5. Multipoint Flow Measurement in Large Lines, Ducts & Stacks

Air pollution emissions monitoring and control begins with accurate and reliable gas flow metering. There's an old industry truism that says, "You can't control what you don't measure," and that applies here. Process plants install the world's most sophisticated air pollution control systems, but they can be ineffective if the flow meters they rely on deliver inaccurate or unreliable data.

Flue gases are the mixed composition hydrocarbon greenhouse gases (GHGs) that are the byproduct of an industrial combustion process. A flue is typically a large pipe, duct, stack, chimney, or other venting attached to a process or industrial manufacturing plant system such as a boiler, furnace, steam generator, oven, etc., through which waste gases are exhausted.

Depending on the type of industrial plant, processes, fuel used, and efficiency, flue gases include:

- Carbon monoxide
- Methane
- Nitrogen
- Nitrogen oxide
- Oxygen and water vapor
- Ozone
- Particulates
- Sulfur oxides

Flow Measurement Environmental Standards

For large stack monitoring applications, the U.S. EPA requires a Continuous Emissions Monitoring System (CEMS) or Continuous Emissions Rate Monitoring System (CERMS). For CERMS, the flow meters must perform an automated and on-demand self-checking of calibration drift (CD) at both a low range and a high range flow point.

In the EU, these systems are referred to as an Automated Measuring System (AMS). The flow meters that support them also need to meet the Quality

Assurance Level 1 (QAL-1) standard confirming compliance to EN 15267-1,-2,-3 and EN 14181 standards.

Measurement Challenges

Measuring the flow of stack or flue gas is a challenge (Figure 1). These gases are generally mixed hydrocarbons in terms of their composition. In addition, the volume of gas that is emitted tends to vary based on the products in production, workload schedules and seasonal fluctuations in temperature and humidity. This variability can lead to irregular swirling flows in stacks that are difficult to measure without multipoint sensing.

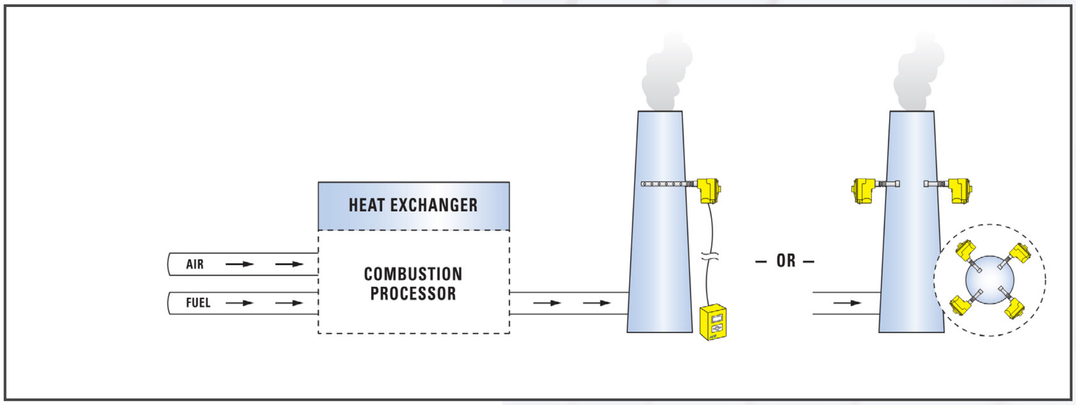

Figure 1: Flow meter installation for flue gas

Large diameter pipes, stacks and ducts present their own unique physical challenges to successful flow meter installation and performance. Installation is complicated by difficult access points, single plane platforms, long cable runs, extra mechanical support and exposure to weather extremes.

Lack of pipe straight-run, distorted flow profiles, low flow rates and wide turndowns rates are common performance challenges for many flow metering technologies. Furthermore, the gas can be dirty and/or at high temperatures, which can result in measurement degradation, clogging and fouling that leads to excessive maintenance procedures or premature flow meter technology failures.

The purpose for gas flow measurement is now increasingly multipurpose: To comply with government regulations and to provide process gas data for scrubbers and flare systems. The combination of these factors results in the need for flow meters that operate accurately and reliably over a wide flow range in rugged environments with distorted and swirling flow profiles.

> There's an old industry truism that says, "You can't control what you don't measure."

Evaluating Sensor Technologies

In considering a flow meter for gas monitoring, the first step is always choosing the appropriate flow technology. There are multiple flow sensing technologies available, and the major ones now include:

- Coriolis (mass)
- Differential pressure
- Electromagnetic

- Positive displacement
- Thermal (mass)
- Turbine
- Ultrasonic
- Vortex shedding

All of these technologies have their advantages and disadvantages depending on the type of process fluid (air/gas or liquids). Process engineers must consider limited straight run challenges, dirt and particulates, mechanical installation considerations, high temperatures and moisture entrained in the flow stream, in addition to cost/benefit considerations in meeting accuracy requirements, maintenance and life expectancy of the equipment.

Flue gas monitoring at a cement plant

By looking at these factors as well as the plant's layout, environmental conditions, maintenance schedules, energy cost and ROI, it will soon be easy to narrow the field. The most common flow sensing technologies chosen for flue gas measurement are differential pressure (averaging pitot tubes) flow meters and thermal dispersion mass flow meters. Both technologies have similar accuracy levels when configured with multiple sensing points within the large cross sectional area of a flue gas line.

For swirling flows of hot flue gases, multipoint sensing generally provides more accurate flow measurement than single point technologies.

Maintenance requirements, which drive up operating and lifecycle costs, as well as reducing ROI, are different with these two technologies. Most averaging pitot tube flow sensors require a daily manual cleaning or compressed air back purge system to keep the inlets from clogging. Thermal flow meters, which have no inlets or any moving parts, can require virtually no maintenance for years.

Conclusions

When you examine the viability of the various air/gas flow sensing technologies available for flue gas monitoring and then look at them according to accuracy, installed costs and lifecycle costs, you increase the probability of selecting the best flow measurement solution. If you have a unique problem, contact any of the flow meter suppliers. They see these challenges every day and have probably already solved the same problem for someone else.

Author: Steve Craig,
Senior Member Technical Staff
Fluid Components International