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the heavyweights of flow measurement

Coriolis, magnetic and ultrasonic flowmeters square off for flow measurement supremacy

By Jesse Yoder, PhD, Flow Research, Inc.

While there are 14 different flow technologies, three stand out from the rest in terms of market size, growth rates and popularity with end users. These three technologies—Coriolis, magnetic and ultrasonic—deserve the title "Heavyweights of Flow." Together, they accounted for close to 50 percent of worldwide flowmeter revenues in 2008.

There is a growing trend in the flowmeter industry towards flowmeters with high accuracy, increased reliability and no moving parts. The fluid to be measured, including oil, natural gas and water, is becoming more expensive. As a result end users are willing to pay more to measure the fluid, and measurement accuracy has become more important. In addition, many companies have reduced engineering and maintenance staffs. As a result, reliability is more important in flowmeters since most companies would rather "set it and forget it" than have to constantly worry about maintenance. All these factors favor new technology flowmeters, rather than the traditional technologies such as differential pressure (DP), turbine and positive displacement.

Accuracy Levels: A Key Feature

Suppliers have made substantial advances in the accuracy levels for Coriolis and ultrasonic flowmeters. Coriolis flowmeters are the most accurate flowmeter made, with accuracies in the range of ±0.1 percent. They are used for both liquid and gas flow measurement. A limited number of Coriolis meters are also now able to handle steam flow applications.

High accuracies are also attainable for ultrasonic flowmeters, but they are mainly associated with multi-path ultrasonic flowmeters. These multi-path flowmeters use 3 to 18 paths or ultrasonic signals sent across the pipe and back, to achieve the high accuracies needed for custody transfer. The market for custody transfer of natural gas is dominated by several companies, and this is the niche-market that is responsible for much of the growth in the ultrasonic flowmeter market.

While magnetic flowmeters have not achieved the same accuracy levels as Coriolis flowmeters, they are still a highly accurate method of measuring liquid flows. Most magnetic flowmeters have accuracy levels of ±0.5 percent or better. Competition from other new-technology flowmeters is encouraging magnetic flowmeter suppliers to produce more accurate meters.

Reliability an Advantage

Coriolis, ultrasonic, and magnetic flowmeters also share another feature that enhances their reliability: They do not have moving parts. Turbine flowmeters have an impeller that rotates in proportion to flowrate. This spinning impeller is subject to wear over time. While differential pressure (DP) flowmeters with orifice plates do not have moving parts, orifice plates are subject to wear, and this wear can degrade flow measurement accuracy. Coriolis flowmeters do not have moving parts, apart from the vibration of their flowtubes, while ultrasonic and magnetic flowmeters remain stationary—they do not rely on spinning or vibrating parts for their flow measurement.

Pressure Drop Also an Issue

Any flowmeter that places an obstruction in the flowstream, or impedes flow, is likely to create pressure drop. DP flowmeters rely on an obstruction in the flowstream to create a pressure differential, whether they use orifice plates, Venturi tubes, flow nozzles, or some other type of primary element. Turbine meters can also create reduced pressure in the line since the fluid passes over a rotor to generate the flow measurement.

Coriolis, ultrasonic, and magnetic flowmeters can also create pressure drop in the line, but this effect is relatively minor. The amount of pressure drop created by Coriolis flowmeters depends on the length and inner diameter of the flowtube. The presence of ultrasonic transducers can generate some loss of pressure in spoolpiece ultrasonic flowmeters. One advantage of clamp-on ultrasonic meters is that the transducers are mounted outside of the pipe, and the linings of magnetic flowmeters can generate some minimal pressure loss, depending on the inner diameter of the flowtube.

Industry Approvals also Important

Coriolis and ultrasonic flowmeters have benefited from approvals by the American Gas Association (AGA) and the American Petroleum Institute (API). The AGA's approval in June 1998 of ultrasonic flowmeters for custody transfer applications gave a boost to this market. The AGA report was called AGA-9. The AGA issued a report called AGA-11 in 2003 on the use of Coriolis flowmeters for custody transfer. The API has also issued several draft standards concerning the use of Coriolis flowmeters for liquid flow measurement. Previously, DP and turbine flowmeters had been the main beneficiaries of industry approvals for flow measurement.

A Steady Stream of New Products

Suppliers have kept the market vibrant with a steady stream of new products. In the past, Coriolis flowmeters in line sizes above six inches were fairly unusual. Only Rheonik (now part of GE Sensing), made such large Coriolis flowmeters. More recently, other companies have begun offering Coriolis meters in these larger line sizes. These companies include KROHNE, Endress+Hauser and Micro Motion.

Another important breakthrough has occurred in the area of price; some suppliers are now offering Coriolis flowmeters for less than $3,000. Straight-tube Coriolis flowmeters are now more accurate and reliable than before.

In ultrasonic flowmeters, suppliers have made significant progress in enabling ultrasonic transit time flowmeters to accurately measure the flow of fluids with some impurities. Previously this type of measurement required Doppler ultrasonic technology. Suppliers have released additional multi-path ultrasonic flowmeters for highly accurate flow measurement. Progress has been made in the use of multi-path flowmeters for both liquid and gas flow measurement. More calibration facilities have also become available for ultrasonic flowmeters.

The development of high-strength direct current (DC) flowmeters has helped magnetic flowmeters meet the challenges of accurately measuring dirty liquids. Previously, these measurements may have required the use of alternating current (AC) magnetic flowmeters. Magnetic flowmeter suppliers have also made progress in reducing the amount of conductivity required for using magnetic flow technology.

Other product developments include the introduction of more liner types and the development of two-wire and wireless/battery-operated magnetic flowmeters.

Other New-Technology Flowmeters

Even though they are new-technology flowmeters, vortex and thermal meters have not shown the same type of growth or market penetration as the heavyweights. There are several reasons for this. One may be that vortex flowmeters lack that one compelling feature that makes them irresistible to end users. While vortex flowmeters have good accuracy, they cannot match the high accuracy of Coriolis and multi-path ultrasonic flowmeters. While they came late to the approvals table, in January 2007 the API published a draft standard for the use of vortex flowmeters in custody transfer applications. This may help boost the vortex flowmeter market. Rather than having one irresistible feature, vortex flowmeters provide accurate and reliable flow measurement in a wide range of applications, including liquid, gas and steam.

Thermal flowmeters were developed in the 1960s and 1970s out of air flow velocity profile and turbulence research, using hot-wire anemometers. The industrialized thermal flowmeters that were developed out of this research were especially-suited for measuring gas flows with a known mixture of gases. Thermal flowmeters benefited from the need for continuous emissions monitoring (CEM) in the early 1990s.

Today, the need to measure greenhouse gas emissions should give a boost to this market. Thermal flowmeters are also used for a variety of gas flow applications, including stack gas and flare gas monitoring, as well as landfill gas recovery, biomass gasification, and ethanol distillation and refining.

A Look Ahead

Despite today's economic environment, look for the heavyweights of flow to maintain their edge. Even though some construction and exploration projects may be delayed or canceled, the long-term trend gives an edge to accurate and reliable flowmeters that require a minimum amount of maintenance. These are the qualities that have given Coriolis, ultrasonic and magnetic flowmeters their advantage in today's market, and these qualities are likely to keep them in the lead in the future.

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