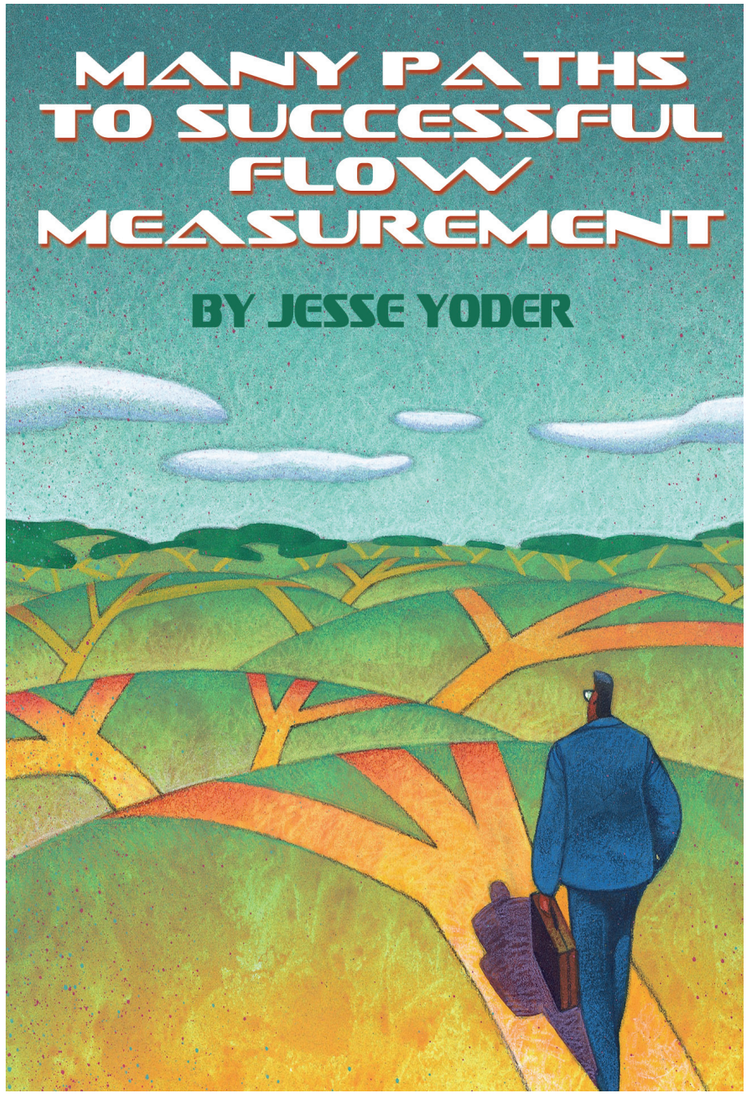
ULTRASONIC FLOWMETERS



Ultrasonic flowmeters have gained a lot of attention over the past five years, primarily because of their ability for measuring custody transfer of natural gas. They are replacing differential pressure (DP) and turbine meters in many natural gas applications. But ultrasonic flowmeters are also widely used to measure liquids. And they are not limited to clean liquids either; a special type of ultrasonic flowmeter can also accurately measure the flow of slurries and liquids with many impurities.

How They Work

Ultrasonic flowmeters are one of the most interesting types of meters used to measure flow in pipes. The most common variety, transit time, contain both a sending and a receiving transducer. Both sending and receiving transducers are mounted on either side of the flowmeter, or on the pipe wall. The sending transducer sends an ultrasonic signal at an angle from one side of the pipe to the other and back. Some ultrasonic flowmeters send more than one signal and have more than one pair of transducers.

The flowmeter measures the time it takes the ultrasonic signal to travel across the pipe and how long it takes the signal to travel back the other way. When the signal travels with the flow, it travels more quickly than it would in conditions of no flow. On the other hand, when the signal travels against the flow, it slows down. The difference between the "transit times" of the two signals is proportional to flowrate.

Transit time flowmeters work best with clean fluids. However, much progress has been made in adapting transit time flowmeters to fluids that contain some impurities. Doppler-based meters, for example, actually require impurities in the liquid to operate properly.

Doppler flowmeters send an ultrasonic signal across a pipe, but the signal goes only part way. Instead of sending the signal to the other side of the pipe, a Doppler flowmeter relies on having the signal reflected by particles in the flowstream. These particles travel at the same speed as the flow. As the signal is reflected, its frequency changes in proportion to the flowrate. The reflected signal is detected by a receiver, which measures its frequency. The meter calculates flow by comparing the frequencies of the transmitted and reflected signals. Doppler ultrasonic flowmeters are used with dirty liquids or slurries. They are not used to measure gas flow.

Some ultrasonic flowmeters, called hybrids, incorporate both transit time and Doppler technology. Which technology is used depends on the flowstream. Hybrid meters are used to handle varying application conditions, including both clean and dirty liquids.

How It All Began

The story of ultrasonic flowmeters began in 1963, when Tokyo Keiki introduced them in Japan for industrial use. Since that time, Tokyo Keiki has become Tokimec (*www.tokimec.co.jp*), and the company still offers ultrasonic flowmeters for sale. Tokimec is located in Tokyo, Japan. However, much has changed in the days since ultrasonic flowmeters were first introduced.

Controlotron (*www.controlotron.com*) became the first U.S. manufacturer to market ultrasonic flowmeters in the United States in 1972. In the late 1970s and early 1980s, both Ultraflux (*www.ultraflux.com*) and Panametrics (*www.panametrics.com*) experimented with the use of ultrasonic flowmeters to measure gas flow. These were the early days in the development of ultrasonic flow technology.

Initially, ultrasonic flowmeters were sometimes misapplied, and were not well understood. This gave the meters a black eye in the minds of some people. Many technological improvements have been made in the past 10 years, and the limitations of ultrasonic meters are now better understood. Advances in transit time technology have broadened the types of liquids that transit time flowmeters can be applied to. And even though Doppler flowmeters still do not measure with the same degree of accuracy as transit time, improvements have also been made in Doppler technology.

Advantages of Ultrasonic

Ultrasonic flowmeters have specific advantages over other types of flowmeters, including new-technology meters. Unlike Coriolis meters, ultrasonic flowmeters do very well in large pipe sizes. Over 85 percent of Coriolis meters are sold for pipe sizes of two inches or less. While Coriolis meters have successfully been used in four-inch and six-inch lines, they become unwieldy and quite expensive in those larger sizes. Size is actually an advantage for ultrasonic flowmeters, since larger pipes provide the ultrasonic signal more room to cross. For pipes six inches and larger, ultrasonic flowmeters in most cases perform better than Coriolis meters.

Ultrasonic flowmeters have an advantage over magnetic flowmeters in that ultrasonic meters can measure the flow of nonconductive liquids, gases, and steam. Magnetic flowmeters have very limited use in the oil & gas and refining industries because petroleum-based liquids are nonconductive. For the most part, magnetic flowmeters cannot be used to meter hydraulic fluids, oil, or natural gas, flare gas, or process gas. They cannot be used to measure steam flow. This is one of the most important reasons why the ultrasonic flowmeter market is growing faster than the market for magnetic flowmeters. Magnetic flowmeters are unable to participate in the fast-growing gas and steam flow measurement markets.

Ultrasonic flowmeters have an advantage over vortex flowmeters in that ultrasonic flowmeters are more successful than vortex meters in measuring low flows. Vortex meters have a difficult time with low flows because vortices are not generated if the flow is particularly low. Some vortex flowmeters also have a difficult time registering zero flow. Ultrasonic meters are also nonintrusive, with the exception of insertion meters. While vortex meters are not as intrusive as orifice plate meters, their bluff bodies can get knocked out of position by impurities in the flowstream.

Ultrasonic flowmeters have an advantage over differential pressure (DP) flowmeters in that they are nonintrusive, with the exception of insertion meters. DP flowmeters require a primary element to make the flow measurement. The intrusiveness of DP flowmeters varies with the primary element used. However, orifice plates cause permanent pressure drop, and are very intrusive. Orifice plates can get knocked out of position, and DP flowmeters with orifice plates need to be recalibrated periodically to ensure that they are still making an accurate measurement.

Ultrasonic flowmeters have several advantages over turbine meters. First, they are either less intrusive or nonintrusive, depending on the model. Also, they do not have moving parts that are subject to wear. Turbine flowmeters use a spinning rotor that is subject to wear over time. While suppliers have improved the durability of turbine flowmeters, rotors are

Ultrasonic vs. Other Meter Types

Type of Flowmeter	Advantages of Ultrasonic
Coriolis	Can meter flow in medium and large pipe sizes
Magnetic	Can meter the flow of gas, steam, and non-conductive liquids
Vortex	Can meter low flows; Are less intrusive
DP	Either less intrusive or nonintrusive, depending on model; Little or no pressure drop; Less need for recalibration
Turbine	Either less intrusive or non-intrusive, depending on the model; No moving parts that are subject to wear

still subject to wear over time.

Mounting Types

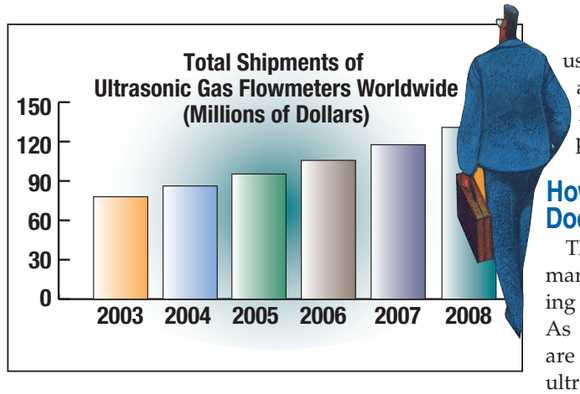
There are several different mounting types available for ultrasonic flowmeters:

- Clamp-On
- Spoolpiece
- Insertion

Many people think of the clamp-on style when they think of ultrasonic meters. Clamp-on ultrasonic flowmeters have transducers that are mounted onto the outside of a pipe. Some clamp-on meters are fixed and others are portable. Fixed clamp-on meters are also referred to as dedicated meters. One disadvantage of clamp-on ultrasonic flowmeters is that the ultrasonic signal has to pass through the pipe wall. This is an additional factor to take into account when computing flow.

Instead of clamping onto a pipe, spoolpiece meters actually replace a section of pipe when they are installed. Spoolpiece ultrasonic flowmeters include a pipe section where the transducers are mounted. Spoolpiece meters come in either flanged or wafer models. If the transducers are in contact with the fluid, they are called "wetted."

Insertion ultrasonic flowmeters are used to measure fluid flow in large pipes. Insertion meters are also called "hot tap" or "cold tap" meters. Insertion ultrasonic flowmeters are used to measure flue gas and flare gas, as well as liquid flows in large pipes.



How Many Paths Does it Take?

The ultrasonic flowmeter market is the fastest growing of any flow technology. As a result, new demands are regularly placed on ultrasonic meters. Suppliers are meeting these demands with innovations that improve product and performance.

In the area of gas flow measurement, Emerson Daniel (*www.emersonprocess.com/daniel/*) has redesigned its four-path ultrasonic flowmeter to extend the range of the meter. The innovation was done by changing the angle at which the four meter chords intersect the pipe axis.

Emerson Daniel is one of the main suppliers worldwide of ultrasonic flowmeters for measuring gas flow. Each supplier of multipath ultrasonic meters has a different number of paths in their ultrasonic meters. Emerson Daniel's meters have four paths, Instromet's (*www.instromet.com*) meters have five paths, and FMC Measurement Solutions' (*www.fmcmeasurementsolutions.com*) meters have six paths.

A different group of companies manufacture multipath ultrasonic flowmeters for liquid applications. Faure Herman (*www.faureherman.com*), based in France, has an 18-path ultrasonic meter for liquid petroleum measurement. So far, Faure Herman is mainly selling this meter in Europe.

Caldon (*www.caldon.com*) makes an eight-path ultrasonic flowmeter for liquid applications. Caldon is mainly focused on selling into the nuclear industry. However, the company has developed an ultrasonic flowmeter that is designed for use in the petroleum industry. Krohne (*www.krohne-mar.com*) manufactures a five-path ultrasonic flowmeter for liquid applications, and more recently a three-path meter.

The jury is still out on the extent to which having a greater number of paths yields better performance. It is clear that flowmeters with four, five, and six paths perform better than single-path or dual-path flowmeters. What is not clear is where the upper bound of benefit lies, in terms of the number of paths.

More Growth Ahead

Much of the rapid growth in the ultrasonic flowmeter market comes from growth in the gas flow measurement market. This growth is due in part to industry approvals given from groups such as the American Gas Association (AGA) for the use of ultrasonic flowmeters for custody transfer. Now suppliers are obtaining approvals from groups such as the American Petroleum Institute (API) for the use of ultrasonic flowmeters in custody transfer of liquids. These approvals are likely to boost the use of ultrasonic flowmeters for measuring liquid flows. Ultrasonic flowmeters offer many paths to successful flow measurement. FC

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