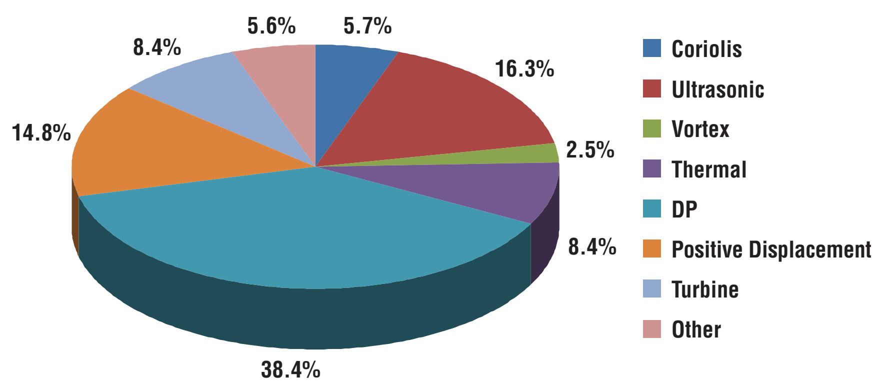
Measuring Gas Flows

Flowmeter Suppliers Jockey for Position In Critical Applications

The world's search for energy has placed a new emphasis on gas flow measurement. There are many types of gases, including natural gas, atmospheric gas, fuel gas, compressed natural gas, and others. Air is a mixture of gases, including nitrogen, oxygen, argon, etc. Individual gases that are especially important include oxygen, hydrogen, and nitrogen.

Natural gas is much discussed in flow measurement because it plays such a critical role in supplying energy. Like air, natural gas is a mixture of gases. These include methane, ethane, butane, propane, and other alkanes. Like petroleum, natural gas is a fossil fuel and is found in the ground. It is extracted and refined into fuels that supply a substantial portion of the world's energy.

There are a number of types of flowmeters that can be used to measure gas flow. Each flowmeter type has its own application strengths and weaknesses. As is the case in the broader flowmeter market, new-technology flowmeters, such as ultrasonic and Coriolis, are replacing the traditional technologies of differential-pressure (DP), turbine and positive displacement. Some traditional flowmeter suppliers are responding to this trend through innovation – with new, more durable materials, added electronics, and new product introductions. These innovations are helping traditional suppliers hold onto their market shares and enabling them to continue to compete in a changing marketplace.



Shipments of Flowmeters for Gas Applications in North America by Flowmeter Type in 2009 (Percent of Dollars)

Ultrasonic Flowmeters

Ultrasonic flowmeters are widely used for gas flow measurement. Inline models send an ultrasonic signal from one side of the pipe to the other and then send a signal in the reverse direction. When the signal travels with the flow, it moves more quickly than when it travels against the flow. Ultrasonic flowmeters measure the transit time of the signal in each direction, with the flow and against the flow. Flowrate is proportional to the difference in these two "transit times."

Clamp-on models measure flow in a similar way, but the transducers are mounted outside the pipe. Though the accuracy of clamp-on models is typically not as high as that of the inline versions, their ability to measure flow without pipe penetration makes them valuable for check metering and temporary flow measurement.

Ultrasonic flowmeters are one of three main types of flowmeters used for custody-transfer of natural gas. In this area, they compete against differential-pressure and turbine flowmeters. In 1998, ultrasonic flowmeters received the approval of the American Gas Association (AGA, *www.api.org*) for use in custody-transfer applications. Ultrasonic flowmeters used for custody-transfer of natural gas must have at least three paths, due to the high accuracy required. Suppliers of these types of flowmeters include Emerson Daniel (*www.daniel.com*), Elster Instromet (*www.elster-instromet.com*), Sick Maihak (*www.sickmaihak.com*), FMC Technologies (*www.fmctechnologies.com*), and KROHNE (*www.krohne.com*). KROHNE is the newest company to enter this market.

Differential Pressure

Differential-pressure (DP) flow technology has been around for more than 100 years. DP flowmeters require the presence of a constriction in the line to create a difference in upstream and downstream pressures. The device that creates this constriction is called a primary element. There are many types of primary elements, and each is suited for particular applications. The most popular type of primary element is an orifice plate, which is a round metal plate with one or more holes in it. Other types of primary elements include Venturi tubes, Pitot tubes, flow nozzles, and wedge elements.

Just as ultrasonic flowmeter suppliers have developed multipath ultrasonic flowmeters for custody-transfer applications, DP flowmeter suppliers have developed single- and dual-chamber orifice fittings for custody-transfer. Dual-chamber orifices are designed to allow the inspection or replacement of the orifice plate without shutting down a process line. Emerson Process Management, Daniel Division, is the leading supplier of single and dual chamber orifice fittings. The use of DP flowmeters in custody-transfer of natural gas is governed by Report 3 from by Jesse Yoder, Ph.D.

the American Gas Association (AGA, *www.aga.org*).

DP flowmeters have been used for many years for custody transfer of natural gas. Today, however, there is a trend towards ultrasonic flowmeters for this purpose. One reason is that ultrasonic flowmeters cause very little pressure drop, while the orifice plate or other primary element of a DP flowmeter has to create reduced pressure for the flow measurement to occur. Ultrasonic flowmeters are also not subject to the type of wear that can occur with an orifice plate. The long-term reliability of ultrasonic flowmeters is typically greater than that of DP flowmeters.

Another application for DP flowmeters is in stack gas flow measurement. Flowmeters used in stack flow measurement are often accompanied with analytical equipment that is used to analyze the composition of the gases flowing through the stack. Much of the need for this type of analysis stems from Environmental Protection Agency (EPA, *www.epa.gov*) regulations. Because of the large size of most stacks, DP flowmeters use multiple measuring points. DP flowmeters typically use Pitot tubes for this purpose. Other flowmeters used for stack gas measurement include ultrasonic and thermal.

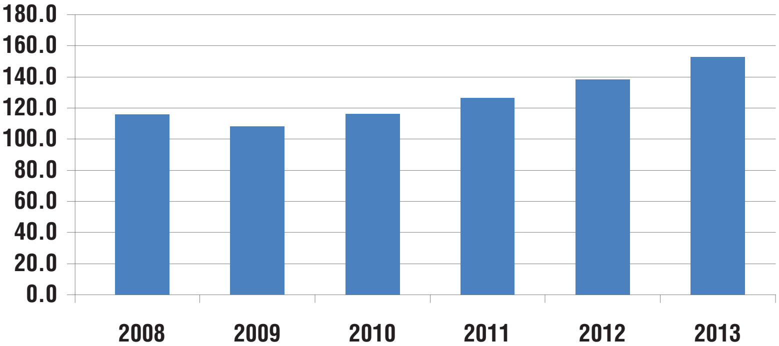
Turbine Flowmeters

Like DP flowmeters, turbine flowmeters have been around for many years. Turbine flowmeters rely on a spinning rotor that rotates in proportion to flowrate. They are widely used for liquid and gas flow measurement, but cannot be used to measure steam flow. Turbine flowmeters excel at measuring clean, steady, medium-to-high speed flows of low-viscosity fluids.

Turbine flowmeters are the third main type of flowmeter used for custody-transfer of natural gas. In 1996, the AGA issued Report 7, which lays out criteria for using turbine flowmeters for custody-transfer of natural gas. Turbine flowmeters, when calibrated properly, can achieve accuracies that rival those of multi-path ultrasonic flowmeters.

While some companies that are using turbine flowmeters for custody-transfer of natural gas are buying replacement turbine meters, many companies are making the switch to ultrasonic flowmeters for new applications. The reason for this is that ultrasonic flowmeters are non-intrusive, and they do not rely on a mechanical rotor to make the measurement. Ultrasonic flowmeters can also handle impurities in the flow better than turbine meters.

In addition to custody-transfer, turbine flowmeters are used as billing meters to measure the amount of gas used at commercial buildings and industrial plants. Here they compete with positive-displacement flowmeters. Positive-displacement flowmeters are favored for low-velocity applications with line sizes between 1.5 inches and 10 inches. Turbine flowmeters, however, are better suited for line sizes above 10 inches.



Total Shipments of Thermal Flowmeters Worldwide 2008 - 2013 (Millions of Dollars)

Positive Displacement

Positive-displacement flowmeters work by capturing the flow in small compartments and then counting how often this is done. Flowrate is calculated based on the number of times these compartments are filled and emptied. The main types of positive-displacement flowmeters are oval gear, rotary, piston, nutating disc, diaphragm, and helical.

Positive-displacement meters are for residential, commercial, and industrial applications. They are widely used in utility gas flow measurement. Here they face competition from turbine flowmeters. However, positive-displacement meters excel at measuring low flowrates, and they do best in line sizes of 10 inches or less. Both diaphragm and rotary meters are widely used for gas flow measurement. While new-technology flowmeters, such as Coriolis, are beginning to make an impact on the gas utility market, in many cases they do not yet have the necessary industry approvals to allow them to be widely used for these applications.

Thermal Flowmeters

Thermal flowmeters are used almost exclusively to measure gas flow. Thermal flowmeters typically inject heat into the flowstream and then measure how quickly this heat dissipates. This value is proportional to mass flow. Two different technologies for thermal measurement are constant power and constant temperature.

One main application for thermal flowmeters is measuring stack gas flows. In the early 1990s, EPA requirements created a need to measure sulfur dioxide (SO2), nitrous oxide (NOx), and other industrial pollutants being emitted from smoke stacks. Due to the large size of these stacks, multiple measuring points were necessary for accurate measurement. Multi-point thermal flowmeters were developed in response to this requirement. Today, a broader need to measure greenhouse gas emission is generating added momentum in the thermal flowmeter market.

Coriolis Flowmeters

Coriolis flowmeters are used to measure gas flows, but they have some limitations. Coriolis meters have an easier time measuring liquids than gases, because liquids are more dense than gases. Coriolis flowmeters also become expensive and unwieldy in line sizes above four inches. However, in the past several years, a number of suppliers have begun producing Coriolis flowmeters in line sizes above six inches. These include Endress+Hauser (*www.us.endress.com*), Micro Motion (*www.micromotion.com*), and KROHNE. Rheonik (now part of GE Sensing & Inspection Technologies, *www.gesensing.com*) used to be the only supplier in this large size market. As a result of this influx of manufacturing capability in the large-line segment, Coriolis flowmeters may begin gaining wider acceptance in large line size applications.

Vortex Flowmeters

Vortex flowmeters are among the most versatile of flowmeters and can readily measure gas, steam, and liquid flows. For many years, vortex flowmeters lacked the necessary industry approvals to compete in custody-transfer markets. Then, in January 2007, the American Petroleum Institute (API) approved a draft standard for the use of vortex flowmeters for custody-transfer purposes. Companies such as Invensys/Foxboro (*www.foxboro.com*) and Emerson Process (*www.emersonprocess.com*) have been active in working with the API on the development and approval of this standard. The standard applies to liquid, steam, and gas flows.

While initial evidence is that so far this standard has had a limited impact on the vortex flowmeter market, end-users figure to begin selecting vortex flowmeters more frequently for custody-transfer applications in the years to come. So far, however, vortex meters have not been able to penetrate the market for custody transfer of natural gas, which is still dominated by ultrasonic, DP, and turbine meters.

A Look Ahead

The flowmeter market for custody-transfer of natural gas is the fastest growing niche in the flowmeter industry. Expect continued competition among multi-path ultrasonic flowmeters, dual-chamber orifice fitting DP flowmeters and turbine flowmeters as suppliers vie for control of this lucrative market. The battle among thermal, ultrasonic, and multi-path thermal flowmeters for measuring stack flows is also worth watching. Even though gas flow can be a difficult measurement to make, flowmeter suppliers are continually identifying novel solutions for this task. FC

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