Technical Publication

Biogas Thermal Mass Flow Meter Improves Operation of S.P.M. Feed Company's Methane Recovery System

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S.P.M. Feed Mill Operations

S.P.M. Feed Company Limited operates in Pakto, Pak Tho Ratchaburi, Thailand, with more than 100,000 head of swine. As a company participating in the organic biomass fermentation and recovery industry, S.P.M. generates power from biogas produced by the organic industrial waste from the livestock. The company also benefits from trading the excess fuel for clean energy development credits: Clean Development Mechanism (CDM).

On-Farm Methane Recovery

Decomposition of livestock waste on feed mill farms and other agricultural operations is a major source of methane-rich biogas when harvested as fuel gas. Rather than emit greenhouse gases into the environment, modern farm operations invest in a digester system to recover gases and reduce emissions. Recovered gases are used to fuel electrical generators to power the facility. Additionally, excess power is sold to the local electric power grid. CDM and certified emission reduction (CER) programs offer additional incentives to implement these methane recovery systems.

The Problem

In all biogas recovery systems, measuring the flow rate of methane and other mixed gases is required to ensure effective and efficient operation of the digester process and effective operation of the gas turbine equipment that uses the biogas from the digester process to produce electric power. Effective flow rate measurement is also required in order to provide tangible evidence of saved emissions (CER) and to receive credits and incentives from government agencies (CDM).

Like most agricultural operations, the S.P.M. Feed Mill operators collect manure from the livestock and then digest it using anerobic conditions in specially constructed reactor tanks that produce methane. The company needed a biogas-specific gas flow measurement technology in order to accurately measure volumetric gas flows and report the amounts to a CDM broker. Biogas measurement applications present several challenges in selecting the proper flow meter:

- Low flow sensitivity due to the low flow vapor recovery from the digester process
- Temperature compensation for correct readings in varying temperatures
- Calibration for mixed gas composition of CH_4 + CO_2 + trace gases
- Wet and dirty gas
- Potentially flammable or explosive gas installation environment
- Easy, low cost installation and low maintenance

Biogas is wet and dirty with particulates that will quickly foul and clog most flow meter sensing technologies. The dirty wet gas also will foul meters that are designed with moving parts and orifices. The S.P.M. Mill operators initially tried

using Oscillator and Vortex technology flow meters. However, these flow technologies contain moving parts or orifices and were unable to measure flows accurately at the low flow rate demanded by this digester application.

S.P.M. also was experiencing repeated flow meter failure caused by the wet and dirty gas. Clogged parts from the wet and dirty biogas environment caused the Oscillator and Vortex flow meters to fail. Using these flow meters, S.P.M. also encountered inaccurate measurement results.

For example, the lowest flow rate measured by these technologies was 100 NCMH. With the flow rate being so low, the Vortex flow meter could not measure the gas accurately enough to support the output of electric power. Also, the workers found they had to shut down the Oscillator and Vortex flow meters several times each month for manual cleaning. These ongoing maintenance requirements interfered with farm operations and productivity.

The Solution

After some investigation, S.P.M. specified the ST51 Biogas Flow Meter, a thermal flow meter from Fluid Components International (FCI) that uses constant power technology for wet and dirty air and gases. The ST51 Biogas Flow Meter (*Figure 2*) is specifically designed as a low cost solution to solve the unique challenges to flow metering in digester process generated methane.

The ST51 features methane gas flow accuracy to ±1% of reading over a broad flow range from 0.08 MPS to 122 MPS, and repeatability of ±0.5 percent of reading. The flow element is available for use in line sizes from 2 inches to 24 inches (51 mm to 610 mm) diameters. It operates over a wide turndown range of 100:1, which is essential due to the variable gas flows in wastewater treatment. It operates at temperatures from -18 °C to 121 °C and withstands pressures up to 500 psig [34 bar(g)].

The ST51's thermal dispersion mass flow measurement technology places two thermowell protected platinum 1000 ohm RTD temperature sensors in the process stream. One RTD is heated while the other senses the actual process temperature. The temperature differential between these two sensors is measured and is directly proportional to the mass flow rate of the fluid (*Figure 3*). FCI's thermal mass flow sensor design utilizes a constant power measuring technique, which provides stable flow sensing. This technology provides better accuracy and repeatability in moist biogas measurement applications.

The key reasons S.P.M. selected the ST51 are the biogas flow

Figure 2: FCI ST51 Biogas Flow Meter

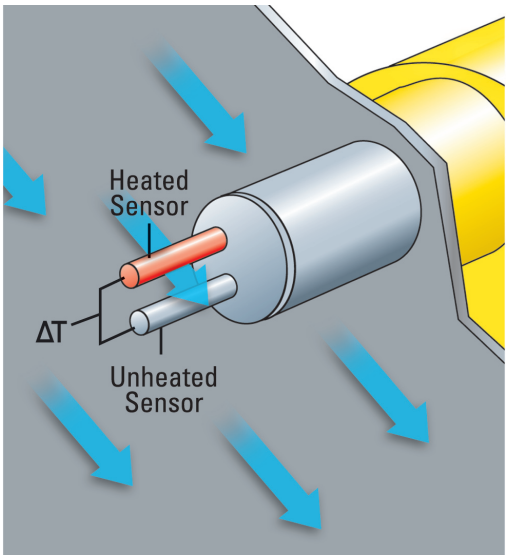

Figure 3: Thermal Dispersion Mass Flow Sensing Theory of Operation

meter's ability to operate continuously with high measurement accuracy and repeatability in a rugged biogas plant environment with virtually no maintenance (*Figure 4*). The ST51 Biogas Flow Meter features a no-moving parts thermal dispersion mass flow sensor design that is highly resistant to clogging. The ST51's resistance to clogging means limited to no downtime required for maintenance and improved productivity. The device operates over a wide flow range with wide turndowns making it sensitive to the low-flow variable nature of biogas production applications.

Also, the ST51 is packaged in an explosion-proof transmitter that is suitable combustible biogas environments and meets safety requirements. The transmitter is housed in an aluminum enclosure that is NEMA 4X approved and meets IP67 requirements for water and dust ingress protection. Input power for the ST51 can be selected as either 18 Vdc to 36 Vdc or 85 Vac to 265 Vac.

Figure 4: Flow meters installed In S.P.M. (roof interior with pipe run and meters)

Key Criteria For Flow Meter Selection in a Methane Recovery Application:

- Accurate and calibrated for specific biogas composition
- Mass or volumetric flow measurement
- Low flow sensitivity, as low as 0.08 m/s
- Wide ranging, 100:1 turndown
- Non-clogging, no moving parts for low maintenance
- No added pressure drop
- Approved for safe installation in explosive gas environment – system agency approvals for Division 1 [Zone 1, II2 GD Ex d IIC]

Table 1: S.P.M. Plant Process Operating Requirements

Media:	Biogas Components	Mole (Volume) Percentage
	Methane	65.000%
	Carbon Dioxide	34.500%
	Hydrogen Sulfide	0.250%
	Oxygen	0.250%

Accuracy: 1.00% rdg + 0.50% of full scale.

Repeatability: 0.50% rdg

	Normal	Min.	Max.	Units
Flow	40	7	500	NCMH
Temperature	30	25	45	°C
Pressure	0.1	0.05	0.16	Bar(g)

Standard Conditions: 1.01325 Bar(abs) and 0 °C

Results

S.P.M. was able to generate power continuously after installing the ST51 Flow Meter, as well as reduced installation and maintenance costs. They no longer need to interrupt the process to clean the flow meter on a monthly basis. They also have eliminated the fouling and clogging issues because the ST51 Flow Meter has no moving parts.

Table 1 displays the S.P.M. plant's digester gas process specifications, flow, temperature and pressure after the installation of the ST51 Biogas Flow Meter. ■