Technical Publication

Greenhouse Gas Flow Monitoring Helps In Global Climate Change Effort

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As of 2010 most of the world's industrialized nations have recognized the climate change issues resulting from global warming that were presented in the 1997 Kyoto Protocol. Since that time, the members of the European Union (EU), the United States (US) Environmental Protection (EPA) Agency and other regional and governmental bodies worldwide have introduced a wide range of policies and regulations all designed to prevent further global warming.

Thousands of industrial process and manufacturing plants with global operations in regions and nations around the planet are now working to comply with a broad range of new regulations. In response, industrial process and manufacturing companies worldwide are implementing energy conservation and overall greener practices ranging from simple recycling of everyday materials to installing complex alternative energy systems.

It is widely accepted now that rising levels of waste greenhouse gases (GHG) that result from industrial production and the everyday living practices of billions of people are the primary causes of global warming. Methane and other GHGs have been targeted as a primary area of concern and regulatory activity.

Methane is the primary GHG emitted from oil and natural gas systems and is more than 20 times as potent as CO_2 at warming the atmosphere, while fuorinated gases are even stronger and can stay in the atmosphere for thousands of years. Nitrous Oxide (NO_2) is also considered part of the problematic pollutant mix.

The EU, EU-15 Member States, now followed by EU-25 members, has either already implemented or is in the process of implementing a number of regulations designed to monitor and minimize the emission of GHGs and other climate threatening pollutants in compliance with the Kyoto Protocols. The US EPA in 2009 and 2010 also implemented new regulations entitled "Mandatory Reporting of Greenhouse Gases." The new US regulations called for certain facilities emitting 25,000 metric tons or more per year of specifed GHG's to provide an annual report of their actual GHG emissions.

GHG Monitoring

The monitoring and reduction of various industrial process and manufacturing plant GHGs requires fow monitoring and fow meters. For years, industrial process and manufacturing plants have been required to monitor fue or stack emissions by their respective global agencies and governments in the fght against air pollution.

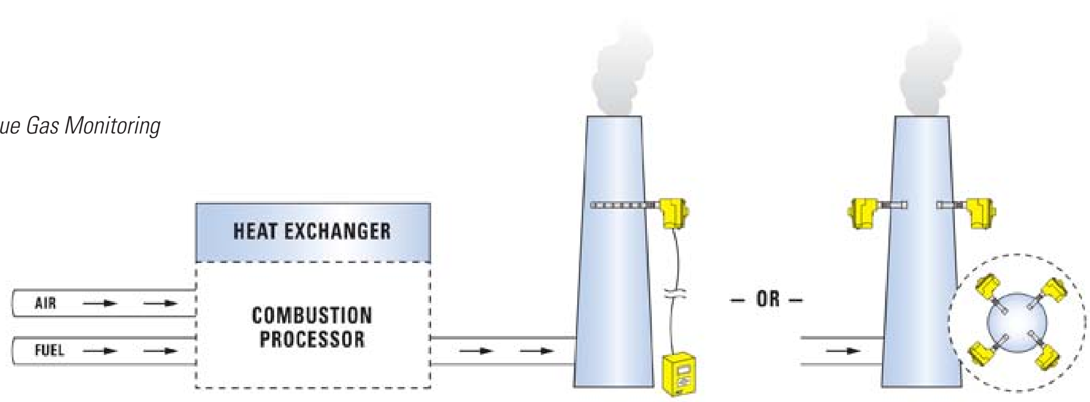
Flue gases are the general name given to the mixed composition hydrocarbon greenhouse gases that are the by-product of an industrial plant combustion process. A fue is typically a large pipe, duct, stack, chimney or other venting attached to a process or industrial manufacturing plant system such as a boiler, furnace, steam generator, oven, etc., through which waste gases are exhausted from the combustion process.

Flue gases are produced by many industrial process and manufacturing industries, including chemical and food processing, petroleum refning, pharmaceutical production, metals such as steel and advanced materials, paper plants, electric power generation plants and others. Depending on the type of industrial plant, processes, fuel used and effciency, fue gases include:

These gases in our atmosphere absorb and emit radiation

- Nitrogen
- Carbon Dioxide
- Oxygen and water vapor
- Sulfur Oxides
- Nitrogen Oxide
- Carbon Monoxide
- Particulates
- Ozone
- Methane

Figure 1: Flue Gas Monitoring



within the thermal infrared range, which has been identifed as the primary cause of global warming.

Gas Measurement Problem

Measuring the fow of industrial process fue gas is a challenge (Fig. 1). These gases are generally mixed hydrocarbons in terms of their composition. They are often wet, hot and dirty gases laden with particulates that can foul fow measurement devices with orifces or moving parts. In addition, the volume of gas that is emitted tends to vary based on the products in production, workload schedules and seasonal fuctuations in temperature and humidity.

The fue itself is typically large and diffcult to access in terms of installing and servicing instrumentation. The purpose for measurement is now becoming increasingly multipurpose: To comply with Kyoto and EPA regulations on the one hand, and to provide process gas data for scrubbers and fare systems. The combination of all these various factors results in the need for fow meters that operate accurately and reliably over a wide fow range in rugged environments challenged with distorted and swirling fow profles.

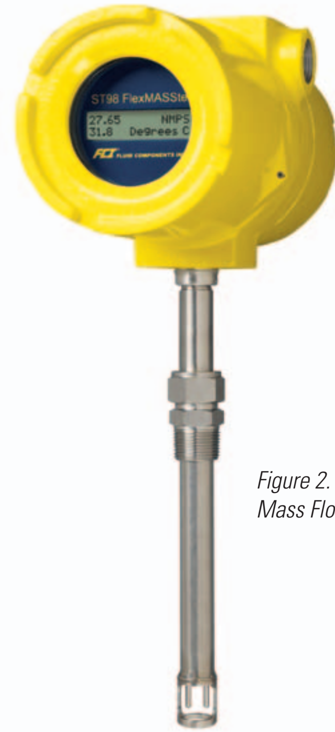


Figure 2. FCI ST98 Mass Flow Meter

Choosing A Flow Meter For GHG Monitoring

In selecting a fow meter for greenhouse gas monitoring or any process gas application, the frst step is choosing the appropriate fow technology. There are multiple fow sensing technologies available, and the major ones now include:

- Differential Pressure
- Positive Displacement
- Turbine
- Electro Magnetic
- Ultrasonic
- Vortex Shedding
- Thermal (Mass)
- Coriolis (Mass)

All these technologies have their advantages and disadvantages depending on the type of process fuid, limited straight run challenges, dirt and particulates, mechanical installation considerations, high temperatures and moisture entrained in the fow stream in addition to cost/beneft considerations in meeting accuracy requirements, maintenance and life expectancy of the equipment. 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 feld to one or two best choices.

Accuracy and Repeatability

It is essential to know the accuracy, repeatability and fow range of the fow meter under consideration and to question instrumentation suppliers regarding their calibration lab facilities and certifcation processes. The accuracy and repeatability of many fow meter technologies also varies depending on line sizes, the equipment upstream and downstream from the meter installation, seasonal weather variability and production changes in plant throughput.

For example a thermal dispersion gas fow meter such as FCI's ST51 fow meter is a good basic choice in smaller line sizes from 51 mm to 610 mm (2 inches to 24 inches) (Fig. 2). This fow meter can be specifed with accuracy of ±2 percent or ±1 of reading, ±0.5 percent of full scale and with fow ranges from 0.08 NMPS to 122 NMPS (0.3 SFPS to 400 SFPS). It is designed specifcally for biogas and methane-based mixed composition

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Figure 3. Installed MT91 Flow Meter

gases, making it suitable for landfll gas energy co-generation, municipal wastewater treatment (digester gas), livestock and dairy farms gas recovery, and biomass fermentation processes.

For applications in larger line sizes up to 1066 mm (42 inches) and for installations that require bus communications of HART or Profbus FCI ST98 Series (Fig. 2), operates over a fow range from 0.21 NMPS to 172 NMPS (0.75 SFPS to 600 SFPS). It features wide turndowns with an accuracy of +1% of reading, +0.5% of full scale. Both the ST51 and ST98 Series fow meters are calibrated matched to their installation conditions and are provided with a certifed calibration performed in a NIST traceable fow lab using precision, bench-standard fow meter equipment in compliance with ASME MFC specifcations.

For large stack monitoring applications, the FCI MT91 fow meter (Fig. 3) is designed to meet the EPA guidelines to measure continuously the emissions on fue gasses, which are generally identifed as CEMS systems in the US and in the EU they are referred to as AMS systems. The MT91 system from FCI is the only thermal dispersion technology fow meter that has been approved by a world leading company for this purpose and region: TUV Rheinland from Germany. The MT91 received the QAL-1 certifcation confrming its compliance to EN 15267-1,-2,-3 and EN 14181 standards.

The MT91 is designed for multi-point gas fow measurement in large diameter pipes, stacks and ducts with a diameter of up to 2.7432 meters (9 feet). It is capable of averaging up to sixteen (16) sensing points placed strategically across a stack's cross-sectional area. This fow meter features a wide turndown range available from 5:1 to 100:1 with fow sensitivity from 0,08 NMPS to 46 NMPS (0.25 SFPS to 150 SFPS). Confgurations are available for operation in high temperature environments up to 454 °C (850 °F).

Where seasonal variability in temperature, humidity and plant throughput are a major concern, FCI's GF90 fow meter can be calibrated for three different gas compositions and fow ranges that can be user selected as needed. By linking three calibrations, the GF90 can also achieve turndown up to 1000:1 and deliver accurate fow measurement to as low as 0.08 NMPS to 487.7 NMPS (0.25 SFPS to 1600 SFPS). Also unique to the GF90, and a function often desired by environmental regulatory agencies, is its ability to verify calibration while it remains installed in the pipe. When specifed with GF90, FCI's exclusive and patented VeriCal™ in-situ calibration verifcation system allows users to periodically verify its accuracy is within specifcations, in the feld, without ever removing the fow meter from service.

Thermal dispersion technology provides a gas fow measurement solution that is easy to install and virtually maintenance free. It can be inserted into a single tap point in the pipe and it has no moving parts to clog or foul in dirty applications. Thermal dispersion technology places two thermowell protected platinum RTD temperature sensors in the process stream (Fig. 4). One RTD is heated while the other senses the actual process temperature. The difference in temperature between the two

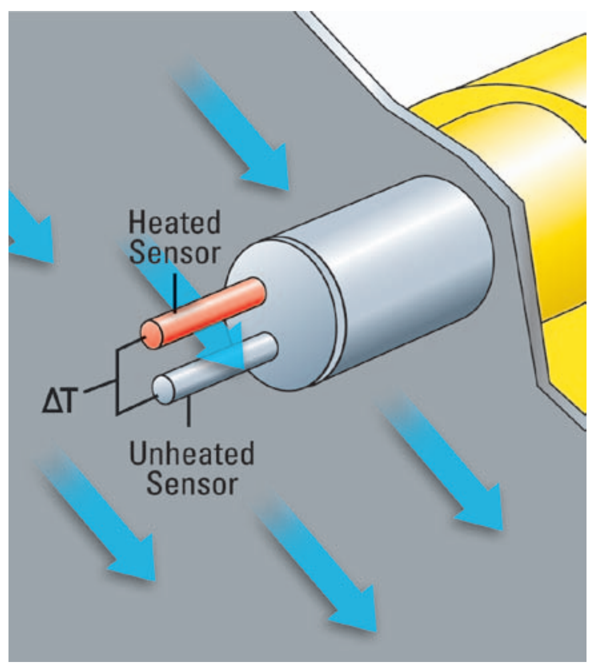

Figure 4. Thermal Dispersion Mass Flow Measurement Theory of Operation

sensors is measured and is directly proportional to the mass fow rate of the fuid. This technique is also direct mass fow measuring and does not require the addition of temperature and pressure sensors for mass fow computations.

Be sure that the instrument chosen meets the accuracy, repeatability and fow range requirements of the plant's process measurement requirements and the regional or local legally required monitoring regulations under installed conditions.

Installation Requirements

Some fow meters are more straightforward than others when it comes to installation. Be sure to ask if the fow device can be inserted directly into the process pipe or if it requires an inline confguration that will require the pipe be cut and spliced in multiple places. The more penetrations required into the pipeline or duct-work the greater the risk of pressure drop, complexity and overall cost of the installation. Some fow measurement devices feature minimally invasive or non-intrusive sensing technology, which makes them much faster and easier to install and that helps to reduce the cost of labor. Don't forget, the easier it is to install, the easier it is to maintain over the long run.

Maintenance and Life

The frequency of maintenance and the expected life of a fow meter are essential criteria to evaluate before selecting a fow meter. In general on one side of the spectrum, some fow meters are relatively inexpensive and designed for a short life expectancy even when used in benign environments with routine maintenance.

At the other end of the spectrum there are more expensive fow meters with robust industrial design using rugged materials for harsh environments with lower maintenance requirements and a longer life. The important thing to recognize is the cost of installing and maintaining an instrument over a long period of time. The initial cost of a fow meter is only part of the story. An apparent bargain on initial purchase price can end up being a cash drain over time and cause on-site technicians a lot of frustration. Make sure the fow meter chosen for the application is backed up by a strong manufacturer's customer service department.

Conclusions

While GHG certifed fow meters have been in the news, global agencies, regional authorities and governments are not certifying specifc fow meter technologies or manufacturing companies that supply them. The important thing is to focus on the specifc process fue gas monitoring requirements while simultaneously meeting local regulations and maintaining company budget goals over the life cycle of the fow meter. ■