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Ultrasonic Flow Meters:

Maintaining Performance in Unstable Conditions

More than 40 years after work began to develop ultrasonic flow meters to measure the movement of liquids through pipelines, the technology is being steadily more utilized. The technology's wide range of applicability is expected to further drive its adoption in the growing chemical and petrochemical industries as well as water and wastewater treatment sectors.

Growth across multiple industries is fueling the need for accuracy and reliability in measuring volumes of transported liquids. But the variability in product composition, viscosity, and pipelines present puzzles in finding the right technology. Difficulties in measuring crude petroleum products, in particular, are not new. When research began on application of ultrasonic flow technology for that task, the challenge was gaining the necessary acoustic resistance between pipeline product and ultrasonic transducers. This obstacle was surmounted when technology pioneers acoustically coupled ultrasonic transducers to various liquids. The impact was groundbreaking.

"That invention," Panametrics engineers wrote in a 2005 paper, "was the cornerstone of ultrasonic flow measurement…."

Other long relied upon measurement technologies pose an array of difficulties amid the rigors of pipeline operation. Turbine meters cause extra pipe line pressure drops requiring compressors to restore it. This results in increased operating cost. Rotors and bearings for turbine meters periodically must be replaced, making the meters vulnerable as those parts break down. Grit and other contaminants in liquids contribute to reduced accuracy.

Coriolis meters offer advantages over turbine meters. The devices are accurate and low-maintenance, with no internal moving parts. But the cons are significant. Relying on a sensor, transmitter, and bent tubes, the technology causes pressure drops, is expensive, and unwieldy on lines larger than 4 inches in diameter, and it is challenged under low density conditions. More than three-fourths of Coriolis meters are used on pipelines 2 inches in diameter or smaller.

Turbine and Coriolis metering technologies cannot meet the current demand with 239 active petroleum pipeline projects being tracked by the U.S. Energy Information Administration, which will transport record production in the United States. Laterals running from mainlines are made at diameters of 6 to 16 inches. Major interstate pipelines typically reach 48 inches with liquids flowing through at high pressure.

Rugged meters delivering the highest standards in accuracy are required for the essential job of measuring, and ultrasonic flow technology has a demonstrated record of meeting the need.

How Ultrasonic Meters Work

Ultrasonic flow meter technology, based on transit time measurement, tracks the time elapsed for ultrasonic pulses traveling a fixed distance between ultrasonic transducers. Mounted through valves into the pipeline, the transducers acoustically communicate with one another, meaning each receives ultrasonic signals transmitted by the other in the pair. Multipath ultrasonic flow meters increase accuracy by measuring the paths of multiple pulses simultaneously. A path refers to the track of an ultrasonic pulse as it travels back and forth across a pipe. Multipath ultrasonic flow meters feature three or more paths. This allows for measurement at more points in the flowstream, which boosts accuracy.

The time between the transmission and reception of pulses to and by the transducers is measured in both directions. If no liquid is flowing, the transit times in either direction is equal. If liquid is flowing, transit times in the direction of flow will be less than transit times in the opposite direction. The difference is proportional to the velocity of the flow.

Measuring high viscosity products with lighter hydrocarbons is difficult, but lower frequency transducers in ultrasonic meters can allow sound to travel through more readily. Meters equipped with powerful, high-speed electronics churning out reams of diagnostic data can ensure problems are identified earlier, resulting in maximum uptime and minimal maintenance.

While delivering high accuracy and high data volume, ultrasonic meters also deliver on the bottom line.

The devices have no moving parts and fewer limitations than other meters. Concerns common in other technologies are eliminated, including drifting, pressure drop, pipe restrictions, and meter maintenance. A single ultrasonic meter can measure flow through a large pipe. Other technologies require a metering station with numerous differential pressure meters to handle high flow in large lines.

Relying on the strength of their technology and the quality of their design and manufacture, ultrasonic meters handle high demand as well as the need for greater overall efficiency.

Validating Ultrasonic Meters

In 2005, Panametrics' Mike Scelzo, Steve Milford, Nick Mollo, and Jed Matson wrote: "Use of ultrasonic flow meters will continue to grow as users continue to become familiar with the technology and achieve success with its use."

Those words have proved true over the last 15 years as ultrasonic flow meters have emerged among the fastest-growing technologies for pipeline applications.

Meters should demonstrate the following attributes:

- ✔ **Accuracy:** The flow measurement provided by a meter can only be trusted if the meter can be successfully calibrated against a known reference. How closely the calibrated meter matches the reference is the accuracy of the meter. Ultrasonic flow meters with properly designed path configurations can meet the stringent accuracy requirements of custody transfer applications.

- ✔ **Repeatability:** The flow rate measurement must not only be accurate, but it must also be stable. Proper ultrasonic signal processing and modern electronics yield readings in very rapid succession that are consistent with the behavior of the fluid. If the fluid properties are stable, users can be sure the reported flow rate will also be stable and repeatable over time under the same conditions.

- ✔ **Turn-down Ratio:** The range of flow rates and fluid properties of many applications can be considerably broad. Petroleum products flow through a single pipeline can shift from heavy, viscous crude oil one day to low viscosity refined product the next. A high turn-down ratio means a single meter can accurately and repeatably measure large swings not only in velocity, the traditional meaning of the term, but also a wide range of Reynolds number.

Custody Transfer

Powered partly by spikes in oil and gas production in the United States' shale basins in 2019, more than 32,000 miles of pipeline were planned or under construction in North America at the start of this year, according to Underground Construction magazine. "[I]t's a pretty good time to be a pipeliner," the magazine's Jeff Awalt wrote.

Behind the trends, the work of extracting and moving resources is more daunting than ever, requiring transmission over vast expanses, varied terrain, and in vastly differing climatic conditions to get products to buyers.

Large terminals and refineries wait at the ends of the lines. But simply getting products to those places is not enough. Accurately measuring the amount of the product being moved is both difficult and essential.

Oil pumped from the earth varies widely in viscosity, from light crude at API gravity of 31 to heavy crude at API of less than 10. It's not just the ability to handle varying viscosity that matters. Pressure, temperature, flow rate and range, fluid composition, quality, accuracy, and redundancy all are critical considerations in finding the right meters.

Other technologies suffer under scrutiny for these attributes. Turbine meters with their various moving parts have been known to fail when faced with wide fluctuations in pressure, temperature, flow, and fluid composition and quality. Coriolis meters are impractical for large pipes.

Getting accurate measures as products are moved to customers is based on calibration and verification at the point of custody transfer. A variation of even tenths of a percent can translate to significant financial gains or losses on either side.

Ultrasonic metering at terminus points assures spot-on accuracy and consistent reliability in custody transfers.

The absence of moving parts means the meters do not degrade mechanically, providing a durable performance base that gives peace of mind to companies and customers alike.

Remote Flow Detection

The stakes are high for pipeline operators. When meters fail to deliver accurate measurements, they can trigger false alarms that send expenses needlessly soaring. Or they can fail to detect leaks, however small. Accurate measures are critical with revenue, the environment, and reputations all on the line. Add to all this the varying conditions inherent in pipelines.

When multipath ultrasonic flow meters are employed, operators get better visibility into their pipelines and more information for decision-making, which reduces risks. In addition, multiple measurement paths can cancel the effects of swirl (provided the paths are orthogonal to one other) and other flow disturbances resulting from viscosity change. Even in the face of poorly developed changing flow profiles, without flow conditioners, measurements can be accurate.

Using the right algorithms, ultrasonic flow meters do not require recalibration when fluids change, maintaining strong, reliable, accurate performance throughout.

Beyond accuracy, ultrasonic meters work faster, expediting the process of monitoring and analysis. That lowers downtime for yield management and asset protection. When there are problems, the meters provide valuable information to allow operators to act swiftly and decisively.

Sweeping technological improvements since Panametrics revolutionized ultrasonic flow has propelled the meters past competitors to the forefront of the market. Their accuracy, reliability, versatility, efficiency, and adaptability make them the smart buy for anyone seeking the highest standards in measurement.

But the strength of the concept must, as in any case, be equaled by the quality of the company producing them. When those two factors match, decision-makers know they are on the path to the right call when deciding where to invest money in measurement technology.

About Panametrics

Panametrics, a Baker Hughes business, has been a pioneer in the sensor technology industry for more than 50 years. With an innovative culture, we continue to develop solutions for moisture, oxygen, liquid flow, and gas flow measurement. Our proven technologies are widely known across many industries including, oil & gas.

Our Sentinel line of high-accuracy ultrasonic flow meters deliver custody transfer-level measurement, easy integration, rugged construction, and reliable performance – even in the unstable conditions of typical pipelines. To learn more about our Sentinel high-accuracy ultrasonic flow meters visit:

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