Landfill Gas

# Improved Landfill Gas Flow Measurement Using Wet Gas Thermal Flow Meters

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# Introduction

Accurate and reliable measurement of landfill gas (LFG) flows is critical to the proper operation and documentation of LFG collection and control systems (GCCS). Sacramento County's Department of Waste Management and Recycling (DWMR) has teamed with Kurz Instruments to implement the use of thermal flow meters that utilize "wet gas technology" at the Kiefer Landfill. These meters have proven to provide accurate and reliable flow measurement while reducing operational costs.

# Background

Operators of LFG collection and destructions systems rely on flow meters to provide accurate and reliable measurements. Federal, State and Local regulations require LFG flows to be measured and recorded for the purposes of tracking air toxics and greenhouse gas (GHG) emissions. Additionally, accurate flow information is critical to the planning and design of any LFG to energy projects.

# Gas Flow Metering Basics

Ideally, it would be most advantageous to have a meter that can directly measure mass flow, has a high turndown range, can measure low flows when required, can operate in dirty environments, can operate in high moisture environments, has low maintenance costs, and has a minimal pressure drop. A variety of flow measurement technologies are available, but the most common two used in landfills are Thermal and Differential Pressure (DP).

Traditional Thermal Mass Meters operate on the principle of a wind chill meter. Thermal meters measure the flow by sensing convective cooling (density x velocity) which results in mass rate compensated for pressure and temperature. Their advantage is that they have most of these ideal characteristics listed above and are the most commonly used meters in landfill operations. They are ideal for dry gas applications. However, when there is moisture present in the gas being measured, which frequently occurs in landfill gas applications, these meters lose their ability to measure accurately.

Differential Pressure (DP) Meters include Pitot Tubes, Orifice Plates, V-cones, Venturi devices and nozzles. These meters operate on the principle of using a constriction or obstruction in the line, which calculates the velocity flow from the differential pressure being measured. DP technology is based on the Bernoulli Principle for a relationship between the pressure and velocity of the gas. These meters have the ability to measure in wet gas applications when they are clean. However, they do not handle the dirty gas well and need cleaning often. In addition, they measure volume instead of mass, have a low turndown ratio, and have a large pressure drop.

Ultrasonic Devices are also capable of measuring wet gases, and operate on the principle of monitoring ultrasonic pulses across a gas stream. It compares the sound pulse flight time with and against the flow direction to compute actual gas velocity. However, they measure volume and not mass, do not handle dirt in the gas stream well, have very high initial costs and high maintenance costs.

Turbine, Vortex, and Coriolis types of meters are rarely used. Turbine meters cannot handle the dirty gas well and need cleaning often, have issues with wet gases, and have a high pressure drop. Vortex meters have issues with dirty gas and have a low turndown range. Coriolis meters have a very high acquisition cost. They can handle a dirty gas stream, but do not tolerate wet gas and also have a sizeable pressure drop.

It is important to choose a gas flow meter that provides consistent, accurate, and reliable information. Each technology has benefits and limitations that must consider gas type, flow rate, velocity, temperature, and initial and maintenance costs. The following table will provide you with a good summary comparison of the gas flow meter technologies available:

| Type | Mass or Volume | Turndown Range | Low Flow | Dirt | Line Sizes | Pressure Drop |
|---|---|---|---|---|---|---|
| Thermal | Mass | 1,000:1 | Yes | OK | 1/8" – Insertion | Low |
| DP | Volume | 10:1 | No | Bad | 1/8"- Insertion | High |
| Turbine | Volume | 50:1 | No | Bad | 1/4"- Insertion | High |
| Vortex | Volume | 25:1 | No | Bad | 1"- Insertion | Low |
| Coriolis | Mass | 100:1 | No | OK | 1/8"-10" | Medium |
| Ultrasonic | Volume | 100:1 | Yes | Bad | 2" – 120" | Low |

# The Problem

The wide range of environmental and biological systems within a landfill (and the complex nature of its content) makes biogas production within the landfill difficult to predict and control. The unpredictable moisture levels caused by leachate, rain, temperature, and humidity create wet gas flows that wreak havoc with most instrumentation systems and confuse system measurements. Incorrect data not only reduces the effectiveness of energy harvesting systems by redirecting biogas from energy production to flaring, but distorts data that landfill operators are required to monitor and report.

Traditional thermal flow meters are calibrated to a known dry gas or dry gas mix. However, in applications such as landfill gas there is a dynamically changing water content, temperature, and quality.

This variable cannot be accounted for through any calibration process. As water droplets impact the heated sensor it loses energy as the liquid evaporates causing the meter to erroneously interpret increased flow. Large water droplets will cause significant flow spikes lasting up to 30 minutes.

Monitoring gas flows containing various amounts of water vapor have been the domain of differential pressure (DP) and ultrasonic technologies. Unfortunately, neither one supports large turndown ratios requirements, and they either have up-front or maintenance cost issues.

# The Solution

Advancements in thermal mass flow meters provide a new alternative to DP and ultrasonic meters. The meter sensors are virtually unaffected by moisture in the flow stream, and the meters require almost no maintenance. Thermal flow meters designed specifically for wet gas environments provide reliable and repeatable capabilities in landfill gas applications.

# Kiefer Landfill

The Kiefer Landfill, located in eastern Sacramento County is owned and operated by DWMR. The Kiefer Landfill opened in 1967 and currently has a waste footprint area of 305 acres and has approximately 30,000,000 tons of refuse in place. The site is permitted up to 660 acres within the 1,084 acre site.

LFG migration was discovered at the Kiefer Landfill in the early 1990s. LFG was found in concentrations of up to 75 percent methane in monitoring wells over 2,000 feet from the landfill boundary south and west of the landfill footprint. LFG has been determined to be the primary source of VOC groundwater impacts. DWMR has made significant efforts during the past 20 years to stop LFG migration and eliminate off-footprint LFG.

A LFG collection and control system (GCCS) was installed and activated in 1997. The original system consisted of 72 vertical interior collection wells, 30 vertical perimeter collection wells, and a 150 million BTU per hour flare. Since that time, the system has been expanded to include over 350 collection devices (vertical wells, horizontal wells, and leachate clean-outs), a second 120 million BTU flare, and a 15 megawatt power plant. LFG is currently extracted at an average rate of 7,200 cubic feet per minute. The GCCS has been largely successful in reducing the presence off-footprint LFG at the Kiefer site.

In 2010 DWMR expanded the Kiefer flare station. The project included installation of a second flare, automation of the control system, and rerouting of manifold piping. DWMR selected Kurz thermal flow meters for installation on this project.

# Use of Kurz meters at Kiefer

DWMR originally installed three traditional Kurz 454FTB flow meters at the landfill in the 2010. A meter was installed in each of the two power plant intake pipes and one on the new flare. The three worked adequately at first during the warm weather, but during cold periods, the meters reading became less accurate and exhibited reading spikes. DWMR consulted with Kurz on this issue. Kurz immediately identified the high moisture content in the LFG as the likely problem.

At that point, Kurz offered DWMR an opportunity to be a beta test site for their yet-to-be released (WGF) wet gas flowmeter, the first thermal flow meter designed for condensing gas applications. DWMR accepted and replaced the standard 454FTB meters with WGF meters. Once the WGF meters were installed, the accuracy issues were resolved and the meters have been trouble free.

# Conclusions

There have been several cost advantages using the Kurz WGF meter:

- There are minimal maintenance issues with the meters. The meters are fully electronic and require only periodic inspection to assure error free operation.
- Regulations require annual calibrations in accordance with the manufacturer “manufacturer’s recommendations”. According to Kurz, their meters do not require calibration due to the electronic design of the meter. The meter is self-calibrating and drift is corrected on a continuous basis. DWMR has performed field calibrations and have proven that the Kurz meters have not drifted and DWMR no longer calibrates the WGF meters annually.
- The accuracy of the meters are improved, therefore fees based on emitted toxics and GHGs are more accurate.

Use of the Kurz WGF flow meters at the Kiefer Landfill has improved the performance of the GCCS and reduced operational costs.