Taking Measure of Advanced Water Metering Technologies

White Paper

Recent advancements in water metrology are bringing utilities metering solutions that will help capture more revenue, provide unprecedented business intelligence, reduce costs associated with owning and operating meters and protect natural water resources.

Sensus is leading metrology innovation with advancements like the intelligent iPERL™ residential water meter, which surpasses the capabilities of traditional meters to support an intelligent water management system. The iPERL meter incorporates remanent field technology, pioneering flow tube design and compatibility with AMR/AMI systems for greater intelligence to help utilities achieve operational and revenue objectives. This paper examines the design and benefits of the iPERL and its potential to impact utilities and end-users.

Water utilities are under pressure due to the rising cost of labor and energy. The industry is focusing its attention on improving operational efficiencies and many utilities are embracing advanced metering infrastructure (AMI) in an attempt to manage those costs.

With new choices in flow measurement technologies, utilities can reduce cost and gain revenue advantages from advanced meter technologies that:

- Capture more revenue by accurately measuring a wider range of high and low flows
- Reduce the cost of owning and operating the meters
- Lessen energy consumption over the life cycle of the meter
- Reduce water loss, wasted energy and repair costs through superior leak detection and by proactive notification of trouble conditions

Sensus, a leading utility infrastructure company, introduced its iPERL intelligent water management system to bring utilities the technology necessary to meet these goals.

In addition to significant technological advancements, iPERL systems feature a lead-free construction, comprised of a composite flow tube. The materials are much lighter than their bronze counterparts and require less energy to manufacture and ship, and comply with lead-free regulations.

Common Metering Technologies

The water industry is undergoing significant regulatory and technological changes. As solid state meters are introduced to the water market, presenting an alternative to mechanical meters, there is an opportunity to educate water utility professionals about the pros and cons of common metering technologies found in ultrasonic meters, fluidic oscillator meters and magnetic flow meters.

Ultrasonic meters use an ultrasonic transducer to send sound waves upstream and downstream through the water, the difference of which is used to determine the water velocity, which is then translated into the volume of water.

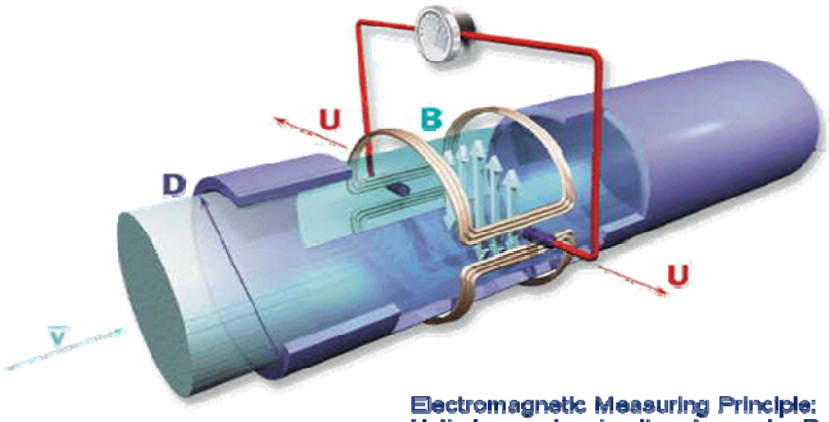
- **Advantages**: There is no measuring element hindering the path of water flow, and there is no reduction of accuracy over time.
- **Disadvantages:** Ultrasonic meters require sound, and sound requires power. The high sampling rate required for high accuracy (nearly continuous sampling) results in a heavy power drain. To conserve power and battery life, the sampling rate can be reduced and the periodic measurements averaged, but accuracy suffers, especially at low flow rates.

Fluidic oscillator meters measure the frequency with which a fluid entering the meter attaches to one of two opposite diverging side walls and then the other, due to the Coandă effect, the tendency of a fluid jet to attach itself to a nearby surface.

- **Advantages:** Measures only the flow of water, so it is not affected by the presence of air in the water system. With no moving parts, it can be used where sand and grit are present in the water.
- **Disadvantages:** Struggles at low flow measurements due to the need to have a minimum flow rate, given a specific vessel size, for the Coandă effect to start.

Magnetic flow meters are based on Faraday's law of induction. An electrical signal is measured when ionized water flows through a magnetic field. The faster the water flows, the more voltage is created and measured. Voltage is linearly proportional to speed; as water speed increases, voltage increases and the measure of volume increases.

- **Advantages:** With no mechanical measuring element inside the flow chamber, there is no reduction in accuracy over time. Measuring performance is linear over the flow range. Maintain accuracy at both forward and reverse flow directions.
- **Disadvantages:** In traditional magnetic meters, creating the magnetic field and sustaining the right electrical environment for accurate readings requires a controlled magnetic field and considerable amount of energy.



Electromagnetic Measuring Principle:
U_i (induced signal voltage) = v • k • B • D
v = mean flow velocity
k = constant factor correcting for geometry
B = magnetic field strength
D = inner diameter

Remanent Field Technology

Remanent field technology, in conjunction with magnetic metering technology, requires far less energy than traditional magnetic meters and permits much greater accuracy, even at intermittent or very low flows. The iPERL intelligent water management system is a magnetic flow meter that utilizes a patented method employing remanent magnetic field technology that helps solve the power demands of traditional magnetic meter technology.

Remanent field technology also uses a pulse of current in a drive coil to magnetize a small piece of magnetic material. The remanent material holds its magnetic field strength without requiring continual battery current consumption and keeps electrical noise low, which allows for accurate measurement of lower water flows.

The magnetic field is reversed each time a pulse of energy is emitted to the material thereby inducing voltages of opposite polarity on each magnetic field flip.

The iPERL preserves energy and optimizes power consumption by applying a self-calibrated field at the time of manufacture. The energy required to power the iPERL is significantly reduced thus enabling a traditional battery to have a 20-year life span.

Traditional magnetic meters have difficulty with low flow because as water flow slows down, the voltage signal is reduced and could be lost in the electronic noise. The iPERL system is able to capture lower flows because field flipping eliminates offset errors, thereby enabling the measurement of very low flows that other magnetic meters cannot measure – as low as 0.03 gallons per minute (gpm).

Compared to traditional positive displacement (PD) meters, iPERL systems can measure to a 20 percent lower flow rate. They are also built to withstand high flows while maintaining measurement accuracy, enabling the capture of 100 percent of water flow.

The Sensus iPERL system measures a wider range of high and low flows.

Unlike PD meters, iPERL systems have no moving parts to wear out or degrade accuracy over time.

For utilities, iPERL systems equipped with remanent field technology offer a metering solution that is more affordable due to lessened energy requirements and that can help increase revenue by accurately capturing low flow water usage that was previously unaccounted for.

Remanent field technology is only available on Sensus iPERL systems, designed for residential applications. It is ideal for any application where PD or multi-jet meters would have been used in the past. It is particularly well-suited for settings where sediment and sand are present in the water, where customers have fire sprinklers or other mission-critical water services, or where well water is being metered.

Innovative Flow Tube Design

The iPERL system flow tube was designed with a glass infused polyphenylene sulfide (PPS) alloy which was carefully selected for its strength and stability over a wide range of temperatures. The rectangular cross section forces the magnetic lines to be perpendicular to the flow lines and enhances accuracy as well as minimizes turbulence and swirling as water enters the flow tube.

Another key advantage of the iPERL system is that it has little effect on water pressure, because there is little resistance in the flow tube. For example, for residential metering at 20 gpm, the head loss for a traditional 3/4" PD meter is just over 5 pounds per square inch (psi); it is less than 3 psi for a 3/4" iPERL meter.

By reducing pressure loss 40 to 50 percent relative to traditional meters, utilities spend less to achieve acceptable water pressure at customer premises.

For systems with elevated storage tanks/towers, reduced pressure loss at the meter makes it possible to sustain customers' water pressure with far less water in storage. For pumped systems, less resistance at the meter level simply means less energy required to push water through the system.

Putting the 'Smart' into the Smart Grid for Water

Fixed wireless communications—the hallmark of advanced metering infrastructure (AMI)—enables meters to be read and even monitored and managed from a remote, central location. This capability eliminates the need to send a fleet of vehicles out into the service area—which in turn reduces fuel consumption and greenhouse gas emissions. Sensus iPERL devices are compatible with industry-standard AMR/AMI systems, including the Sensus FlexNet™ network..

Globally, water is a precious commodity, to be used and conserved wisely. Leaks in the water distribution system or at customer sites represent not only lost water, but wasted energy to pump it for no purpose. Intelligence in the system enables utilities to be proactive instead of reactive. With remote notification of leaks, tampering, out-of-threshold operating conditions, low battery and more, utilities can alert customers to an issue before the customer is aware of it or before any damage occurs and quickly identify, troubleshoot and resolve field issues.

The iPERL meter is referred to as an intelligent water management system in part because it offers a sophisticated suite of alarms that are communicated via Sensus' FlexNet AMI system. For example, application alarms can detect leaks, reverse flow, tampering, empty pipes, and battery life. AMI connectivity allows utilities to be informed of these events in real time for faster resolution and improved customer service.

The iPERL register is made of a hermetically sealed glass covered 9-digit programmable display to provide a water-tight seal and a method for visual leak detection. Specific events and alarm conditions are logged along with the state of the device and the time the event occurred.

Peak flow and consumption data, measured at utility defined intervals ranging from 15 minutes to 24 hours, is stored in the iPERL system datalog to provide the utility with additional information on consumer usage patterns.

The iPERL system was designed with special algorithms for self-monitoring and self-adjusting power consumption. Battery consumption is continuously monitored from its start of life and the iPERL system automatically adapts power characteristics based on temperature and environmental considerations. The iPERL firmware tracks water velocity and time periods of usage.

Based on usage patterns, the iPERL may conserve power by adjusting the magnetic field flip, analog to digital converter (ADC) sampling rate and/or clock frequency of the main microprocessor. By flipping the magnetic field, the electrode offset voltage is eliminated, which improves the iPERL system's ability to conserve energy. The battery consumption algorithm will find the minimal water usage times (i.e. 1 am to 5 am) and reduce the field flip rate or duration during this minimal usage time. The ADC will continue to sample during this time while sending updates to the processor, but the instant water begins flowing through the iPERL system, it reverts to standard operation.

Summary

Water meters, largely unchanged for decades, have historically been viewed as just a utilitarian component in the water delivery system. Now, new solid state flow measurement technologies offered the opportunity for meters to deliver real business benefits—cost savings and new revenues—as well as competitive differentiation.

Sensus iPERL systems can help utilities reduce annual energy and maintenance costs, remotely manage meter reads, proactively identify potential problem conditions and capture previously unaccounted for revenue by accurately measuring the full range of low to high flow water usage over the system's lifetime.

For water utilities, iPERL technology will drive additional revenue by measuring at flow rates lower than current products on the market can measure, sustain high accuracy over its operating range and throughout the life of the meter due to a design that reduces friction and wear, and reduce the energy costs associated with pumping due to reduced pressure loss at the meter. In addition, the iPERL will help streamline and reduce costs associated with meter operation and maintenance and will provide investment reassurance with guaranteed accuracy over its 20-year product life.

For utility customers, the iPERL will improve water system performance and reliability, thanks to early notification to the utility of trouble conditions such as leaks, often before the customer has even realized a problem exists. Customers will also benefit from more accurate billing and detailed information on their usage due to higher meter accuracy, continuous measurement and compatibility with AMI/AMR systems for on-demand data.

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