



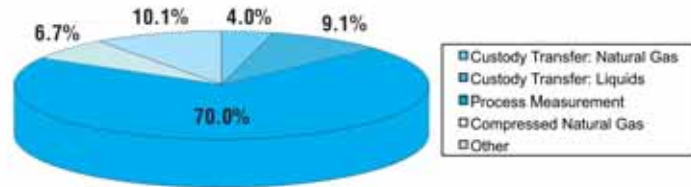
## When Accuracy Matters

Coriolis flowmeters are the highest accuracy meters on the market. And while they are most widely used in the chemical industry, Coriolis usage is growing most rapidly in the oil & gas industry. Coriolis flowmeters have a very limited use for steam applications. One main area of growth for Coriolis flowmeters is in the custody transfer of petroleum liquids, where they are replacing positive-displacement meters. Approvals by industry organizations, including the American Gas Association (AGA, [www.aga.org](http://www.aga.org)) and the American Petroleum Institute (API, [www.api.org](http://www.api.org)), have played a major role in the acceptance of Coriolis meters for custody-transfer applications.

The battle between straight-tube and bent-tube flowmeters is an important part of the total picture in the Coriolis space. KROHNE ([www.krohne.com](http://www.krohne.com)) introduced the first commercially successful straight-tube Coriolis flowmeter in 1994. Straight-

tube meters address the problem of pressure drop because the fluid does not have to travel around a bend. This makes them better able to handle high-velocity fluids. Straight-tube meters can also be drained more easily, which is important for sanitary applications. And straight-tube meters have a more compact design than bent-tube meters, which can be quite large and unwieldy, particularly in the larger sizes. There is increasing use of Coriolis flowmeters in large line sizes – above six inches. At least four companies are now manufacturing these large size meters. Even though the large majority of Coriolis flowmeters still go into applications with line sizes of two inches or less, the large line size meters represent a growth area for this market. Companies that currently offer

Shipments of Coriolis Flowmeters in North America by Application in 2008 (Percent of Dollars)



large line size flowmeters include GE Sensing ([www.gesensing.com](http://www.gesensing.com)) — which acquired Rheonik in January 2008 — Endress+Hauser ([www.endress.com](http://www.endress.com)), Micro Motion ([www.micromotion.com](http://www.micromotion.com)) and KROHNE.

Coriolis flowmeters offer accuracy and reliability, which figure to be key characteristics going forward as increased fuel costs make accurate measurement of fuel flow applications more important, especially for custody transfer. **FC**

*Analysis provided by Flow Research ([www.flowresearch.com](http://www.flowresearch.com)). For more information on the Coriolis flowmeter market, visit Flow Research's Web portal [www.FlowCoriolis.com](http://www.FlowCoriolis.com).*

# differential-pressure flowmeters



## Elemental Improvements

Primary elements are used with differential pressure (DP) transmitters to create a constriction in the line. The DP flow transmitter measures the difference in upstream and downstream pressures and uses this value to compute flowrate.

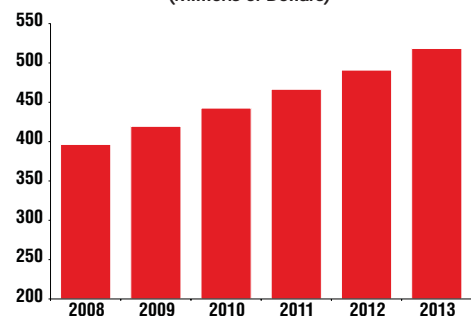
The main types of primary elements are orifice plates, Pitot tubes, Venturis, flow nozzles, and wedge elements. Orifice plates dominate this market, but Venturis and Pitot tubes are also widely used. One disadvantage of using primary elements is that they create a pressure drop, but they have to create this difference in pressure for the flow measurement to be made. On the other hand, DP flowmeters are well researched and well understood, and they have a very large installed base.

Primary elements suppliers have made a number of technological improvements in primary elements in the past five years. Emerson Rosemount ([www.rosemount.com](http://www.rosemount.com)) has introduced a

conditioning orifice plate that reduces the upstream requirements for a DP flow measurement. Veris ([www.veris-inc.com](http://www.veris-inc.com)) has introduced the Accelabar that combines elements of a flow nozzle with elements of an averaging Pitot tube. Emerson Daniel ([www.daniel.com](http://www.daniel.com)) has upgraded its Senior Orifice Fitting with the release of the new Senior Model 2000 Orifice Fitting. The Model 2000 is designed for longer life and lower cost of ownership. It has check valves and o-rings that are designed to prevent the escape of any potentially harmful content through the valve. Both Emerson's Senior and Junior orifice fittings are widely used in custody-transfer gas flow measurement.

Some companies, such as Emerson Rosemount, offer integrated DP flowmeters that incorporate a primary element with a DP flow transmitter to create a DP flowmeter. This reduces the need for impulse piping and valves and also makes it possible to calibrate the device before shipping with

Worldwide Shipments of Primary Elements (Millions of Dollars)



the primary element already attached. Emerson Rosemount offers both its orifice plates and its Annubar averaging Pitot tube as an integrated flowmeter. The popularity of these integrated flowmeters is likely to increase as end-users seek to cut costs and simplify the installation process. **FC**

*Analysis provided by Flow Research ([www.flowresearch.com](http://www.flowresearch.com)). For more information on the DP flowmeter market, visit Flow Research's Web portal [www.FlowDP.com](http://www.FlowDP.com).*

# magnetic flowmeters



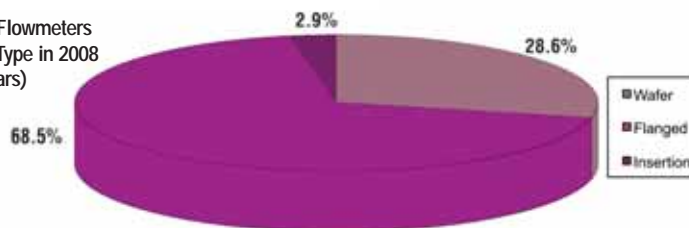
## Low Cost of Ownership Drives Demand

Magnetic Flowmeters are displacing traditional technology flowmeters, such as differential pressure (DP), positive displacement and turbine, in some applications.

Ultimately, the key advantage magnetic flowmeters offer is lower cost of ownership when compared with many traditional technology flowmeters. The flowtube of a magnetic flowmeter is highly durable and subject to little change. Today's linings, including PTFE, EFTE, PFA and hard rubber, are highly durable and designed to handle slurries as well as water containing chemicals. With no primary element to replace and no moving parts to introduce wear, magnetic flowmeters represent a very stable and reliable long-term method of measurement with minimal maintenance costs.

While the magnetic flowmeter market is a mature and stable one, there are some new product developments in the magne-

Shipments of Magnetic Flowmeters Worldwide by Mounting Type in 2008 (Percent of Dollars)



ter market, and these new developments figure to stimulate continued growth. One recent development is the advent of two-wire magnetic flowmeters, which are powered by an external source, which lowers the cost of the flowmeter.

Magnetic flowmeters come in three different mounting types: wafer, flanged and insertion. Wafer-style meters offer a lower cost than flanged, but flanged magnetic flowmeters perform better in hazardous and high temperature applications. Both wafer and flanged meters typically have higher accuracy than insertion-style meters.

Insertion meters are used in the larger

line sizes, such as those eight inches and above, because their cost is significantly lower than wafer and flanged magnetic flowmeters in the larger sizes. The main disadvantage of insertion magnetic flowmeters is reduced accuracy. Still, the use of insertion magnetic flowmeters in the larger line sizes is on the rise. **FC**

*Analysis provided by Flow Research ([www.flowresearch.com](http://www.flowresearch.com)). For more information on the magnetic flowmeter market, visit Flow Research's Web portal [www.FlowMags.com](http://www.FlowMags.com).*

# thermal flowmeters



## Hot Market for Mass Flow Controllers

Thermal flowmeters are mainly used for gas flow measurement, including airflow, natural gas flow and the flow of other industrial gases and mixtures. While many thermal flowmeters are of the insertion variety, wafer and flanged versions are also available. A limited number of thermal flowmeters are used to measure liquid flows.

Another category of thermal flowmeters includes a controlling valve, even though nearly all of them use a thermal flowmeter principle to measure flow. These devices are called mass flow controllers, and they are widely used in the semiconductor industry to measure and control the flow of gases used in the chip-making process. The majority of mass flow controllers sold worldwide today are used in the semiconductor industry. While nearly all mass flow controllers use a thermal method, a small portion of them uses a differential-pressure (DP) measurement method.

Mass flow controllers are also used in

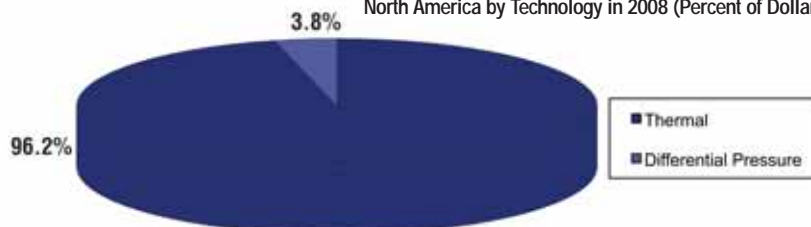
industrial and laboratory/research environments. These include chemical, biotech and pharmaceutical, gas analytical, fiber optics and glass and fuel cells. Some companies that have mainly sold into the semiconductor market are now looking to expand their presence in industrial environments. Major suppliers of mass flow controllers to the semiconductor market include Horiba/STEC ([www.horibastec.com](http://www.horibastec.com)) and Celerity ([www.celerity.net](http://www.celerity.net)).

The industrial and lab/research markets are made up of a wide variety of industrial

segments. Some of these, such as automotive and aerospace, are going through difficult times due to rising energy costs. Others, such as fuel cells and power, are thriving due to the search for alternative energy sources. The need to find alternative energy sources will drive additional research and development in the foreseeable future. Mass flow controllers will benefit from these industrial segments, as they are used to measure and control gas flows in these segments.

Some consolidation has been occurring among the mass flow controller suppliers.

Shipments of Mass Flow Controllers in North America by Technology in 2008 (Percent of Dollars)





## Users Stick with What They Know

Turbine flowmeters are widely used for both liquid and gas applications. Installed base is a relevant factor in the turbine market because users tend to replace flowmeters with the same technology. As such, the large installed base of turbine flowmeters worldwide will continue to be a source of orders for new meters in the future.

Turbine meters are specified by approval bodies for use in custody-transfer for utility measurement in residential, commercial and industrial applications. These organizations include the American Water Works Association (AWWA, [www.awwa.org](http://www.awwa.org)), the American Gas Association (AGA, [www.aga.org](http://www.aga.org)) and the International Standards Organization (ISO, [www.iso.org](http://www.iso.org)) in Europe.

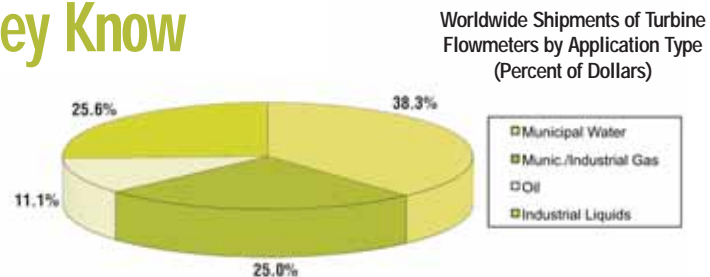
The approval of a standard by the American Gas Association for using turbine flowmeters for custody transfer of natural gas has been a significant factor in the use

of turbine meters for gas applications. However, turbine meters face competition from ultrasonic meters, and a report on the use of Coriolis flowmeters has also been approved by AGA (Report #11). Differential-pressure flowmeters are also widely used for natural gas flow measurement. So while turbine meters have enjoyed an advantage in the past based on their approvals, this advantage is diminishing as newer technology flowmeters are approved for custody transfer of natural gas.

Despite the competition, however, there are several reasons why turbine meters will continue to maintain their wide usage for gas flow applications. One is that turbine meters have a significant cost advantage

over ultrasonic meters, especially in the larger pipe sizes. Their price may also compare favorably to DP flowmeters, especially in cases where one turbine meter can replace several DP meters. Finally, users who are already familiar with turbine technology and who don't want to spend the extra money required to invest in a new technology are likely to stay with turbine meters. **FC**

*Analysis provided by Flow Research ([www.flowresearch.com](http://www.flowresearch.com)). For more information on the turbine flowmeter market, visit Flow Research's Web portal [www.FlowTurbine.com](http://www.FlowTurbine.com).*



# ultrasonic flowmeters



## A Market in Boom

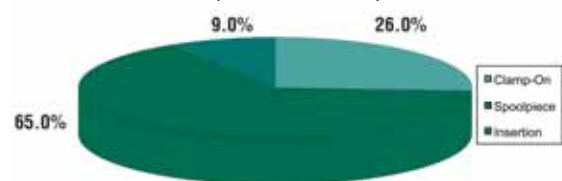
The ultrasonic flowmeter market is a fast-growing market with over 50 suppliers worldwide. With so many suppliers, it is not surprising that the landscape of this market has changed significantly in the past several years. In January 2006, NuFlo Measurement Systems, a division of Cameron ([www.c-a-m.com](http://www.c-a-m.com)), acquired Caldon Inc. of Pittsburgh, Pa. While Caldon mainly supplies ultrasonic flowmeters to the nuclear industry, the company has begun to expand into the process industries. Then, in May 2006, Siemens ([www.siemens.com](http://www.siemens.com)) purchased Controlotron, a company that is mainly known for its clamp-on ultrasonic flowmeters. In February 2007, IDEX Corporation ([www.idexcorp.com](http://www.idexcorp.com)) acquired Faure Herman ([www.faureherman.com](http://www.faureherman.com)), a French manufacturer of an 18-path ultrasonic flowmeter for liquid applications. More recently, in January 2008, IDEX purchased ADS LLC ([www.adsenv.com](http://www.adsenv.com)), which specializes in environmental services

for the water & wastewater industry. Included in the ADS portfolio is Accusonic ([www.accusonic.com](http://www.accusonic.com)), a Massachusetts-based manufacturer of multi-path transit-time ultrasonic flowmeters for water applications.

Since ultrasonic flowmeters began to be used in industrial markets in the 1970s, many technological improvements have been made. Initially, transit-time flowmeters were used for clean liquids, while Doppler flowmeters were used for dirty liquids. In the past 20 years, improvements in electronic processing technology have enabled transit-time flowmeters to handle a wider range of fluids, including those that are not completely clean. This has led to increased use of transit-time flowmeters at the expense of Doppler meters. Suppliers have also significantly increased the accuracy of transit-time meters during this time.

Ultrasonic flowmeters are also being

Shipments of Ultrasonic Flowmeters in North America by Mounting Type in 2008 (Percent of Dollars)



more widely used to measure process gas and flare gas. Insertion meters are used to measure flare gas in stacks, and ultrasonic flowmeters are used more widely in the chemical and refining industries. While the growth of ultrasonic meters to measure process and flare gases is not as rapid as the growth of multi-path meters for custody transfer of natural gas, it is still an important factor in the overall growth of ultrasonic meters. **FC**

*Analysis provided by Flow Research ([www.flowresearch.com](http://www.flowresearch.com)). For more information, visit Flow Research's Web portal [www.FlowUltrasonic.com](http://www.FlowUltrasonic.com).*



## When the Steam Clears

Vortex flowmeters are one of the few meter types that can measure liquid, steam and gas flow with relative ease. In fact, they are used to measure steam flow almost as much as they are used to measure liquid flow. While past generations of vortex meters had problems with vibration errors, suppliers have implemented software and electronic solutions to deal with these problems.

Vortex flowmeters are well equipped to measure steam flow because they can handle the high temperatures and pressures associated with steam flow. They also have wide rangeability. Steam is the most difficult fluid to measure. This is due not only to the high temperatures and pressures of steam, but also because the measurement parameters vary with the type of steam.

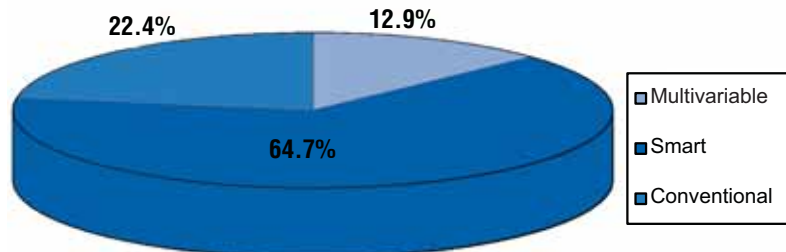
Steam is often measured in process plants and for power generation. Vortex and differential-pressure flowmeters are the primary meters used to measure steam.

Vortex flowmeters can measure steam flow at varying velocities.

For many years, vortex flowmeters did not have industry approvals for custody-transfer applications. This changed in January 2007 when the American Petroleum Institute (API, [www.api.org](http://www.api.org)) approved a draft standard for the use of vortex flowmeters for custody transfer of liquid, steam and gas. The approval of this standard is expected to spur additional growth in the vortex market.

Another growth factor for the vortex

Shipments of Vortex Flowmeters Worldwide by Mounting Type in 2008 (Percent of Dollars)



flowmeter market is the increased number of suppliers of multivariable flowmeters. While multivariable flowmeters are somewhat more expensive than their single-variable counterparts, they provide substantially more information about the process than single-variable meters. **FC**

Analysis provided by Flow Research ([www.flowresearch.com](http://www.flowresearch.com)). For more information on the vortex flowmeter market, visit [www.FlowVortex.com](http://www.FlowVortex.com).

## At Flow Research, we see flow from many points of view.

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