For over a century, water meters most commonly operated according to mechanical principles—the flow of water through the mechanism turned a nutating disc (see the sidebar on page 31), oscillating piston, turbine rotor, and other mechanical parts that measured the volume of water passing through the meter. When solid state electronic technology allowed for encoder registers to operate electronically, the stage was set for a similar revolution (or, in a real sense, a lack of revolutions) in the meter itself.

Increasingly in recent years, the water industry has started adopting ultrasonic technology for cold water measurement, which involves acoustic frequencies significantly higher than those that humans can hear. In an ultrasonic meter, piezo electric transducers generate ultrasonic waves and translate them back to electric current, creating measurable signals. Without having to rely on moving parts, an ultrasonic meter operates according to the transit-time principle, also called “time of flight,” wherein the difference between the speed of a signal going against a flow and a signal traveling in the direction of the flow results in a time difference. The faster a fluid moves, the greater the time difference between the signals. By comparing the upstream and downstream times, one can precisely calculate fluid velocity.

With the current breed of ultrasonic meters, all sensing is done within a meter installed like any other. Within the piping portion of the meter main-case, the ultrasonic signal is reflected from one transducer upstream to another, a short distance downstream. In turn, the downstream transducer transmits a signal that is reflected back to its counterpart upstream. As described here, the basic operating principle is relatively simple—measure the time of flight in each direction, and the difference in times is proportional to the water velocity.

CONTINUOUS, HIGHER-RESOLUTION MEASUREMENT AND ENHANCED LOW-FLOW ACCURACY

While ultrasonic technology isn’t new, improvements in battery technology, signal processing, and even waterproofing electronics have allowed it to become a viable measurement solution for the water industry. In terms of battery power management, today’s ultrasonic technology typically requires less power than other solid state flow-measurement technologies. Some ultrasonic meters even provide a 20-year warranty, which pairs well with advanced metering infrastructure (AMI) meter interface unit warranties.

Because battery power is less of a concern, ultrasonic water meters can support higher-resolution measurement, providing continuous measurement multiple times per second. This enables extended low-flow accuracy beyond traditional mechanical
meter capabilities. With ultrasonic meter signal-processing technology, it’s possible to achieve continuous measurements as frequently as four times every second. The greater the frequency of the measurement, the better and more consistent the accuracy at low flow rates. Ultrasonic water meters with higher-resolution signal processing provide for standard residential meter testing through continuous measurement. This means they do not require configuration in special test modes and can be tested on a meter test bench just like a mechanical meter.

Not having to forgo low-flow accuracy means that even some ¾-in. ultrasonic meters can exceed the low-flow accuracy of ⅝-in. mechanical meters. Before, with traditional mechanical meters, planning for higher flow rates to accommodate fire sprinklers or irrigation systems often required the selection of a larger-size meter—sometimes as large as 1 in. In the process of designing for higher rates of flow, sensitivity to lower flows was often sacrificed. This is not the case with an ultrasonic water meter, which makes it ideal for applications requiring a wider operating range. Because an ultrasonic meter provides a higher-end flow range than a mechanical meter of the same size without sacrificing low-flow accuracy, it is well suited for water lines that service combination potable and residential fire service or irrigation systems.

**READY FOR WATERBORNE DEBRIS WITH NO PARTS TO WEAR OUT**

Another set of applications for which an ultrasonic water meter is ideal involves reclaimed water or sandy water conditions. That’s due in large part to the absence of moving parts in the meter. Debris such as sand and dirt pass easily through the ultrasonic water meter with no effect on meter accuracy, which provides a benefit for areas of the desert West and Southwest of the United States—especially those enduring the longstanding drought. In fact, many water utilities in drought-stricken areas are making it a point to specify meters that can handle these environments while being able to measure wide flow rates.

In addition, the no-moving-parts design of ultrasonic meters helps ensure that accuracy is maintained over the life of the water meter. No-moving-parts technology means no wear points. And no wear points means avoiding the loss of accuracy that can be experienced with mechanical meters over time. This sustained accuracy, coupled with continuous measurement, provides today’s water utilities with even more opportunity to generate maximum revenue.

Although the upfront costs of implementing ultrasonic solid state water meters may exceed those of mechanical water meters, those utilities considering ultrasonic technology should keep in mind total life cycle value. The absence of moving parts inside an ultrasonic meter also means that material and labor costs are greatly reduced over the lifetime of the meter compared with some mechanical meter designs. A maintenance-free meter design is much more conducive to reducing operating costs both in the short run and long run.

Adding still more to the life cycle value, the higher accuracy at low flow rates achieved over the life of the ultrasonic water meter can help save more than operating costs. Over the span of 15 to 20 years, this increased and sustained accuracy captures water that might otherwise have gone unmeasured by a mechanical meter—resulting in increased revenues that can more than pay for the incremental price premium for the meter. This amounts to recapturing potentially millions of gallons—as well as dollars—in nonrevenue water.

**INTEGRATION WITH OTHER TECHNOLOGIES**

The latest ultrasonic metering technology can be integrated with other field-proven technologies. For instance, it’s possible to combine a fully potted electronics enclosure with a maincase cast in lead-free, NSF 61-compliant bronze, providing the best of both worlds—state-of-the-art measurement with proven structural integrity. The bronze maincase eliminates stripped threads or broken meter spuds that can occur with composite meter bodies either during installation or from stress resulting from piping concerns over time. When you add this physical durability of the maincase to the sustained accuracy of the meter, you have a meter

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**Nutating Versus Fully Potted Technology**

Water meters that use a nutating, or rhythmically wobbling, disc or plate as part of their measuring chamber capture the flow of water that moves the disc (the positive displacement principle in action). The number of disc revolutions determines the flow rate.

When electronics are said to be fully potted, the assembly’s circuitry and wires are immersed in a protective compound, often of silicone or epoxy. Once potted, the electronics are more resistant to damage from moisture, corrosion, shock, or vibration.
that not only retains its performance throughout its life but also provides a residual scrap value at the end of its life cycle, unlike composite meters.

Another field-proven technology that is easily integrated with ultrasonic metering is radio frequency (RF) data transmission. The combination of encoded metering output with RF transceivers creates an easy-to-install, powerful, and solid foundation for an automatic meter reading (AMR) or AMI metering system. The integrated radio functions without wires that could accidentally become crimped or broken, and eliminates possibilities of tampering.

Water utilities need not be concerned about practical considerations of installation such as size or positioning of the meter. Today’s latest ultrasonic meters can be designed such that their physical profiles easily fit within shallow pits and even the smallest meter boxes.

Just as ultrasonic meters can be designed for the needs of excessively dry and desert locales in North America, they can also be manufactured to withstand the wetter climates and conditions of our continent. For instance, meters in residential pit applications throughout the Southeast are frequently subject to flooding. Especially for utilities in these types of regions, waterproofed, fully potted meter and radio electronics should be key criteria when selecting an ultrasonic meter for pit applications.

Smart meter technology, with flags for alarm conditions, would seem to be a natural fit with the newest ultrasonic solid state water meters, and that is indeed the case. One example of such a meter has internal flags that register reverse-flow events that can be correlated with data from acoustic leak sensors along distribution lines, helping to proactively identify breaches in water mains and reduce major water loss. Intermittent and continuous leak events can likewise be flagged. These types of automatic condition alerts are often familiar to utilities that have leveraged them in solid state encoder registers fit to mechanical meters. This functionality, as well as interleaved rate-of-flow data and on-screen diagnostics and icons, is being integrated with ultrasonic technology to assist field technicians and homeowners who want to better understand issues regarding water consumption.

The water industry has come a long way since the introduction of ultrasonic technology and offers today’s water utilities more flexible, more efficient, and more affordable options to leverage AMR and AMI data. With its no-moving-parts design, high-resolution measurement, increased accuracy, and adaptability to different applications, it’s now possible for water utilities in North America to implement ultrasonic metering technology that meets their specific needs.

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