# Advances in Flowmeter Technology

Flowmeters are getting smarter, smaller and more specialized.

By Nathan Hedrick, Endress+Hauser

Several of the trends in flowmeter technology in 2018 are simply expansions, updates and refinements to existing technology, but two trends are turning the flowmeter industry on its ear: advances in flowmeter diagnostics and the adoption of smartphone-like technology to improve access, communications and in the not-too-distant future the displays attached to flowmeters.

In this article, we'll look at trends involving tiny flowmeters, specialty flowmeters, advanced diagnostics, improved communications between flowmeters and the enterprise, and the looming trend toward embodying smartphone technology into flowmeters.

## Tiny Flowmeters Pack Capability

Some flowmeters have been getting smaller over the years. A web search turns up dozens if not hundreds of compact, small and relatively inexpensive flowmeters. Electromagnetic flowmeters (magmeters) probably lead the trend toward miniaturization, mainly because the size of the flow element only needs to be barely bigger than the pipe or tube carrying the conductive liquid.

Tiny magmeters are now available for pipe sizes as small as 0.5 inches (Figure 1).


**Figure 1:** The tiny Picomag electromagnetic flowmeter from Endress+Hauser contains a sensor and transmitter in the same housing.

Such tiny flowmeters are ideal for use on process skids, where space is often limited, or in difficult to reach locations.

Although tiny, these flowmeters pack extensive capabilities. The Picomag, for example, has 4-20mA, pulse, switch and 2-10V outputs. IO-Link digital communications connectivity provides flexible integration into automation systems. Its Bluetooth wireless interface provides direct access to process and diagnostics data, and enables the user to configure the measuring device on the fly. The device can be operated and configured on Android and iOS devices via Endress+Hauser free app called SmartBlue.

For 2019 and beyond, look for the miniaturization trend to continue expansion into other measuring technologies as well.

Like most flowmeter technologies, magmeters provide a volumetric flow measurement. But many applications require mass flow measurement, an area where Coriolis flowmeters excel.

## Measuring Mass Flow

Grandview Research (Ref.) says, "The magnetic segment holds the largest share in the market. However, ultrasonic and Coriolis are expected to register the highest CAGR during the forecast period owing to advancements in technology that make ultrasonic and Coriolis flowmeters highly reliable and accurate."

Grandview projects the use of Coriolis flowmeters will rise significantly over the forecast period. "Widespread adoption of Coriolis flowmeters in the oil & gas, chemicals, and refinery sectors is anticipated to influence the market positively," they say.

One of the main reasons for this increase is the ability of these flowmeters to measure mass flow. This capability used to come with a substantial price premium, but the price difference between mass flowmeters and volumetric flowmeters is dropping, spurring its use.

Ultrasonic flowmeters are non-contact, and can be used in very large line sizes. In the past Coriolis flowmeters were mostly used on smaller line sizes, but another trend is its increasing size. Several companies offer Coriolis flowmeters in line sizes more than 10 inches making them more suitable for use in ship loading and offloading applications. For 2019, expect a continued incursion by Coriolis meters into the overall flow market.

Additionally, users are recognizing that Coriolis meters have a lot of advanced capabilities beyond basic measurement. For example, most Coriolis meters measure not only mass flow rate but also density, temperature, and some even measure viscosity.

These qualitative parameters open up a world of possibilities for users, and we are seeing a growing trend of viewing Coriolis meters as process analyzers. For example, in the oil & gas industry, Coriolis meters can offer a variety of values such as API referenced correction of volume and density as well as Net Oil and Water Cut measurement. In the food & beverage industry, these same density and temperature measurements can be used to derive Brix, Proof, or % concentration of binary mixtures among many other possibilities.

So, while reduction of price between Coriolis and volumetric flow measurement technologies is certainly a consideration, it is the additional precision and multivariability that is tipping the scales in favor of Coriolis meters for many users.

## Specialized Flowmeters

In olden days, instrument engineers sometimes had to “make do” with standard flowmeters. When an application was particularly difficult—abrasive, hot, cold, acidic or otherwise unfriendly toward conventional flowmeters—engineers specified stainless steel, ceramic, or other liners for flowmeters and hoped for the best. This sometimes led to premature failures.

Today, the availability of exotic materials such as Tantellum, Hastelloy C, Monel, Inconel and a host of specialty alloys makes it possible to fabricate a flowmeter that can handle almost any fluid or gas. In addition, flowmeter manufacturers are more than willing to design and build devices to meet the needs of specific industries.

Complicating the situation are the never-ending and ever-changing regulations from agencies such as FDA, EU, AGA, EPA and dozens of others calling for instrumentation to meet various specs. For example, a hygienic flowmeter may have to meet ASME BPE, EHEDG and 3A standards, and provide full GMP compliance for sterile processes—while at the same time withstanding clean in place and sterilize in place operations, and high pressure washdowns. This calls for a specialized flowmeter (Figure 2).

While the instrumentation world has always had specialty flowmeters, the trend is that manufacturers are producing more devices to meet new regulations, solve new application problems, and provide flowmeters for smaller and smaller market niches.

Thanks to improved manufacturing techniques, laser 3D printing, computer modeling and simulation, and advanced microelectronics, manufacturers can now produce specialty flowmeters much faster than before, allowing them to quickly dominate a market.

## Smart Flowmeters Getting Smarter

So-called “smart flowmeters” have been in use for decades, but they are getting much smarter these days, and are now capable of self-diagnostics and self-verification.

Self-diagnostics means that the flowmeter is capable of detecting when it has a problem by continuous monitoring of relevant internal parameters related to its mechanical, electromechanical and electronic components.

Typically, a failure mode, effects and diagnostic analysis is used during the flowmeter’s design phase to identify critical components in the signal chain, starting at the process-wetted

**Figure 2:** The Endress+Hauser Proline 300 Coriolis flowmeter is a specialty device for use in hygienic applications.

parts and followed by the electro-mechanical components, amplifier board, main electronic module and outputs. A proper margin of safety is then assigned to every critical path or component.

Firmware in the transmitter continuously monitors the entire signal chain for deviations. For example, if the diagnostics detect an error, Endress+Hauser's Heartbeat Technology sends an event message that conforms to NAMUR recommendation NE 107. The event is displayed on the flowmeter's front panel and can be sent as a message over a digital communication link to the automation system. The message also includes troubleshooting tips and remedial instructions.

Today, it is possible to design flowmeters with a self-diagnostics coverage of 94% or higher (in accordance with IEC 61508), and very low rates of undetected failures.

Many but not all flowmeter manufacturers employ a similar type of self-diagnostics these days, but a new trend is toward self-verification.

Depending on the industry, flowmeters must be calibrated periodically. For example, the chemical industry has requirements for proof testing per IEC 61508 and IEC 61511, while the oil & gas industry must adhere to contractual agreements between buyer and seller, and comply with government agency mandates.

But why remove a flowmeter and take it to a lab for calibration if it doesn't need it? Enter self-verification.

A self-verification is done on command from the automation system or at the instrument itself. During self-verification, diagnostics perform checks, and then a report is generated which can be used to verify that the device is still working properly.

**Figure 3:** The Endress+Hauser Proline 300/500 family of flow instruments comes with standard communication interfaces—and with LAN, WLAN and Webserver capabilities for connecting directly to the enterprise.

For example, Endress+Hauser's Heartbeat Technology fully complies with the requirements for traceable verification according to DIN EN ISO 9001:2008, Section 7.6a, "Control of monitoring and measuring equipment."

Self-verification is a trend that will expand in 2019 because it saves time and money. Performing self-verification on a flowmeter can extend calibration cycles by a factor of 10 or higher. In some cases, it may even be possible to replace wet calibrations completely with self-verification.

### Enterprising Flowmeters

In olden days, flowmeters were wired back to an automation system via a simple but limited system involving 4-20mA wires encased in conduit and/or laid in a cable tray. At the automation system, the single process variable flow signal was used for control and monitoring of a unit or a process.

The trend today is to instead use a digital data link to send not only the flow process variable to an automation system, but also many other data points related to other variables, diagnostics, calibration, etc.

HART, FOUNDATION Fieldbus and PROFIBUS PA/DP have been available for many years, but now we are seeing growth in industrial ethernet protocols such as EtherNet/IP and PROFINET. Wireless transmission protocols, such as ISA100 and WirelessHART, are also available with some types of flowmeters. For flowmeters not available with wireless communications, adapters are available to convert a 4-20mA or HART output to WirelessHART.

With modern microelectronics, today's flowmeters (Figure 3) offer many communications options.


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**Figure 4:** WLAN, Bluetooth and Webserver interfaces allow technicians to monitor, diagnose and configure flowmeters from smartphone apps.

For example, the Endress+Hauser Proline 300/500 Coriolis and electromagnetic flowmeters come with 4-20mA HART, PROFIBUS PA, FOUNDATION Fieldbus, Modbus, EtherNet/IP or PROFINET interfaces—as well as recently added Web server, WLAN and LAN capabilities. The new interfaces for networks allow a customer to access the device from anywhere in the plant—or anywhere in the world, for that matter—depending on how it is set up.

One recent advancement is the incorporation of new protocols to ease the connection to enterprise network.

For example, the Proline 300/500 flowmeter has an OPC-UA Server application package built into the flowmeter that allows the device to communicate with an OPC-UA client and be integrated into Industrial Internet of Things (IIoT) applications. This is accomplished through networking the flowmeter via either LAN or WLAN. This allows the DCS or PLC to be dedicated to the control function while this additional path of communication can be dedicated to diagnostic, monitoring and/or reporting purposes.

What all this means is flowmeters can now shortcut the once complex procedure of getting flow and status information to SCADA, CMMS, ERP and other "enterprise level" networks. With these new communication capabilities, the software can easily access the data it needs directly from the device.

For 2019, the trend will be for more and more flowmeters to offer direct connection to enterprise network.

## Wireless Capabilities

Mobile technology is also working its way into flowmeters. As we've seen, today's flowmeters can already have wireless, Bluetooth and Webserver capabilities—which means flowmeters can be accessed, probed, configured and diagnosed over smartphones, tablets and handheld devices (Figure 4).

What is already in place is evident in the Picomag which was introduced previously in this article. It features an auto-rotating display which self-orients based on the installation of the meter.

In the future, we will likely expand the incursion of smartphone technology. For example, many displays today feature optical or infrared "buttons" so that maintenance can interact with the devices through the cover. This allows for operation in hazardous areas and ensures the housing remains sealed from environmental effects such as humidity and rain.

You will continue to see improved interaction with flowmeters which more closely mirrors the way we interact with mobile devices such as smartphones and tablets.

**References**

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## About the Author

Nathan Hedrick has more than nine years of experience consulting on process automation. He graduated from Rose-Hulman in 2009 with a Bachelor's degree in Chemical Engineering. He began his career with Endress+Hauser in 2009 as a Technical Support Engineer. In 2014, Nathan became the Technical Support Team Manager for Flow where he was responsible for managing the technical support team covering the flow product line. He became the Flow Product Marketing Manager in 2015 and was named the National Product Marketing Manager for flow in 2018.



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