at Dublin San Ramon Services District. He has over 24 years of experience in the wastewater industry, including 15 years as a private Instrumentation Technician, two years with EBMUD, and seven years with DSRSD. Mr. Miller has a CWEA Grade 4 Electrical/Instrumentation Technologist Certificate and is a Technical Advisory Committee Member for Tri-Valley Regional Occupational Program Waste Water Treatment Class.

Dean Wilson has been the Manager for the City of San Leandro Water Pollution Control Division since 2003. He plans and directs the operation of the wastewater plant, environmental services, laboratory, collection system maintenance and related facilities. He's responsible for monitoring legislation, regulatory action and administrative activities related to water quality issues, hazardous materials and other environmental issues to ensure compliance with federal, state and local regulations.

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