

# A complex flow instrumentation market

Desire for accuracy and reliability drive users to new-technology flowmeters.

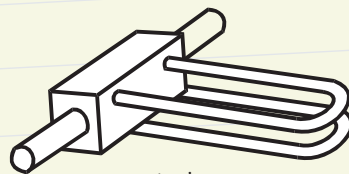
BY JESSE YODER

There are 10 main technologies used to measure flow. Suppliers find themselves competing with other companies making the same type of flowmeter and with suppliers making different types of flowmeters. Thus, the flowmeter market has a built-in complexity that some other instrumentation markets lack.

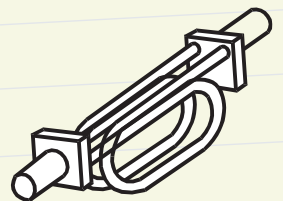
While technology distinguishes flowmeters, so does the modernity of that technology. New-technology flowmeters include those using Coriolis, magnetic, ultrasonic, vortex, and multivariable differential pressure (dP) technologies.

*Coriolis:* Micro Motion introduced the first commercially successful Coriolis flowmeters in 1977. Coriolis flowmeters use one or more vibrating tubes, usually bent. The fluid passes through the vibrating tubes. The fluid accelerates as it passes toward the point of maximum vibration and decelerates as it leaves this point. The result is a twisting motion in the tubes. The degree of twisting motion is directly proportional to the fluid's mass flow. Position detectors sense the positions of the tubes.

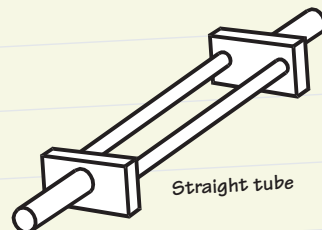
## Coriolis



Cantilevered tube



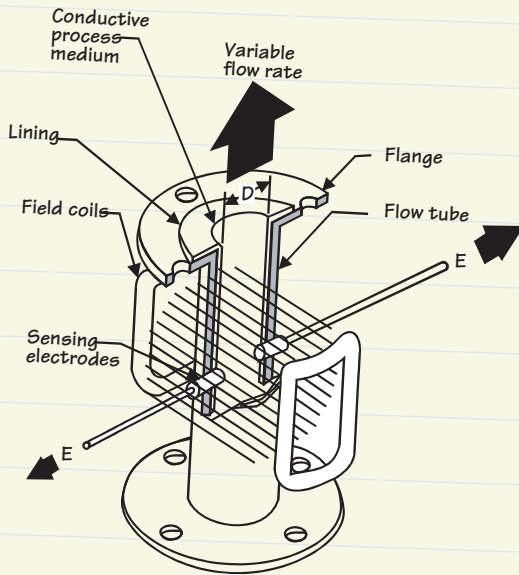
Projected loop



Straight tube

**Magnetic:** These flowmeters debuted in Holland in 1952. Magnetic flowmeters use wire coils mounted outside of a pipe. A voltage runs through the coils, generating a magnetic field inside the pipe. As the conductive liquid passes through the pipe, a separate voltage emanates from the system. This voltage relates to the flow rate and is detectable.

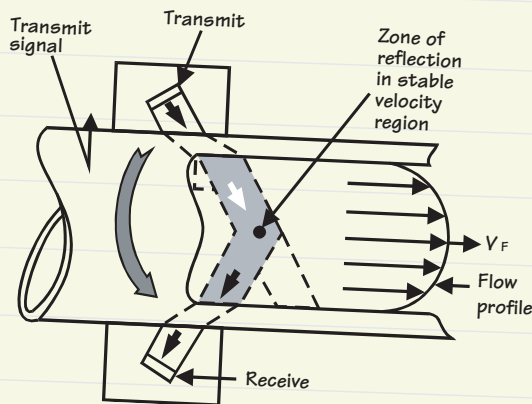
**Magnetic**



**Ultrasonic:** Tokyo Keiki (now Tokimec) offered ultrasonic flowmeters for sale in 1963 in Japan. There are two main types of ultrasonic flowmeters: transit time and Doppler. Transit time ultrasonic meters have both a sender and a receiver. They send two ultrasonic signals across a pipe: one traveling with the flow and one traveling against the flow.

The ultrasonic signal traveling with the flow travels faster than a signal traveling against the flow. The ultrasonic flowmeter measures the *transit time* of both signals. The difference between these two times is proportional to flow rate.

**Doppler ultrasonic**



Transit time ultrasonic flowmeters usually monitor clean liquids. Doppler ultrasonic flowmeters measure dirty liquids. They compute flow rate based on a frequency shift that occurs when their ultrasonic signals reflect off particles in the flow stream.

**Vortex:** Attempts to commercialize vortex flowmeters occurred as early as 1958, and Eastech introduced them in 1969. In 1979, Yokogawa became the first major process control supplier to offer vortex flowmeters when it brought out the YEWFLOW.

Vortex flowmeters employ a principle called the von Karman effect. According to this principle, flow alternately generates vortices when passing by a bluff body. In a vortex meter, the bluff body is a piece of material with a broad, flat front that mounts at right angles to the flowstream.

Flow velocity is proportional to the frequency of the vortices. Volumetric flow rate equals the cross-sectional area of the pipe times the velocity of the flow.

**Multivariable dP:** Bristol Babcock offered the first multivariable pressure transmitter in 1992. It typically measures more than one process variable, including dP, static pressure, and process temperature. These values compute volumetric flow and mass flow.

One of the main advantages of multivariable dP flowmeters is the savings that arise by buying one instrument instead of three. Instead of buying a pressure transmitter, a pressure transmitter, and a temperature transmitter separately, users get the capability of all three instruments in one meter.

The cost for a multivariable transmitter is in the \$2,000 range, rather than the \$2,700 or \$2,800 it could cost to buy these devices separately.

**ACCURACY DRIVES USER CHOICE**

High accuracy continues to be a major factor driving the flowmeter market. As part of this analysis of the worldwide flowmeter market, we interviewed 300 flowmeter users from North America, Europe, and Asia. We asked Coriolis flowmeter users why they chose that type of metering.

Accuracy was the No. 1 response. Indeed, 63% cited accuracy. Many Coriolis flowmeters have accuracy in the 0.1% range. The Coriolis flowmeter is the most accurate meter available.

In the same survey, 36% of those using magnetic flowmeters gave accuracy as the reason for doing so. Many magnetic flowmeters have accuracy in the 0.5% range.

Accuracy in a flowmeter is important to users for many reasons, but primarily for custody transfer applications and measuring liquid components during manufacturing.

Magnetic flowmeters are widely used in food processing and pharmaceutical appli-

cations, where accuracy is most important not only for public health and safety reasons but also for legal liability. Coriolis and magnetic flowmeters are among the most accurate meters.

Industry's shift toward accuracy is also benefiting ultrasonic flowmeters. The accuracy of ultrasonic flowmeters has improved substantially through the development of multipath flowmeters.

These highly accurate meters use multiple pairs of transmitters to send an ultrasonic beam across the flow stream at different angles. They then use an averaging method to compute flow rate. Because they measure flow at different locations, multipath ultrasonic meters are significantly more accurate than single path meters.

The American Gas Association approved multipath ultrasonic meters for use in custody transfer in June 1998—a major boost to the ultrasonic market. The need for accuracy is less of a benefit to vortex and multivariable dP meters, as neither is as accurate as Coriolis, magnetic, or ultrasonic meters. However, both vortex and multivariable dP meters have other advantages. Vortex meters are the lowest-cost new-technology meter, while multivariable dP meters offer higher accuracy than most single-variable dP transmitters.

Both vortex and multivariable dP meters can be very attractive choices for applications that do not require the accuracy of a Coriolis or a magnetic flowmeter.

### PRIMARY ELEMENTS WEAR OUT

Reliability is the other main criterion used by customers, besides accuracy, when selecting flowmeters. Users today prefer flowmeters they do not have to constantly recalibrate or check for accuracy. This means users are moving away from flowmeters that have moving parts subject to wear.

None of the new-technology flowmeters have moving parts, although the flow tube in a Coriolis flowmeter does vibrate, and the shedder bar in a vortex meter may at times be subject to some motion, due to the pressure of the flow stream.

Moving parts are not the only potential source of unreliability. Another source is wear. One of the main reasons users are switching from dP meters to new-technology meters is that primary elements are subject to wear. This is especially true of orifice plates, which account for a majority of primary elements used.

The bearings of positive displacement meters are also subject to wear, as are the bearings and rotors of turbine meters. New-technology meters are more reliable than traditional technology meters, in part because they have fewer sources of wear.

A flowmeter's nonintrusiveness into the process stream is also important to users today. Any time a flowmeter or its components intrude into the process line, pressure drop occurs. Pressure drop is an issue because it can be expensive to accelerate the fluid back to its original velocity. It requires running pumps and using up energy, including electricity. Having a component intrude in the line also creates a possibility that something will knock that component out of position.

Thus, finding a flowmeter that is not intrusive and that doesn't create pressure drop is important. Here's how the new-technology flowmeters stack up:

### CLAMP-ON METERS LESS ACCURATE

Coriolis flowmeters create pressure drop because they require the fluid to pass around corners and curves. Much of the drive toward straight-tube Coriolis meters results from the desire to avoid the pressure drop of bent-tube meters.

Magnetic flowmeters are for the most part nonintrusive, with the exception of insertion style meters and in-line meters with a smaller inside diameter than the inside diameter of the pipe.

Ultrasonic flowmeters are nonintrusive, although their transducers can intrude into the flow stream and cause some pressure drop. Clamp-on-style ultrasonic meters are completely nonintrusive because they rely on a signal that generates from a transducer outside the pipe. However, clamp-on meters typically do not have the same accuracy level as in-line meters.

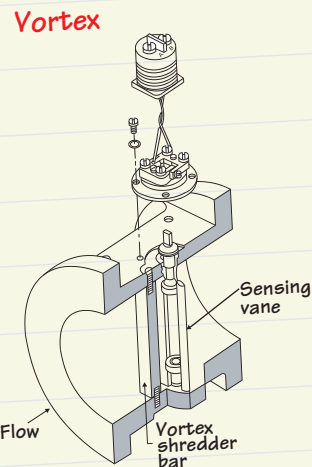
Vortex meters are more intrusive than either magnetic or ultrasonic flowmeters, due to the shedder bar. While the shedder bar on most vortex meters is quite small, it does intrude into the flow stream and cause some pressure drop.

**Multivariable dP** The pressure drop and intrusiveness of a multivariable dP flowmeter is due to the primary elements— orifice plates and flow nozzles—that cause substantial pressure drop. Pitot tubes cause comparable pressure drop to the shedder bar in a vortex flowmeter.

So while the desire for accuracy, reliability, and nonintrusiveness are the most important reasons why users select new-technology flowmeters, other factors play a role as well: price, technology improvements, and communication protocols.

The application is also important. The flowmeter selection process begins with the application, which dictates what types of flowmeters are possible. Magnetic flowmeters, for instance, simply don't work on nonconductive fluids.

Upon identifying the applicable flowmeters, our study finds that the user then considers accuracy, reliability, and nonintrusiveness most important. IT



### Behind the byline



Jesse Yoder has 15 years' experience as an analyst and writer in process control. He is the founder of Flow Research in Wakefield, Mass. Flow Research and Ducker Worldwide released a study titled "The World Market for New Technology Flowmeters" this past November. Contact Dr. Yoder at [jesse@flowresearch.com](mailto:jesse@flowresearch.com).