20 Flowmeters

Whatever happened to Doppler flowmeters?

By Dr. Jesse Yoder
President, Flow Research, Inc.

Ultrasonic flowmeters were introduced for commercial use in 1963 by Tokyo Keiki in Japan. Transit time and Doppler are the two main types of ultrasonic flowmeters. A transit-time ultrasonic meter has both a sender and a receiver. It sends an ultrasonic signal across a pipe at an angle and measures the time it takes for the signal to travel from one side of the pipe to the other. When the ultrasonic signal travels with the flow, it travels faster than when it travels against the flow.

The difference between these times is proportional to flowrate. Transit time ultrasonic flowmeters are mainly used for clean liquids.

Doppler ultrasonic flowmeters also send an ultrasonic signal across the pipe. Like transit time meters, a Doppler flowmeter send its signals to a receiver. When there is no flow in the pipe, the signal frequency received is the same as the signal transmitted. When there is flow in the pipe, and the fluid contains particles or bubbles, the signal reflects off these particles or bubbles, back to the sensor or receiver. This reflected signal has an altered frequency that differs from the frequency of the transmitted signal. This shift is proportional to the flowrate of the fluid. The meter calculates flow by comparing the transmitted and reflected signal frequencies. Doppler ultrasonic flowmeters are effective with dirty liquids or slurries, and used with both liquids and gases.

The Doppler effect was first observed in 1842 by Christian Doppler, a 19th century physicist and mathematician who studied the behavior of light. He noted that the observed frequency of sound and light waves depends on how fast the source and observer are moving relative to each other. This principle has come to be known as the Doppler effect.

While Doppler did not work with flowmeters, his principle was used over 100 years later to form the basis of Doppler flowmeters. Doppler flowmeters have the distinction of readily making one of the most difficult measurements in flow: measurement of fluids containing bubbles, sand, dirt and other impurities. With the exception of magnetic flowmeters, most other flowmeter types thrive on clean water, gas or steam, with few or no impurities.

In the early days of ultrasonic flowmeter development, Doppler flowmeters were more widely used than they are today. So what has happened to Doppler flowmeters?

Today, transit time flowmeters are much more capable of handling fluids that are not completely clean. Since transit time flowmeters typically have greater accuracy than Doppler flowmeters, end-users select them for many applications that would previously have required Doppler flowmeters. Alternatively, they might select another technology like magnetic or even vortex rather than Doppler meters.

Secondly, Doppler remains almost exclusively a clamp-on technology. In fact, in a recent study of the ultrasonic flowmeter market, Flow Research was unable to find any suppliers offering inline (spoolpiece) Doppler flowmeters. There does not appear to be anything in Doppler technology that makes a Doppler inline meter impossible, but it remains a clamp-on technology.

Clamp-on flowmeters have advantages and disadvantages. Portable clamp-on meters are mobile. However, the pipe wall can attenuate the signal, lending some uncertainty to the resulting measurement. Build-up on the pipe wall can also impact the pipe diameter, affecting signal accuracy and reliability. Clamp-on meters must be installed properly to work correctly.

Flowmeter markets trend toward greater reliability and higher accuracy. Much of the research and development work on ultrasonic flowmeters done today is directed toward multipath transit time meters that send multiple signals across a pipe at different locations to achieve higher accuracy. Multipath ultrasonic meters are invariably inline meters. There is no analogue in Doppler meters to inline multipath transit time meters.

Research and development dollars are a precious resource, and it is not surprising that suppliers choose to develop more accurate and reliable multipath transit time meters, along with large line size Coriolis meters. After all, these are the meters that serve the fast-growing custody transfer market. But where are the new and cutting-edge developments from Doppler flowmeter suppliers? Until these meters become substantially more accurate and reliable, they will most likely continue to lose market share to transit time ultrasonic, magnetic and vortex flowmeters.