Ultrasonic Flow Meters In The Energy Measurement Spotlight

By **Jesse Yoder, Ph.D.**

Ultrasonic flow meters are among the most popular of the flow meter types. They are used for a wide range of applications, including natural gas and petroleum liquids custody transfer, check metering and flare gas measurement. While they are most widely used in the oil and gas industry, ultrasonic flow meters can also be found in the refining, power, chemical, water and wastewater and other process industries. What accounts for the popularity of ultrasonic flow meters in these industries?

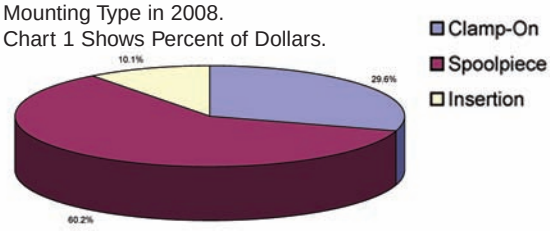
Ultrasonic flow meters were first introduced into commercial markets in Japan by Tokimec in 1963. Controlotron brought out the first clamp-on ultrasonic flow meter in the United States in 1972. Unfortunately, ultrasonic flow meters were not well understood during the 1970s and 1980s when they were first used. As a result, they were often misapplied, and many users got a negative impression of them. They did not come to be widely used in industrial markets until the 1990s.

In many ways, the ultrasonic flow meter market is a market of dichotomies. The fit of ultrasonic flow meters for a given application depends on the ultrasonic technology, the mounting type, the number of paths, and other considerations. For example, transit time flow meters are best suited for clean liquids, while Doppler meters are better suited to dirty liquids. End-users who understand these different aspects of ultrasonic technology will be in a better position to select the right type of meter for their application.

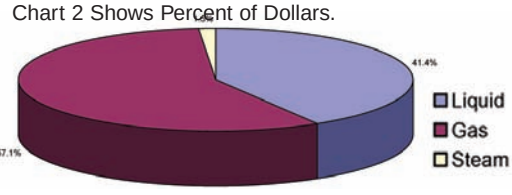
Two Main Technologies

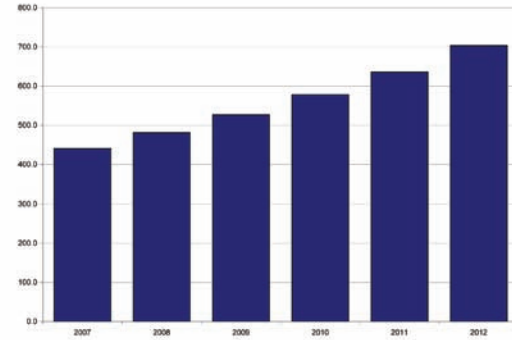
The two main ultrasonic flow meter technologies are transit time and Doppler. Transit time meters have both a sender and a receiver. A transducer sends an ultrasonic signal at an angle from one side of the pipe to the other and back. The signal travels faster when it travels with the flow than when it travels against the flow. The flow meter determines how long it takes for the signal to cross the pipe in one direction, and how long it takes the signal to cross the pipe in the reverse direction. The difference between these two times is proportional to flow rate.

Shipments of Ultrasonic Flowmeters Worldwide by Mounting Type in 2008.
Chart 1 Shows Percent of Dollars.



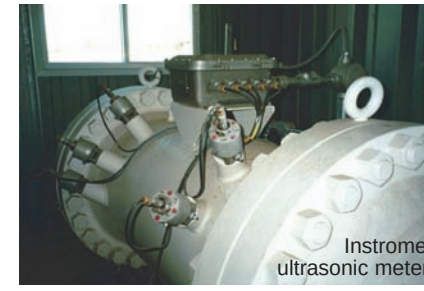
Shipments of Spoolpiece Ultrasonic Flowmeters Worldwide by Fluid Type in 2008
Chart 2 Shows Percent of Dollars.





Shipments of Ultrasonic Flowmeters Worldwide: 2007-2012 (Millions of Dollars). Compound Annual Growth Rate (CAGR) = 9.8%.

Doppler ultrasonic flow meters also send a signal across the pipe. However, with Doppler technology, the signal bounces off particles in the flow stream instead of the other side of the pipe. The flow particles are traveling at the same speed as the flow. As the signal from the transducer travels through the flow stream, its frequency shifts in proportion to the mean velocity of the fluid. The reflected signal is detected by a receiver, which measures its frequency. The meter calculates flow by comparing the transmitted and reflected frequencies.



Instromet ultrasonic meter.

Mounting Types

Ultrasonic flow meters come in the form of either clamp-on, spoolpiece or insertion meters. The transducers of clamp-on ultrasonic flow meters are mounted outside the pipe. The ultrasonic signal passes through the pipe wall and then through the fluid inside the pipe. For accurate measurement, it is important to know the thickness and material of the pipe so that the inside diameter of the pipe can be accurately determined. Clamp-on flow meters have the advantage that they are completely non-intrusive, and can easily be moved from one location to another.

Spoolpiece meters require cutting the pipe, as they are mounted directly in the pipe. For spoolpiece meters, the transducers are mounted in the meter body. Spoolpiece meters are generally used when high accuracy is required, as there are fewer unknowns involved in the flow calculation. They are not portable like clamp-on meters, and typically cost more than clamp-on meters. In 2008, spoolpiece ultrasonic flow meters accounted for about 60% of total worldwide ultrasonic flow meter revenues.

Insertion ultrasonic flow meters have two or more wetted transducers that are typically mounted on either side of the pipe. Because the transducers protrude through the pipe wall, insertion meters avoid the issues relating to pipe wall and material that are important for clamp-on meters. Insertion meters may be used when difficult pipe conditions make clamp-on meters impractical. Insertion meters are less portable than are clamp-on meters. While they typically do not achieve the same accu-

racy levels as spoolpiece meters, they are less expensive than spoolpiece meters.

Number Of Paths

Transit time ultrasonic flow meters send an ultrasonic signal from one side of the pipe to the other. This signal is referred to as a path. Ultrasonic flow meters are distinguished according to the number of paths they use in computing the flow rate. Single path meters use only one path. Dual path meters, which use two paths, can be classified with single path meters. Multipath meters use three or more paths. Multi-path meters can achieve higher accuracy levels than single-path meters because they use multiple paths to compute the flow rate.

Much of the growth in the ultrasonic flow meter market in the past five years has come from growth in the market for custody transfer of natural gas. Most of these ultrasonic flow meters have four, five, or six paths, depending on the manufacturer. They are spoolpiece meters, and many of them exceed $30,000 in cost. Leading suppliers to this market include Instromet, Daniel Division of Emerson Process Management, and Sick Maihak. FMC Technologies is also an active supplier in this market segment.

Advantages Of Ultrasonic Flowmeters

One advantage of ultrasonic flow meters is that they create little or no pressure drop in the line. Clamp-on meters create no pressure drop, since they are mounted outside the pipe. Spoolpiece and insertion ultrasonic flow meters may create minimal pressure drop, depending on the location of their transducers. By contrast, orifice plate and turbine flow meters create a significant amount of pressure drop as a result of their location in the pipe.

Ultrasonic flow meters can be highly accurate, depending on the method of measurement. The most accurate ultrasonic flow meters are spoolpiece multipath meters for gas or liquid flow measurement. While there seems to be no direct correlation between the exact number of paths and accuracy, multipath meters are typically more accurate than their single or dual-path counterparts. This accuracy is especially important when measuring high-value products such as crude oil and natural gas.

Reliability is another key advantage of ultrasonic flow meters. Because they have no moving parts, ultrasonic flow meters require less maintenance than some other meters such as turbine meters. While orifice plate meters do not have moving parts, the orifice plate is subject to wear, and needs to be checked periodically. Even though the purchase price of ultrasonic flow meters may be higher than some competitive meters, many end-users have learned to distinguish between purchase price and total cost of ownership. Their reduced maintenance requirements may give some ultrasonic flow meters an edge in cost of ownership over competing meters with a lower purchase price.

Industry Approvals

Much of the growth in the ultrasonic flow meter market has come as a result of industry approvals. In the mind-1990s, a European group called Groupe Europeen de Recherches Gazieres (GERG) published a report that specified criteria for the use of ultrasonic flow meters to measure natural gas flow. This report laid the foundation for the American Gas Association (AGA) to issue its report in June 1998. This report, called AGA-9, detailed the criteria for using multipath ultrasonic flow meters for custody transfer of natural gas. AGA-9 was very influential in the growth of the ultrasonic flow meter market after its publication.

Industry associations play a key role in the energy industry. When flow meters are used as cash registers, and large amounts of money changes hands, it is important for both the supplier and the customer to agree on the conditions that the flow is measured under. By publishing standards for the use of these flow meters, organizations such as the AGA and the American Petroleum Institute (API) facilitate the use of new technologies without opening up either side to disagreements or possible lawsuits. These standards are typically the result of much deliberation by committees that contain representatives of supplier companies and end-users alike. One reason for the advantage that differential pressure (DP) and turbine flow meters have had for so many years in gas flow measurement is that they were previously the only approved types of flow meters for many applications.

Liquid Flow Measurement

While much of the focus for ultrasonic flow meters has been on gas flow measurement, there has also been significant activity on the liquid side. In 1997, KROHNE introduced a five-path ultrasonic transit time meter for liquid applications. This meter is used for custody transfer of liquids. In 2003 KROHNE followed this up by bringing out a more economical version of this meter with three paths rather than five.

Cameron is another company involved in ultrasonic liquid flow measurement. In January 2006, Cameron acquired Caldon of Pittsburgh, PA. Caldon was mainly known for its ultrasonic flow meters for liquid applications in the nuclear industry. More recently, the company has begun to expand into the oil and gas markets with its two-path, four-path, and eight-path ultrasonic meters. Faure Herman offers an 18-path flow meter for liquid measurement. Faure Herman, which is based in France, was acquired by IDEX Corporation in February 2007.

While industry approvals have not come as quickly for ultrasonic flow meters on the liquid side as on the gas side, the API has published a report that describes criteria for the use of ultrasonic flow meters for custody transfer of liquid hydrocarbons. This approval by the API can be expected to have a beneficial long-term effect on the ultrasonic flow meter market for liquid applications. Other competitive meters in this arena include differential pressure, turbine and Coriolis.

Oil Prices Are On A Roller Coaster

In July 2008, oil prices peaked at $147 per barrel. Oil prices then went into a six-month decline, and bottomed out in December 2008 at just over $31 per barrel. Since December, the price of oil has been on a slow but steady rise. In June 2009, the price of a barrel of crude oil was back above $70 per barrel. Demand for both oil and natural gas declined during the worldwide economic downturn, but demand is returning as economies begin to move into recovery mode.

The price of crude oil is important because it has a direct impact on exploration and production activity. Drilling for oil is profitable in some locations at US$70/bbl; however, these same locations may not be profitable at US$40/bbl. Instrumentation companies that sell into the oil and gas industry can expect to see more demand for instrumentation from the oil suppliers as oil prices rise. This includes suppliers of ultrasonic flow meters.

A Look Ahead

Look for ultrasonic suppliers to continue to focus on innovation. Growth in this market has attracted some very large companies to enter through acquisition. Among these companies are GE Infrastructure, Siemens, Cameron, and IDEX Corporation. The net result of this acquisition activity has been a positive one for the market, since these larger companies have had more money to put into research and product development activity.

Increased activity in oil and gas production and exploration, along with greater reliance on natural gas, will continue to put ultrasonic flow meters in the measurement spotlight. Another area that will experience growth is the use of ultrasonic flow meters to monitor flare gas and stack gas emissions. Ultrasonic suppliers appear to be guided by the adage "Find a need and fill it." As the world experiences rising energy demand, ultrasonic flow meter suppliers are well-positioned to meet the resulting need for flow measurement. *P&GJ*

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