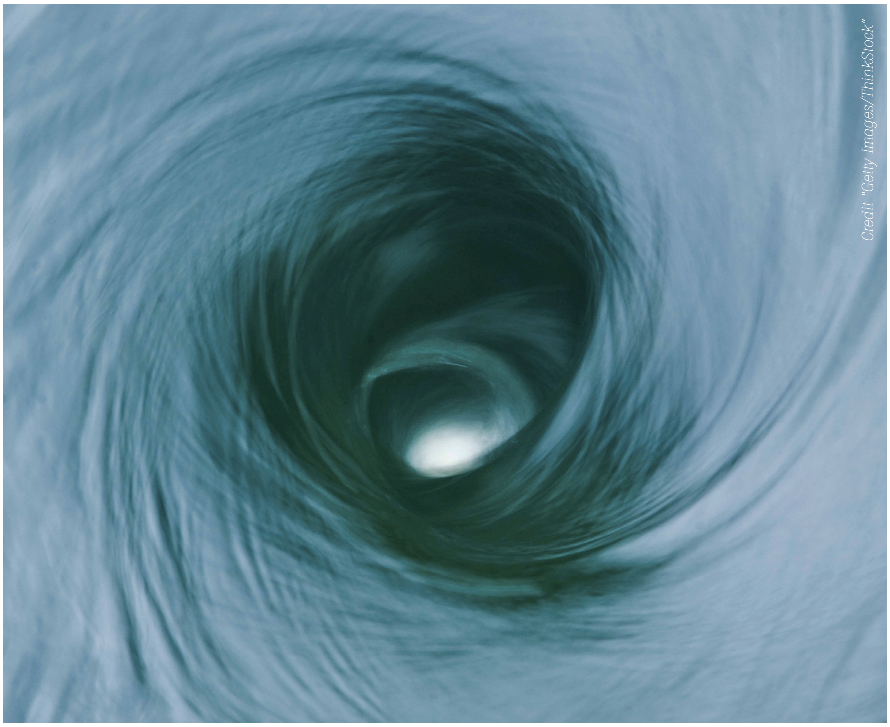
In the **EYE** of the **Vortex**

The history and evolution of vortex flow measurement

By Jesse Yoder, Ph.D.



Vortex flowmeters were first introduced by Eastech in 1969. Yokogawa (*www.yokogawa.com*) popularized the vortex flowmeter in the early 1970s, and other major suppliers have followed, including ABB (*www.abb.com*), Emerson Rosemount (*www.rosemount.com*), Endress+Hauser (*us.endress.com*), Foxboro (*www.foxboro.com*), Sierra Instruments (*www.sierrainstruments.com*), Spirax Sarco (*www.spiraxsarco.com*), Vortek Instruments (*www.vortekinst.com*), and others.

Like other flow measurement devices, vortex meters experienced application issues in the early days of their development. One problem was the effects of vibration tended to create false readings. Suppliers created software to mitigate the vibration issues, and this has proved to be an effective solution.

Vortex flowmeters are different from most other new-technology meters in that they penetrate the flowstream, although in a limited way. Vortex meters operate by means of a bluff body, which is a broad, flat object, often made of metal. When inserted into the flowstream, the bluff body generates vortices, which are detected by a sensor on one or both sides of the pipe. The flowmeter counts the number of vortices, and this number is proportional to flowrate.

Vortex meters are among the most versatile type of meter—they can readily measure liquid, gas, and steam flow. Other new-technology meters, such as ultrasonic and Coriolis, can readily measure liquids and gases, but have difficulty with steam. Thermal meters are used almost exclusively for gas flow, while magnetic flowmeters excel at measuring liquids, but cannot measure steam or gas flow. Vortex meters are the only new-technology meter that readily measures all three fluid types.

Vortex flowmeters are well suited for measuring steam flow, in particular, and they are widely used for this purpose. Steam is the most difficult fluid to measure due to its high pressure and high temperature, and because the measurement parameters vary with the type of steam. Main types of steam include wet steam, saturated steam, and superheated steam.

In addition to their ability to tolerate high process temperatures and pressures, vortex meters have wide rangeability. This allows them to measure steam flow at varying velocities.

Multivariable Flowmeters

In 1997, Sierra Instruments (*www.sierrainstruments.com*) introduced a new multivariable vortex flowmeter. In the past 10 years, a number of companies that previously had only single-variable vortex flowmeters have entered the multivariable vortex flowmeter market as well. These include Yokogawa, Emerson Rosemount, ABB, Endress+Hauser, and others.

Multivariable flowmeters measure more than one process variable. In addition to volumetric flow, they typically have a pressure transmitter and a temperature sensor and/or transmitter. These values are used to compute mass

Vortex flowmeters are a versatile measurement device suited to a range of application needs. (Photos courtesy of VorTek Instruments, Yokogawa of America, and Sierra Instruments.)

flow. In the past, these values were measured independently and then output to a flow computer, which performed the mass flow calculation. Now the computation for mass flow is being done within the flowmeter itself, and the volumetric flow, pressure, and temperature values are fed into the multivariable flowmeter for calculation of mass flow. Multivariable vortex flowmeters can also readily measure steam flow.

Cost is one advantage of multivariable vortex meters. While they cost more than single variable meters, they typically cost less than buying the components separately. In addition, multivariable vortex meters have the advantage of the components being calibrated together before they are installed in the field, giving higher reliability and potentially higher accuracy.

Measuring Low Flowrates

One weakness of vortex technology is the difficulty that vortex flowmeters have in measuring low flowrates. This difficulty is inherent in the technology itself. Shedder bars may not shed vortices at all, or they may not shed vortices at a regular rate, if the flow is too low. Other meters, such as thermal mass meters, do a better job than vortex meters of measuring flow at low flowrates.

In a no-flow situation, a vortex meter will register zero flow. However, it is unable to immediately respond as flow begins. A vortex meter with an output of 4-20 mA will have an output of 4 mA at zero flow. As flow picks up, it may suddenly jump to 4.8 mA when the flowrate is fast enough to register on the vortex flowmeter. The flowrate that is represented by the readings between 4 mA and 4.8 mA is a "blind spot" for the meter.

Some companies have taken steps to improve the capability of their flowmeters at low flowrates by using a very small shedder bar that is more sensitive to lower flowrates than meters with larger shedder bars. While this technology can push back the limits of low flow, it does not completely solve the problem of low flow measurement.

Another approach to handling low flowrates is through the use of reduced-bore meters. Reduced-bore vortex flowmeters are narrower in diameter where the bluff body generates vortices than at either end of the flowmeter. Generally the internal diameter of the meter is reduced by either one meter size or two meter sizes. Flow speed is increased where the pipe is narrowed. Reduced-bore vortex flowmeters can more easily handle low flowrates. Reduced-bore flowmeters are also typically easier to install than standard-bore meters, and their installation costs tend to be less.

While reduced-bore vortex flowmeters have only appeared fairly recently, beginning with the single line size versions, they are becoming increasingly popular. Look for more suppliers to introduce them in the next several years, including both one-meter and two-meter size reduced-bore meters. Their use will increase as more customers learn about their advantages and have a chance to try them out on their own applications. Emerson Rosemount and Yokogawa are among the companies that manufacture reduced-bore vortex meters.

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Dual-Sensor Flowmeters

Another innovation in vortex flowmeters is in dual-sensor meters. When a shedder bar generates vortices, a sensor downstream detects the vortices and the flowmeter counts how many there are. These sensors are typically piezoresistive, ultrasonic or capacitive. Having two sensors downstream rather than just one offers the benefits of redundancy, making for a more reliable flowmeter, though it doesn't necessarily enhance performance.

A second innovation is to have two vortex flowmeters in the same line and calibrate them together. This also is done for the purposes of redundancy. It is reminiscent of the arrangement some companies have for custody transfer of natural gas where they put two turbine meters or two ultrasonic meters in series. While having two vortex flowmeters in series does not improve the performance of the individual meters, it does provide a more stable and reliable installation.

Vortex Flowmeter Performance

The vortex flowmeter market has not grown as rapidly as the Coriolis and ultrasonic flowmeter markets, and it is not nearly as large as the magnetic flowmeter market. One factor holding it back is that it is more intrusive than those other three meters. A bluff body can get knocked out of place, as can an orifice plate, and the result is an unreliable measurement. Coriolis, ultrasonic, and magnetic flowmeters are not intrusive in this way, and they provide more stable measurements.

Secondly, there is a limit to how much information the vortex transmitter can derive from counting the number of vortices. Apparently this is not sufficient for vortex flowmeters to achieve accuracies of much over 0.5 percent. Ultrasonic and Coriolis meters reach higher levels of accuracy. In order to achieve a breakthrough in accuracy or performance, someone will have to figure out how to derive additional information from the vortices than what is currently being derived. FC


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