Technical Publication

Precision Air/Gas Flow Measurement Helps Turn Landfills Into Green Electric Power Generators

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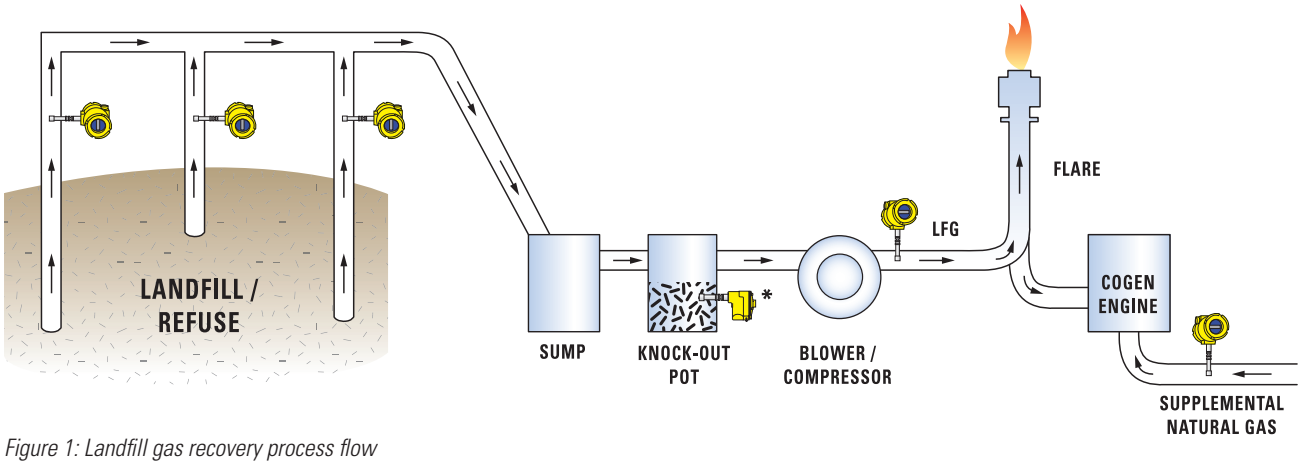

Figure 1: Landfill gas recovery process flow

A leading supplier of landfill gas extraction and recovery systems located in the Midwest region of the US relies on flow meters from Fluid Components International (FCI) for gas flow measurements in landfills. The company has developed hundreds of landfill gas system flares and extraction system skids that are in operation worldwide, which all require accurate gas flow measurement. .

With the help of landfill gas extraction and recovery systems, landfill owners and operators are solving the challenges and meeting ever increasing regulations to reduce greenhouse gas emissions, meeting good neighbor goals and reducing operating costs. Decaying organic materials in landfills are a continuous, rich source of biomethane gas that can be harvested for the production of onsite electric power generation for and/or be delivered and sold to the local power grid, either as electricity or as natural gas to support nearby homes and businesses.

The biomethane gas is extracted from the landfill with multiple wellhead taps and collected via a network of pipes leading to a common header pipe. This main pipe collects enough gas to fuel to drive turbines that in turn produce clean electric power (Figure 1). Typical landfill gas extraction systems for co-gen electric power require turbines, compressors, blowers, pumps, flow meters, knock-out pots and a flare burner or oxidizer gas unit.

Accurate landfill gas flow measurement is essential to the gas extraction system to measure and control the system's operation. In addition, data is reported to the operators and regulatory agencies on the amount of gas being extracted and utilized and/or disposed of via the flare or gas oxidizer system.

The Problems

Landfill gas flow is measured at several points in the system to provide landfill operators with critical information for optimal gas production, control, safety and reporting. Landfill gas applications present several challenges in selecting the proper flow meter:

- Low flow sensitivity during start-up and for seasonal changes, which produce lower flow rates
- Temperature compensation for correct readings in varying temperatures
- Calibration for mixed gas composition of CH_4 + CO_2 + trace gases
- Wet, dirty gas with corrosive H_2S content
- Potentially flammable or explosive gas installation environment
- Easy, low cost installation and low maintenance
- Complies with GHG regulations [1]

Landfill gas is primarily a mixture of methane (CH_4), carbon dioxide (CO_2), hydrogen sulfide (H_2S) and traces of oxygen (O_2), nitrogen (N_2), other gases and water. While a typical landfill gas mix could be 50%-55% methane and 45%-40% CO_2, actual compositions can vary widely depending on the location, refuse types and age. An actual on-site gas analysis is always required before specifying equipment to harvest and measure it effectively.

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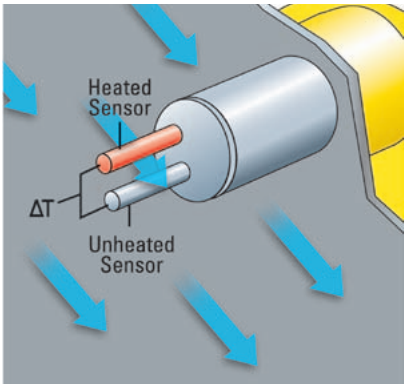
Also dependent upon site conditions the landfill gas can be dirty and wet, which can be highly corrosive when it comes into continuous contact with the equipment necessary to harvest it. Extreme conditions may dictate filtering, gas drying and/or the use of specialty metal components, such as Hastelloy, to mitigate corrosion and ensure long service life of the components.

The gas flow rates can be widely variable depending on the volume of refuse and seasonal changes in temperature and humidity, which means instrumentation and other equipment must be able to measure effectively with wide swings in gas flow. Therefore a flow meter with a wide turndown is essential. Another consideration for flow meter selection is its capability to support different or changing gas compositions. A flow meter with on-board storage of multiple calibrations that can be user assigned in the field is ideal, but a flow meter manufacturer with field service technician's who can perform site calibration verification and adjustments is an acceptable alternative.

Figure 2: FCI Model ST98 mass flow meter in a landfill gas system

Figure 3: Thermal dispersion mass flow measurement theory of operation



Due to the fact that landfill gases can create a potentially explosive situation, engineered safety is a must and instrumentation must be suitably rated and approved for the installation. While some situations might allow for remotely locating electronics outside of the defined hazardous environment, the safer, best-practices approach is to install instrumentation that have received suitable agency approvals. Flow meters should have full instrument (sensor element, electronics and the enclosure.) approvals, not just the enclosure. Applicable approvals include FM, FMc/CSA, ATEX, IECEx, and others, depending on the country.

The engineers at the gas extraction system manufacturer identified multiple flow measurement technologies that could potentially support their applications. Their primary objective was to find a flow meter technology that provided accurate measurement of mixed composition gas, which also was suitable for wet, dirty gas, carried global agency approvals for installation where methane gas was present, was easy to install and required no maintenance to provide worry-free continuous operation.

The Solution

After identifying several potential flow meter technologies for its landfill applications, the systems manufacturer contacted FCI for assistance. FCI specializes in thermal dispersion technology for the direct mass flow measurement of gas and is one of the industry pioneers of its application in rugged environments. Thermal mass flow meters provide a landfill gas flow measuring solution that is accurate, repeatable, easy to install and requires virtually no maintenance (Figure 2).

FCI's thermal dispersion mass flow measurement technology, constant power, places two thermowell protected platinum 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).

In moist landfill gas measurement applications, FCI's constant power technique provides superior accuracy and repeatability. The alternative thermal dispersion technique, constant deltaT, can read erratically in moist gas applications. FCI's constant power provides a light heating effect which actually dries condensate moisture off the sensor to ensure stable readings and performance.

FCI recommended to the gas extraction systems manufacturer the installation of its ST98 flow meter (Figure 4), which is ideal for landfill gas measurement and features high accuracy to ±1% of reading, ±0.5% of full scale. Exceptionally consistent, the meter offers repeatability to ±0.5% of reading and is fully temperature-compensated for accurate measurement under variable environments.

With its highly reliable thermal mass sensing element, the FCI meter delivers precision gas flow rate, totalized flow and temperature measurement. This insertion style meter operates over a wide flow range from 0.75 SFPS to 600 SFPS (0.21 NMPS to 172 NMPS). It features a wide, 100:1 turndown ratio and operates at pressures up to 250 psig [17 bar (g)].

The meter's transmitter features robust, microprocessor-based electronics. The transmitter can be integrally mounted with the sensor or remote mounted up to 1000 feet [300 m]. Its enclosure is NEMA/CSA Type 4X (IP66) rated and it carries global agency approvals on the full instrument for explosion-proof, Division 1 [Zone1] installations.

FCI calibrates the meter and its other product lines in its own Calibration Laboratory. All laboratory equipment is National Institute of Standards (NIST) traceable, as well as certified to ISO 9001:2000 and AS9000. The laboratory also meets MIL-STD-45662A and ANSI/NCSL-Z-540 requirements.

FCI's flow calibration laboratory provides gas flow calibration capabilities ranging as low as 0.001 SCFM (0.00017 NCMH) to ranges that exceed 5000 SCFM (8500 NCMH) and can match installation conditions for applications with temperature ranges from –100 °F to 850 °F (-73 °C to 454 °C).

Conclusion

When choosing a flow meter for landfill gas measurement, there are a number of key criteria to review:

- Accuracy and calibrated for mixed methane landfill gas composition

Figure 4: Model ST98 mass flow meter

- Low flow sensitivity with wide turndowns to accommodate variable gas flows
- Multi-functional with the ability to measure both the flow rate and totalized flow
- Temperature compensation to ensure accuracy in widely variable outdoor landfill operating conditions
- No moving parts to clog or foul in the presence of wet, dirty gases, as well as special materials available to resist corrosion
- Agency approvals for use in Division 2 (Zone 2) and Division 1 (Zone 1) hazardous environments where combustible gas is a threat to people and plant equipment
- Complies with GHG regulations, such as the USA EPA's GHG mandate

The meter provides flow rate and totalized flow data from each landfill gas well to ensure continuous operation and

optimal data collection. The meter was selected by the landfill gas extraction systems manufacturer because of its ease of installation, in-place agency approvals for hazardous gas locations (Div 1) and because FCI is able to calibrate the meter to the systems manufacturers' requirements for mixed composition gases.

Footnote

[1] While not a factor originally, this is a mandatory factor in the US now. The US EPA enacted its GHG mandate legislation in 2009 and specific requirements for flow meters must be considered when selecting landfill gas flow meters. 40 CFR, Part 98, subpart HH applies specifically to landfill gas operations and details the full reporting and compliance requirements.

The Midwest based landfill gas extraction system manufacturer and its customers became very concerned about compliance of their installed systems as well as new systems going forward. Responding to this concern FCI met with and worked directly with the US EPA in Washington, DC, to confirm thermal dispersion flow metering technology was acceptable and further confirmed that FCI's calibration methodology also complies with that stipulated within the mandate.

For more information specifically on this topic visit web site information at:

www.epa.gov/climatechange/emissions/ghgrulemaking.html

www.fluidcomponents.com/Industrial/App/EPA-GHG-Mandate.asp