Clamp-on ultrasonic flowmeter improvements

Ultrasonic flow measurement technology offers a low-cost method to measure flow. The advantage of clamp-on ultrasonic flow sensors is installation without stopping a process to put a hole in a pipe to insert a conventional sensor.

By John Erskine, Michael Scoon, and Brian Sternberg

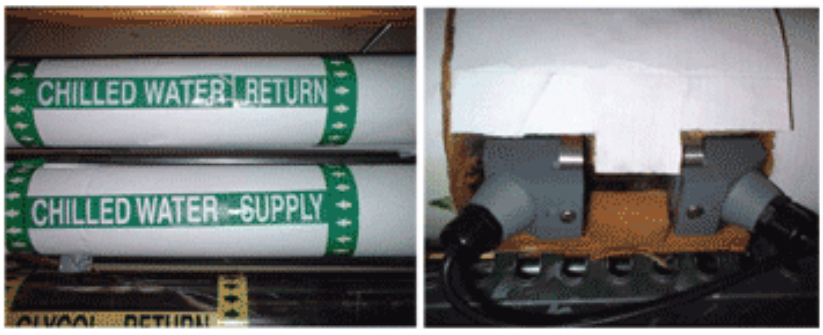
Two years ago, at a flowmeter presentation for a state-owned oil company in the Middle East, we led off with a tried-and-true technology: Differential pressure meters. As expected, this technology was well-known and fully accepted throughout the organization. As we went down the list of technologies in our portfolio, clamp-on ultrasonic meters met with a cooler reception: “No disrespect intended, but frankly we’ve tried everybody’s, and we could not get any to work …”

History

Since their introduction, clamp-on ultrasonic flowmeters have had a shaky reputation in the field of flow measurement.

Original models relying on the Doppler principle were often misapplied, as the promise of a noninvasive solution exceeded the limits of the technology. (Doppler meters were never suitable for clean liquids.) Experienced field people tell stories of installing the first ultrasonic meters near metropolitan areas, where the meter tended to behave more like an AM radio.

In the 1990s, transit time (“time of flight”) ultrasonic technology became widespread—a more robust solution was now available for clean liquid applications. However, this too was far from a panacea: Depending upon the make and model, users were still limited as to the levels of turbulence, straight pipe requirements, minimum fluid velocities, and overall accuracy at which the flowmeter could perform successfully. On the whole, despite relatively lower costs for installation and maintenance, clamp-on ultrasonic flowmeters have remained a second (or third) choice for process engineers around the world.



A set of clamp-on ultrasonic transducers mounted on a chilled liquid system.

Technology development

Ultrasonic flowmeter manufacturers have not sat idly by during this time; you may be surprised to learn just how far clamp-on ultrasonic technology has come. Today's clamp-on ultrasonic meter is highly advanced, making the technology well worth a fresh look by engineers and field instrumentation managers. Major improvements include data acquisition speed, speed of sound measurement, and digital communications.

As microprocessor technology continues to improve, so do the capabilities of the ultrasonic flowmeter.

As late as five years ago, most ultrasonic meters were making raw readings at a rate of less than 10 times per second. Today, this rate is poised to exceed 100 times per second. Such a vast improvement allows for substantial enhancements to performance in two critical areas—response time to changes in flow rate and more sophisticated data filtering. Manufacturers are leveraging these improvements into more accurate (and more repeatable) flowmeters that respond almost instantly to varying flow rates.

Transit time flowmeter accuracy is a function of fluid speed of sound measurement, and in this area manufacturers also have made major strides. Engineers have refined techniques to measure speed of sound on the fly, improving signal-to-noise ratios and on the whole pushing the envelope at which transit time technology can succeed. Improvements to sound signal transmission ("signal strength") further this cause, and today's transit time meters work on applications where they would have failed years ago—dirtier or gaseous fluids, thicker pipe walls, larger pipes, and applications with greater amounts of turbulence.

Over the past 15 years, transit time metering has continued to evolve, and now it includes multi-path technology that employs multiple wetted sensors. The sensor array, which can range from three to six paired sensors, takes several readings across the fluid stream (liquid or gas) and produces accuracies that meet government weights and measures standards. Multi-path ultrasonic flowmeters are widely used in custody transfer processes where line sizes exceed 4 inches, replacing Coriolis and differential pressure flowmeters, which have been the leading technology for many years.

Although these are in-line meters, they deserve special mention here to underscore the position that ultrasonic technology in general has secured.

Transit time liquid flowmeters have benefited from advanced microprocessor technology, in terms of greater accuracy and greater success rates out of the box.

Industrial communications

Finally, as with other flowmeter technologies, today's clamp-on ultrasonic meters feature a host of communication and software enhancements to make them compatible with advanced control systems: Digital communications such as Modbus and Ethernet IP; heat energy measurement calculations along with industry standard communications

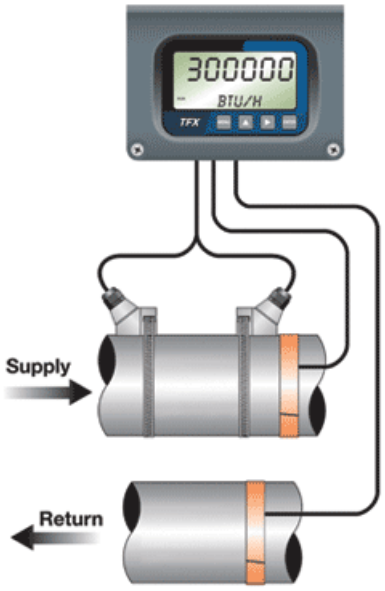
such as BACnet; and user-friendly meter programming and configuration via USB.

New applications

Clamp-on ultrasonic meters today are being utilized in new applications as well. Testing and monitoring of heat exchangers, radiators, and chillers is a growing application for ultrasonic flowmeters combined with energy calculation software. The meter is clamped around the pipes before or after the heat exchanger; high-accuracy RTDs (also available as non-invasive devices) are attached at the inlet and outlet. By measuring the flow and differential temperature, users can calculate the energy removed in BTUs [(Q*?T)/500]. Equipment efficiencies can be calculated as a baseline, and ongoing performance can be continuously monitored. When using a clamp-on ultrasonic meter over a mechanical technology, one need not be concerned with pressure loss, contamination, or impeding flows through the system. As engineers and operators become more concerned with managing energy and resources, ultrasonic meters become a strong choice to support these efforts.

There is always room for improvement, but clamp-on ultrasonic flowmeters have truly begun to deliver on their original promise with greater accuracy and reliability. Use of ultrasonic flowmeters has increased due to improvements and simple non-invasive installation.

Ultrasonic meters are worth new consideration for flow measurements.



An ultrasonic flowmeter utilized in energy flow application. One set of clamp-on ultrasonic transducers is mounted on the supply or return line; a clamp-on Pt1000 RTD is mounted on the supply and return lines. Measuring volumetric flows and the difference between supply and return temperature allows for calculations of heat energy usage.

ABOUT THE AUTHORS

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