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Three Dirty Little Secrets

About Coriolis Flow Meters

Ever since Coriolis flow measurement technology achieved mainstream appeal, industry has been fervently striving to take advantage of its benefits. And while Coriolis is clearly a highly advantageous solution for many crucial flow measurement applications, it is not without flaw.

What's so great about Coriolis?

Before we get into the dirty little secrets, let's discuss why Coriolis is such a highly regarded measurement technology.

Coriolis meters measure the actual mass flow moving though a pipe (pounds and kilograms), and thus are resistant to the external influences that can cause dramatic offsets in velocity-based flow measurement systems.

With Coriolis, pressure and temperature compensations aren't a consideration. A pound of cold fluid weighs the same as a pound of hot fluid, and concerns about how much room a substance takes up in the pipeline or the speed at which it is flowing are largely nonfactors with Coriolis measurement.

On the calibration front, mass flow and total mass units are not affected with variations in temperature and pressure, and Coriolis meters require no conversion factors. Since Coriolis meters are unaffected by varying flow profiles, users need not worry about straight-run piping before or after the measuring points. Coriolis simply does not care what the flow profile is, as a bucket of water and sand weighs the same whether the water is calm or swirling around with the sand all mixed up in it.

As if the aforementioned advantages were not compelling enough, Coriolis meters measure flow with accuracies of 0.1 percent of rate or better with repeatability, and they can also measure density, temperature, volumetric flow, and viscosity, if so equipped. So, the question arises, why would anyone use anything other than a Coriolis meter for flow measurement?

While Coriolis technology is widely accepted as the most accurate and versatile flow measurement system on the market, it is not without flaw. (123ducu/iStock)

There are flies in the Coriolis panacea

Dirty little secret no. 1:

The first barrier to Coriolis world domination can be summed up in a single word ... price. A one-inch line magnetic flowmeter and transmitter, for example, can be had for $3000 or less. A comparably sized Coriolis meter can run upwards of $9000 or more.

For those who have evaluated Coriolis meters in the past, this may be the not-so-secret dirty little secret.

Recently, however, more price-competitive Coriolis meters have come to market, with some even seeing prices nearing the territories of the foundation sensors they are replacing. These lower-priced Coriolis meters offer less accuracy, fewer features, and lack the robust displays of their higher-priced counterparts.

The availability of stripped-down Coriolis meters is a response to market demand for a price-sensitive Coriolis sensor. Strip out all but the most basic performance, and you get a good mass meter that does what a foundation sensor does for a small increase in price, but with huge gains in ease-of-use and performance.

Dirty little secret no. 2:

Another challenge faced by Coriolis flowmeters is one of process noise. Coriolis meters hate process noise. No matter if that noise is from a pump, a variable drive or just footsteps on a cat walk, noise can easily upset the precise measurement of a Coriolis sensor.

Since the Coriolis sensor is carefully monitoring and measuring micro-variations in the flow tubes' motion, the smallest of external vibration can be picked up and sampled, thus introducing an offset or error in the calculation.

The challenge for the Coriolis sensor is to maintain a high degree of sensitivity while at the same time metering in a sampling of protection from noise. The solution is a vast array of filters that can modify the digital signal or the analog outputs to present the desired nature of I/O.

Typically filters are used to slow or average the output signals to stabilize them. In more advanced states, the filters monitor a vast array of data produced in the modern Coriolis sensors and then use adaptive algorithms to learn and contour the output as required.

The benefit filtering can have on the usability of the Coriolis sensors is astounding. The cost, however, is in the expense these features add and, at times, in added complexity to use the sensor.

Dirty little secret no. 3:

Directly related to the issue of noise is the challenge of gas void fractions or dual-phase flow. Dual-phase flow is a condition that occurs when there is gas (or voids) entrained in liquid flows, or when there is liquid dispersed within a gas flow.

Initially, Coriolis sensors were susceptible to errors when flowing a dense liquid, such as water, entrained with slugs of lightweight air. When passing through the vibrating tubes of a Coriolis meter, these slugs had a propensity to stall the meter, which required it to be restarted. However, Coriolis technology has evolved over the years, and newer devices can easily handle entrained air while maintaining accuracy and repeatability.

What is causing concern for today's Coriolis meters is accuracy and repeatability when the percent of gas content is varying across the span of the meter.

Imagine a weigh scale with a weight on it ... The weight compresses the scale and the needle displays the weight (mass). If you lift the weight off the scale just a bit, then the scale loses its ability to measure the mass.

In a Coriolis meter, when a gas bubble is suspended in a liquid stream in the Coriolis tube and the bubble is not touching the walls of the tube, then just like the weigh scale, the Coriolis meter cannot effectively measure the mass. This is called decoupling.

The answer to this conundrum is not a simple one. Filters can be used, and adaptive algorithms can help assure the tubes maintain a controlled motion. Sensors can be employed to evaluate the nature of dual-phase flow and estimate or calculate the amount of mass that may have escaped measurement.

In the end, however, the nature of the dual-phase flow can have infinite variety, and the Coriolis sensors must rely on their programing to evaluate what is moving through the pipe. This often means flow values where gas content is varying across the span of the meter may only be representative of actual values, while other times that representation may be less than accurate.