Solid-state, ultrasonic technology in gas metering

Sponsored by: Sensus

Gas meters are important for gas supply companies: they are the basis for billing. It is therefore critical that a gas meter continuously and accurately measures how much gas is delivered to the customer. Since the basics of how these measurements are conducted have been nearly unchanged for decades, the industry is ripe for disruption. The commercial viability of ultrasonic gas meters is poised to deliver stiff competition to the traditional mechanical diaphragm equivalent, and the switch to "smart gas" will accelerate this.

While ultrasonic metering technology is not new, it has only recently become cost competitive with mechanical alternatives. Ultrasonic meters also deliver many advantages, including precision, dramatically reduced wear and tear, and compatibility with advanced, smart gas metering infrastructure.

The ultrasonic gas meter is now poised to be a game-changer in residential gas metering. Future-forward gas utilities that adopt this technology can leverage its advantages to increase process efficiencies and hone a competitive advantage in the smart gas landscape.

Figure 1: The Sensus Sonix IQ ultrasonic meter for residential class use (250 and 400 CFH), weights about 6 lb. Source: Sensus

Future-forward gas utilities that adopt this technology can leverage its advantages to increase process efficiencies and hone a competitive advantage in the smart gas landscape.

History of ultrasonic gas metering

After several decades of use, ultrasonic flow technology got an unexpected boost in the late 1980s when British Gas set up a competition to develop a more compact gas flow meter. Two of the winning entries used ultrasonic technology as the driver and showed promise at this early stage, ultimately leading to a single-path ultrasonic meter. Originally developed for the European market, this new and improved design was more compact and accurate than traditional diaphragm meters. Seeing the potential for a better gas monitoring system, the parent company of Sensus acquired the technology and produced over 1.3 million residential, single-path ultrasonic meters between 1993 and 2000.

On the heels of its success in Europe, ultrasonic gas meters were ready for a test drive in North America. While residential ultrasonic gas meters have made steady inroads since their introduction in 2000, the higher cost — almost three times that of a traditional mechanical meter — prevented wider adoption.

That no longer remains true today. Modern ultrasonic meters, which are now price competitive, are positioned for rapid growth in North America.

Mechanical residential gas meters

Most residential gas meters use century-old mechanical diaphragm technology. This consists of a box inserted in the middle of a gas-carrying pipe. On entering the box, the gas is forced by valves to pass through a set of balloon-like chambers made of flexible sheets or diaphragms. The design of the chambers and valves is such that the pressure of the gas

Sponsored by:

SENSUS a xylem brand

Produced by:

IEEE

makes the chambers alternately expand and contract.
The moving diaphragms are attached to a crankshaft so that the back-and-forth motion is converted into a rotational motion of a mechanical shaft. The faster the gas passes through the meter, the faster the shaft rotates. This rotation drives an indicator, which displays the volume of gas that has passed through the meter.

Over the decades, the design has improved, using newer materials and modern manufacturing techniques. Indicators have improved as well. Automatic meter reading (AMR) radios remotely obtain a simple index reading, but are still limited by the mechanics and challenges of the meter. Partly due to cost concerns and partly due to inertia, the vast majority of existing residential meters remain the mechanical diaphragm type, operating on the same principle.

Ultrasonic gas meters

Ultrasonic meters operate on the principle that soundwaves are influenced by the speed and flow direction of the gas through which they pass. An ultrasonic soundwave transmitted through flowing gas will travel slower in the upstream direction than in the downstream. Moreover, the difference in speed between downstream and upstream varies linearly with the speed of the gas, as well as with the gas's properties, temperature and pressure.

An ultrasonic flow meter contains transducers that do double-duty: they both generate sound pulses from electric currents and detect them. This unique feature allows single-path ultrasonic meters to work with just one pair of transducers, one upstream and one downstream. Software analyzes these readings in nanoseconds to infer the speed of the gas, using known relationships between the properties of gases and of

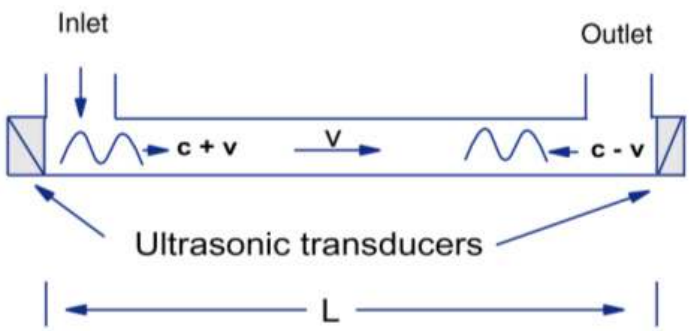

Figure 2. Fundamentals of ultrasonic measurement. Source: Sensus

sonic waves at different temperature and pressure conditions.

Advantages of ultrasonic over mechanical meters

Compared to the older mechanical diaphragm meters, ultrasonic flow meters boast a number of advantages. First off, they are far more precise and measure a larger range of gas flows and usage swings.

Ultrasonic flow meters have no mechanical components to wear out and can go for a much longer period without maintenance. Diaphragm meters are made of elastomers that stiffen, shrink or change shape with changing temperatures, accelerating wear and tear. The solid-state construction of ultrasonic gas meters means greater resistance to freezing

Figure 3. The Sensus Sonix IQ ultrasonic meter for residential class use (250 and 400 CFH), weighs about 6 lb. Source: Sensus

and contamination of parts, which again prolongs life. Ultrasonic gas flow meters operate under a wide variety of environmental conditions.
The ultrasonic gas meters are smaller and lighter, facilitating installation in tight spaces. The Sensus Sonix IQ ultrasonic gas meter (250 and 400 CFH), for example, weighs about 6 lb, while mechanical equivalents can weigh four times this amount. It typically takes just one worker to install the Sonix IQ ultrasonic gas meter.

Until recently, the only obstacle to the adoption of ultrasonic residential gas flow meters was cost. With mass production, the key technologies used in ultrasonic flow meters — long-life batteries, transducers, sensors and inexpensive microcontrollers powerful enough to perform the analysis in real time — are decreasing in cost.

The Sonix IQ gas flow meter is connected to the utility and provides continuous usage logs, so the meters are theft- and tamper-proof. Utilities download accurate usage information, leading to more accurate billing statements and decreasing incidences of theft.

A foundation for smart gas

Aside from competitive costs and other benefits, modern ultrasonic meters are also future-forward and more readily adaptable to future technologies like smart gas and advanced metering infrastructures (AMI).

As ultrasonic flow meters containing microcontrollers become more common in residential gas pipes, additional use cases will likely follow. Intelligent meters can now send the gas readings directly to the utility's remote billing computer over a wireless network, replacing the traditional method of inspecting the indicators on each meter and recording the gas readings manually.

Equally important, with ultrasonic gas flow meters like the Sonix IQ, utilities get more than just a remote meter read. They are able to access comprehensive data logs that include corrected volume, uncorrected volume, pressure, temperature and alarm information. Applications residing in the back-end system monitor this steady stream of information, including

pressure. Since the remote shut-off feature functions because of automated monitoring, it does not require additional prompting from the utility company. A proactive approach to gas management leads to greater efficiencies in terms of time, labor and safety for all parties.

It is also possible to remotely send commands the opposite way, from the central utility to the microcontroller. The microcontroller can actuate a valve inside the meter and shut off the gas. Ultrasonic gas meters provide the foundation for a smart grid that monitors and reacts to situations like over-pressurization, temperature extremes, excess flow and seismic or other natural disasters.

Additional features and functionalities are also wirelessly delivered to the microcontroller as software updates. In this way, the entire utility network can be made more intelligent over time.

Today's ultrasonic meters have built on the successes from the 1980s on and are now cost-competitive. Residential ultrasonic gas meters are simply the best choice when it comes to efficiency and lasting value. They are smaller, lighter, tamper- and theft-proof and operate accurately under a variety of environmental conditions and usage situations. The shovel-ready interface to the smart gas technologies of tomorrow means companies making the switch to ultrasonic meters can now get ahead of the competition and stay there.

Learn more about the industry's leading smart gas meters on the Sensus website.

References

AMI Trends and Developments in Gas and Water Utilities
Ultrasonic Domestic Gas Meters — A Review
Ultrasonic Flowmeters: A Sound Technology
Ultrasonic Meters for Commercial Applications

Ultrasonic gas metering on the ground

The Energy Cooperative is a non-profit utility organization in Newark, Ohio, comprising natural gas, propane and electric companies under its umbrella. Over the years, large consumer demand for devices such as pool heaters or backup electric generators meant that gas meters needed to handle high-volume gas measurements over relatively short periods.

After finding their mechanical meters were insufficient, The Energy Cooperative established a working relationship with Sensus and systematically installed Sonix meters to fit a variety of ongoing gas monitoring needs, expanding their use from residential to commercial and industrial clients as well.

After starting with Sensus Sonix 600 ultrasonic meters, The Energy Cooperative is on its way to piloting the Sonix IQ in its suite of gas metering devices. Dave Getty, gas utility manager for the organization, outlines the many advantages of the ultrasonic technology that Sonix monitors deliver. These include:

- No mechanical parts means less wear over time.
- Custom devices for various use cases. The Sonix 600, used in residential metering, is smaller and lighter than its commercial equivalent, making it more aesthetically pleasing for customers.
- All-electronic design means precision and extensive diagnostic capabilities.
- Ability to function with high accuracy through a range of environmental conditions.
- Tamper-proof alerts lets utilities know if units are being rigged or malfunctioning.

The Energy Cooperative is looking to build on these advantages of the Sonix ultrasonic meters to develop a more comprehensive strategy to gas metering. It is working with Sensus to use the company's FlexNet advanced metering infrastructure to meet evolving needs in both the present and future.

As the case of The Energy Cooperative illustrates, mechanical rubber diaphragm meters might have worked for decades, but new ways of gas use demand technologies that are more cutting-edge.

SENSUS
639 Davis Drive
Morrisville, NC 27560 USA

ENGINEERING 360 MEDIA SOLUTIONS
201 Fuller Road, Suite 202
Albany, NY 12203-3621
Tel: +1 518 880 0200

ABOUT SENSUS

Sensus, a Xylem brand, helps a wide range of public service providers – from utilities to cities to industrial complexes and campuses – do more with their infrastructure to improve quality of life in their communities. We enable our customers to reach farther through the application of technology and data-driven insights that deliver efficiency and responsiveness. We partner with them to anticipate and respond to evolving business needs with innovation in sensing and communications technologies, data analytics and services.