Technical Publication

The Challenges Of Combined Heat And Power Generation From Biogas

Fluid Components International (FCI)

FLUID COMPONENTS INTERNATIONAL LLC

Visit FCI online at www.FluidComponents.com | FCI is ISO 9001 and AS9100 Certified

FCI World Headquarters
1755 La Costa Meadows Drive | San Marcos, California 92078 USA
Phone: 760-744-6950 **Toll Free (US):** 800-854-1993 **Fax:** 760-736-6250

FCI Europe
Persephonestraat 3-01 | 5047 TT Tilburg, The Netherlands | **Phone:** 31-13-5159989 **Fax:** 31-13-5799036

FCI Measurement and Control Technology (Beijing) Co., LTD | www.fluidcomponents.cn
Room 107, Xianfeng Building II, No.7 Kaituo Road, Shangdi IT Industry Base, Haidian District | Beijing 100085, P. R. China
Phone: 86-10-82782381 **Fax:** 86-10-58851152

Driven by tight budgets and competing needs for limited CAPEX funds, wastewater treatment plants are increasingly looking to reduce their operating expenses. Many are now referring to themselves as water resource recovery facilities (WRRFs), reflecting a heightened focus on recovering nutrients, methane, and a host of other properties from their waste flows. The largest boon to date has come from thermal energy, but producing biogas comes with its own set of challenges, including accurate gas flow measurement.

Using The Power Of Biogas

WRRFs with anaerobic digesters have the opportunity to use biogas for beneficial and cost-saving purposes. Combined heat and power (CHP), also called cogeneration, produces electrical and thermal energy concurrently. Biogas CHP uses methane gas generated by the digesters as fuel to provide electricity and heat for digesters and buildings.

Reusing biogas this way is highly efficient. It avoids the waste of energy that occurs when electricity travels over distribution lines. Biogas CHP systems also reduce the need for flaring. Greenhouse gas emissions are reduced, thus lowering the WRRF's carbon footprint.

Using biogas CHP saves electrical and heating costs at the WRRF. CHP also reduces dependence on the electrical grid, improving system reliability.

Given all these benefits, it seems that biogas CHP systems would abound. However, per the U.S. EPA's 2014 report, *Combined Heat and Power – A Guide to Developing and Implementing Greenhouse Gas Reduction Programs*, "as of August 2013, CHP systems were operating at only 185 wastewater treatment facilities in the United States, providing 612 MW of electric capacity. And of these sites, only 143 were fueled by biogas generated at the facility, for a total of 352 MW (ICF, 2013)." As there are 14,748 wastewater treatment facilities in the U.S., according to U.S. EPA (2016) Clean Watersheds Needs Survey 2012-Report to Congress, it's fair to say that biogas CHP continues to be an under-utilized resource at WRRFs. Yet, with continued emphasis on sustainability, it will likely prove to be an attractive option going forward.

Challenges For Implementing Biogas CHP

As with all major projects, a technical and financial analysis will determine the feasibility of a CHP project. However, even when such analysis is positive, operating a biogas CHP has

challenges. In a 2011 U.S. EPA and Combined Heat and Power Partnership report, *Opportunities for Combined Heat and Power at Wastewater Facilities: Market Analysis and Lessons from the Field*, phone interviews were conducted with operators at 14 WRRFs using biogas CHP. Operators were asked about specific benefits and challenges they encountered.

One major point was that a biogas CHP is separate and beyond the operation of a wastewater treatment facility. System design requires much diligence. Engineers specifying equipment should be familiar with CHP specifically for WWRFs. Operations and maintenance staff must also be well educated on the intricacies of the mechanical and electrical equipment.

Biogas CHP Instrumentation

Biogas CHP systems are complex, and proper operation requires robust and reliable instrumentation.

Gas Flow Measurement

As an example, accurate and precise fuel measurement is critical for efficient cogeneration. Gas levels must be measured at several locations in the process for proper operation, safety, and reporting. However, biogas flow measurement proves difficult for several reasons.

Wet, Dirty Gas

Biogas is generally composed of approximately 55 to 65 percent methane and 30 to 40 percent carbon dioxide. Other components include nitrogen, hydrogen, hydrogen sulfide, and various other impurities. It's

typically a moist gas. The mixture is potentially explosive and corrosive. Care must be taken to avoid excessive gas buildup in the digester or release of the gas into the environment. In addition, the mix of gases can change due to process modifications or weather.

Low Flow Velocity

Digester gas flow velocities change, sometimes only reaching low rates, so flow meters must have both low-velocity sensitivity and wide turndowns.

Temperature Changes

Most wastewater treatment facilities are outdoors and affected by seasonal weather changes. Flow meters must be able to provide reliable data in extreme weather environments.

Other Environmental Factors

Biogas CHP systems may be in areas subject to vibration, corrosive atmospheres, or other punishing factors. Instrumentation for cogeneration facilities must be rugged enough to maintain accuracy and reliable operation in a tough environment.

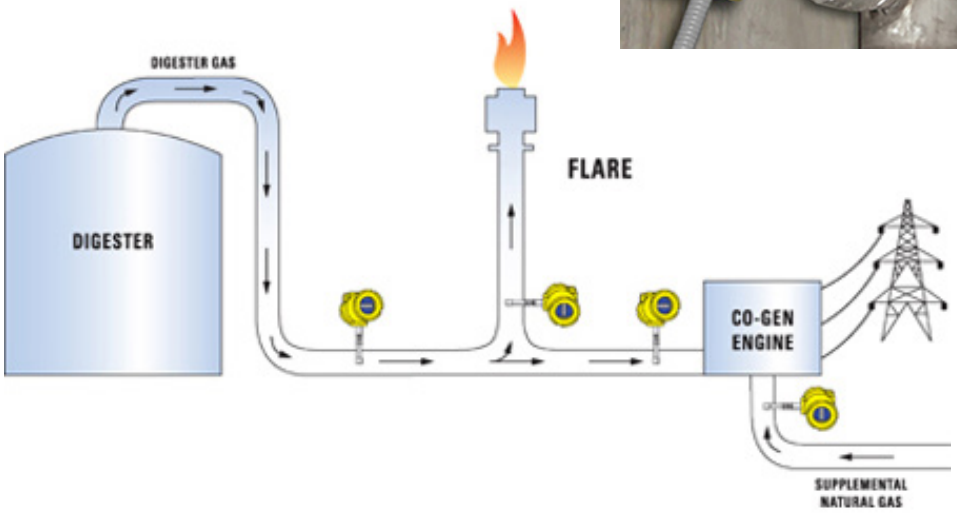
In addition, biogas CHP flow meters need to be operator-friendly and easy to maintain.

Thermal Flow Meters For Accurate Biogas Measurement

To provide the reliable and accurate gas flow measurement critical for cogeneration facilities, flow meters must be able to address the challenges above. Thermal dispersion flow meters have proven successful at meeting the necessary requirements.

When evaluating thermal mass flow meters, look for models that measure both flow rate and totalized flow. Meters designed with a no-moving-parts flow element and an absence of small holes that are prone to clog tend to function well in the dirty gas environment. Fluid Components International (FCI) manufactures a range of meters with precision, application matched calibration for biogas. Also, the meters' constant power measuring technique creates a slight heating effect that dries condensation off the sensor. This improves precision when measuring moist biogas.

To address low flow velocities, look for flow meters with low-flow sensitivity. FCI's thermal mass flow meter has a low-flow sensitivity of 0.6 feet per second with a wide, 100:1 turn-down.



By installing meters with built-in temperature and pressure compensation, you eliminate the need for additional temperature and pressure sensors and density calculation devices. Not only is this design space-saving, but it also lowers maintenance requirements.

It's also paramount to install meters that are rugged, vibration-tolerant and explosion-proof to ensure long-life and safety in harsh environments.

Thermal mass flow meters provide the accurate, precise flow measurement needed for optimal biogas CHP operation and safety. With the no-moving-parts technology, they're operator-friendly, requiring minimal scheduled maintenance. And with reduced maintenance requirements, they have lower lifecycle costs than many alternative technologies.

The Future Of Biogas CHP

Wastewater leaders continue to reach for additional cost savings and improved sustainability. Technological improvements are making anaerobic digestion and cogeneration more attractive.

As these systems become easier and more cost effective to operate and maintain, it's likely their numbers will increase. Ensuring they operate efficiently and safely, by using accurate and reliable instrumentation, will lead to sustainable wastewater treatment. ■