INTRODUCING the 'Multi-Tech' Flowmeter

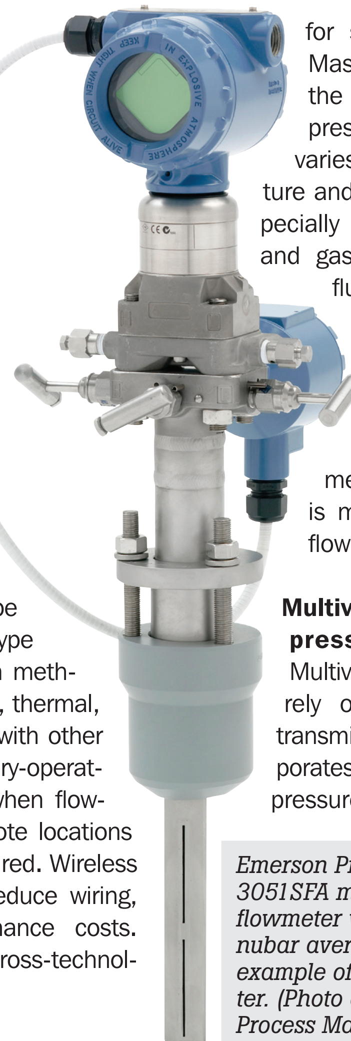
When technologies unite in the name of flow measurement

By Jesse Yoder, Ph.D.

"Multi-tech" is a term that is short for multiple technology. Multi-tech flowmeters have been around for many years, but have never been recognized as a class of meter. Multi-tech meters are ones that either use multiple technologies to make a flow measurement or in conjunction with a flow measurement, or meters that have a design that is used with multiple flow technologies to measure flow. So, it could be said, multi-tech flowmeters are those that either: 1. Use one or more technologies in addition to their flowmeter principle of operation; or 2. Are cross-technology flowmeters.

Some multi-tech flowmeters use other technologies in addition to their flowmeter operating principle. For example, multivariable flowmeters use pressure and/or temperature sensors to help determine the density of the fluid. They then compute fluid density in light of the actual process conditions. These meters use the density measurement together with a volumetric flow measurement to determine mass flow. Mass flow controllers use either a thermal or differential-pressure method to compute mass flow and add a control valve to control the flow. Mass flow controllers, which can be considered a type of flowmeter with a control function, are another type of multi-tech flowmeter.

Another type of multi-tech flowmeter makes use of a flowmeter technique or design that works with multiple flow technologies. Examples of these types are insertion, battery-operated, and wireless flowmeters. All of these meter types have a certain technique or method in common, and they can be used with more than one type of flowmeter. The insertion method can be used with vortex, thermal, magnetic, ultrasonic, and with other types of flowmeters. Battery-operated flowmeters are used when flowmeters are placed in remote locations and when portability is desired. Wireless flowmeters are used to reduce wiring, installation, and maintenance costs. These meters are called cross-technology multi-tech meters.



Emerson Process Management's 3051SFA multivariable DP flowmeter with integrated annubar averaging Pitot tube is an example of a multi-tech flowmeter. (Photo courtesy of Emerson Process Management)

Multivariable Flowmeters

Multivariable flowmeters are one example of a type of multi-tech meter. They determine volumetric flow by using one of the main flow principles, such as vortex or differential pressure (DP), then use the temperature and pressure values of the fluid from the sensors to compute mass flow.

The difference between volumetric flow and mass flow is most important for steam and for gases. Mass flow is a function of the number of molecules present in the flow. This varies with fluid temperature and pressure, and it is especially pronounced for steam and gases. The amount of a fluid present varies with the density of the fluid, and these flowmeters determine density from temperature and/or pressure measurements. Density is multiplied by volumetric flow to derive mass flow.

Multivariable differential-pressure flowmeters: Multivariable DP flowmeters rely on a multivariable DP transmitter that typically incorporates both temperature and pressure sensors. Measuring DP flow requires the use of a primary element, which can be an orifice plate, a Venturi tube, a flow nozzle, a Pitot tube, a wedge meter, etc. The primary element places a constriction in the line so that the DP flow transmitter can compute flow based on the difference between upstream and downstream pressure.

Multivariable DP flowmeters are mainly used to measure the flow of steam and gas. While they do not have the same accuracy as Coriolis meters, they are lower in cost. They can also be used on almost any size flowmeter, while Coriolis meters are limited to the lower line sizes. The wide variety of primary elements available gives them versatility with different fluid types and conditions. For example, flow nozzles are widely used with steam, while Venturi tubes are often used for large line sizes.

Multivariable vortex flowmeters: Vortex flowmeters are another important type of multivariable flowmeter. First introduced in 1997 by Sierra Instruments (*www.sierrainstruments.com*), vortex meters combine a volumetric flow measurement with temperature and/or pressure sensors to compute mass flow. The volumetric flow measurement is based on counting the number of vortices generated by a bluff body that is inserted into the flowstream. Vortex flowmeters are especially suited to steam flow measurement because of their ability to handle temperature and pressure extremes. Multivariable vortex meters are mainly used to measure steam and gas flow. Other companies that have brought out multivariable vortex meters include Emerson Rosemount and Yokogawa.

Almost any type of volumetric flowmeter can be turned into a mass flowmeter by adding temperature and pressure sensors and the required tables for computing mass flow based on these values. While some multivariable magnetic flowmeters are made, they are not widely used because magnetic flowmeters can only be used on liquids, which are nearly incompressible. In the past, the flowmeter outputs were sent to a flow computer, which calculated mass flow based on volumetric flow and density. However, with multivariable flowmeters, the required tables and software are placed into the transmitter itself, which does the mass flow calculation. This eliminates the need for the flow computer.

Measuring mass flow directly: Coriolis flowmeters measure mass flow "directly," meaning they don't measure it using a calculation. Coriolis flowmeters use a twisting tube that responds to differences in fluid acceleration. By measuring the amount of twisting motion, the Coriolis flowmeter determines mass flow, which is directly proportional to the amount of twist in the tube.

It might seem that Coriolis flowmeters should be called multi-tech flowmeters, since they typically output two or more variables, including mass flow and density. However, the term "multi-tech flowmeter" refers to flowmeters that use one or more technologies in addition to those used in the principle of operation of the flowmeter, not to the number of outputs.

Some flowmeters use multiple technologies in their principle of operation, but these are not classified as multi-tech

Multi-Tech Flowmeter Classification

Multivariable DP: Multivariable DP flowmeters rely on a multivariable DP transmitter that typically incorporates both temperature and pressure sensors.

Multivariable Vortex: Multivariable vortex meters combine a volumetric flow measurement with temperature and/or pressure sensors to compute mass flow.

Mass Flow Controllers: Mass flow controllers use a control valve to control the flow as well as measure it, although some are shipped without a control valve.

Insertion Flowmeters: Insertion flowmeters are called-so because the sensor is inserted into a pipe, usually through a hole that is drilled into the pipe. Some different types of insertion flowmeters include magnetic, ultrasonic, turbine, vortex, and thermal.

Battery-Operated & Wireless Flowmeters: Battery-operated flowmeters are used when flowmeters are placed in remote locations and when portability is desired. Wireless flowmeters are used to reduce wiring, installation, and maintenance costs. These meters are called cross-technology multi-tech meters.

flowmeters based on that alone. Vortex flowmeters, for example, use pressure sensors in the shedder bar to determine the alternating effect of the formation of vortices as measured by pressure sensors in the shedder bar. The vortices formed are sensed by a variety of technologies, including piezoresistive, ultrasonic, and capacitive. But these are all part of the operating principle of vortex flowmeters that are used to measure volumetric flow. Vortex meters do not become multi-tech meters until pressure and/or temperature sensors are added for the purpose of determining mass flow, making them multivariable meters.

> "Why should we have **another flowmeter category?** We already have new, traditional, and emerging technology flowmeters, along with **all the individual flowmeter types**. There is a simple reason for this category—it defines something that is **both important and common** to certain types of flowmeters."

Mass Flow Controllers

Mass flow controllers are another type of flowmeter that use an additional technology beyond its flowmeter operating principles. Mass flow controllers use a control valve to control the flow as well as measure it, although some are shipped without a control valve. Most mass flow controllers are 2" or less in diameter, and they are widely used in the semiconductor industry. They also have a growing use in industrial environments, including chemical, fuel cells, metals processing, gas analyzers, solar/photovoltaic applications, and many other industrial applications where gases are measured. Mass flow controllers are almost entirely used for gas flow measurement and control, though some do exist for liquid applications.

Cross-Technology Multi-Tech Flowmeters

Another group of multi-tech flowmeters use a technique or method across a range of technologies. These flowmeters are still classified according to their flowmeter type, such as magnetic or ultrasonic, but they have a unique feature that sets them apart from other flowmeters of the same type. Examples include insertion, battery-operated, and wireless flowmeters.

Insertion Flowmeters: Insertion flowmeters are called-so because the sensor is inserted into a pipe, usually through a hole that is drilled into the pipe. Insertion meters have some important advantages. One is that they can handle flow measurement in pipes of almost any size. Secondly, they do not have a meter body, like inline meters, so they typically are less expensive than their inline counterparts. One disadvantage of insertion flowmeters is that they are typically not as accurate as inline meters. Some different types of insertion flowmeters include magnetic, ultrasonic, turbine, vortex, and thermal.

Insertion magnetic flowmeters are of special interest because large line size magmeters get very expensive. Some have diameters as large as 110". Inline meters also require cutting a segment from the pipe, while insertion meters can be installed through a hole in the pipe, reducing installation costs. Insertion ultrasonic flowmeters typically place a sending and receiving transducer on either side of the pipe. This causes very little pressure drop. Because the signal does not have to pass through the pipe wall, they are more accurate than clamp-on meters.

Battery-operated and wireless: Battery-operated and wireless flowmeters are used in remote places where electricity is unavailable or wiring is impractical or not available. Battery-operated and wireless magnetic flowmeters are a small but growing segment of the magnetic flowmeter market. These meters are used for water applications, including distribution, extraction, agriculture, irrigation, and networking. Remote locations that would have been uneconomical to wire for power are now being done almost routinely. This change means that the magnetic flowmeter benefits of higher accuracy, minimal flow pressure drop, and reduced maintenance are now affordable to many end-users.

Other types of battery-operated flowmeters include ultrasonic and vortex. Battery-operated ultrasonic flowmeters are used for applications in pure water, sea water, wash water, sewage, process liquids, oils, and chemicals. Battery-operated vortex flowmeters are used for circulating water, well water, and wastewater applications, among others. Vortex meters have minimal pressure drop and can handle dirty water applications. Their main weakness is measuring very low flows.

Wireless is also a growing trend among temperature and pressure transmitters, including differential pressure transmitters. Honeywell (*www.honeywellprocess.com*) has a wireless DP transmitter that operates in four modes—differential pressure, orifice flow, open-channel, and level. Wireless pressure transmitters are used for remote monitoring of oil, gas, natural gas, and production wells. Wireless has also reached the area of communication protocols. Emerson Process Management (*www.emersonprocess.com*) is offering a WirlessHART pressure transmitter. This transmitter is offered for differential, gauge, and absolute pressure transmitters.

Why Recognize Multi-Tech Flowmeters As a Category?

Why should we have another flowmeter category? We already have new, traditional, and emerging technology flowmeters, along with all the individual flowmeter types. There is a simple reason for this category—it defines something that is both important and common to certain types of flowmeters. These meter types usually get discussed in the context of the type of flowmeter they are. So multivariable meters get discussed with vortex meters, battery-operated meters get discussed as segments of the magnetic flowmeter market, and insertion meters get talked about as a type of thermal or ultrasonic meter. But the different types of insertion or multivariable flowmeters seldom get considered alongside other flowmeter types with the same technology.

Someone who is looking for a multivariable flowmeter may wish to know how vortex multivariable meters compare to multivariable DP flowmeters. Or an end-user looking for an insertion flowmeter might want to know how insertion magnetic, vortex, ultrasonic, thermal, and turbine all compare. While such a person could probably piece the information together from different sources, they are more likely to find it if these meters are all considered part of the same category of meter, i.e., multi-tech meter. It is also possible that the concept of multi-tech meter could suggest or inspire new ways to measure flow.

It is likely that other types of flowmeters can be considered multi-tech meters. These include steam flowmeters, gas flowmeters, and possibly custody-transfer meters. The flowmeters described above are the most obvious candidates for the multi-tech category, but it is probable that other types will be added as the category is considered. FC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