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PROCESS INSTRUMENTATION

Two applications triggered **the rise of Coriolis flow measurement**

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Coriolis measurement has been adopted as a default technology in many application scenarios due to its high accuracy and immunity to process variables (temperature, pressure and flow profile). However, Coriolis wasn't always widely accepted. Two applications, in particular, helped what was once a nascent flow measurement technology gain a foothold in the marketplace.

A brief history of flow measurement

In the early days of flow measurement, the market relied primarily on mechanical flowmeters. These meters generally relied on a swept or known volume and the velocity of flow to generate a measurement. Most early-generation flow sensors worked similar to a container and timer. The timer began as the flow started and ended when the container was full. The volume of the flow was divided by the fill time to produce a flowrate.

As continuous flow became more commonplace, the technology evolved to support a system of continuous filling and emptying of containers, rather than just dumping the containers when full. In these flow measurement systems, volume, movement and time were joined together to produce a flowrate. These meters were simple and easy to service, not too costly, and, if properly maintained, offered good performance.

From here technology offered more developed electronic options, like pressure-based flow, and open-channel level, thermal mass, vortex, magnetic and inline non-contacting ultrasonic flow metering.

Each technology offered improvements in accuracy, reliability, repeatability and cost of ownership. Though each also had distinct advantages, there was not a single meter that was well suited to a broad array of applications. All these earlier meters were still hampered by being volume - and velocity-based. As such, any process variables that changed the volume – like temperature or pressure – or the velocity – like piping configurations or flow disturbances – were likely to cause errors.

Coriolis technology emerges

Early iterations of Coriolis flow technology were viewed with much skepticism in the chemical and oil and gas industries. Time honored flow and weight measurement methods were well understood and had been acceptable for generations. In the stoical industries of chemical and oil and gas, caution is called for when evaluating the need and advantages of any new technology introduction.

As Coriolis technology emerged onto the marketplace, it seemed to be too good to be true, boasting unprecedented levels of accuracy and application flexibility. Adding to the hesitance to adopt the promising technology, early Coriolis sensors were significantly more expensive than the currently accepted technologies.

Nevertheless, Coriolis started to win fans in the chemical industry, as trial installations proved out the value of Coriolis meters with accuracy performance that far surpassed any measurement method that had been used before. For critical flows with high-value materials that had to be accounted for precisely, Coriolis established itself as a cost-effective answer. In applications where the value of the measured fluid may not have been significant, but where the precise measurement of that fluid as an additive was significant to the overall success of the application, Coriolis was also earning a place as a valuable measurement method.

In the oil and gas industry, the requirement of precision and repeatability was not as critical in the heady days of the petroleum business. Profits were high, markets were secure, and recovery, transport and processing of the product were handled acceptably by time-honored measurement methods.

However, from the 1970s on, the value of petroleum products has risen precipitously, and the increase in governmental regulation started to drive accountability the need for a better way to measure flowrates was needed. During this time frame, Coriolis sensors were undergoing significant improvements.

The oil & gas industry has been a steady adopter of Coriolis flow measurement due to the inherent flexibility the technology offers in a variety of application scenarios. (pixinoo/iStock)

Coriolis accuracies increased, as did features with the ability to measure densities and temperatures along with increased robustness and stability. Coriolis meters now could measure gases as well as liquid fluids.

In addition, the presence of gas voids in the liquid flow stream no longer crippled the flow measurement. The addition of complex noise filters and algorithms to mitigate process noise further increased the value of Coriolis flow. The American Gas Association approved the use of Coriolis flowmeters for custody transfer of natural gas. The American Petroleum Institute has also approved Coriolis for custody-transfer applications. The approvals enabled Coriolis to be used for fiscal metering, cementing its place as one of the premier measurement technology in both the petroleum and chemical businesses.

Coriolis advantages for chemical processing

For chemical manufacturers, Coriolis sensors offered relief from the constant adjustment and tweaking required with many volumetric flow sensors, where flow accuracy was conditional on the temperature and pressure of the flow. Faced with the constant limitations, adjustments and requirements of volumetric flow sensors, the chemical industry saw Coriolis sensors as a potential cost reducer, as they offered the opportunity to increase uptime and reduce startup and service costs.

In addition, many chemical processes are dependent on mass measurement for their recipes. Since Coriolis meters deliver mass as well as density measurement insitu, they were seen as an ideal fit for many chemical process applications.

While volumetric data can be used to derive mass flow, ultimately the data has to be converted, adding the chance for variation or error in the measurement. Such errors come about if the conversion's contributing factors, like temperature, pressure or density, are variable. These factors are typically set and do not have the ability to adapt to the process changes.

> 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 precision measurement of a Coriolis sensor.

Coriolis flow sensors are essentially just pieces of pipe added to the process, and there is nothing, or very little, protruding into the flow stream. This means there is no interference in the flow to disturb the process. This reduces pressure loss, allows for easy sensors cleaning, and can offer a very small package, which requires very little realestate to do its job. All of these factors added to the early success of Coriolis in chemical processing applications.

Coriolis advantages for oil and gas

The oil and gas industry has been a steady adopter of Coriolis due to the inherent flexibility the technology offers in a variety of application scenarios. On the exploration and production side of the industry, sensors are used to precisely dose process fluids and slurries at drilling sites. Coriolis offers both mass measurement and density measurement to assure the quality and the quantity of the flowrates being delivered.

Petrochemical flows coming up from the sites also have to be measured for quantity and quality. Water and gas content must be measured and, once separated; the oil or gas custody must be transferred to a holding area or a transport system, such as a pipeline, rail or truck. Custody transfer, or fiscal metering, is custom tailored for Coriolis flow measurement, as the technology provides industry-leading accuracy and relative immunity to errors from changes in fluids, temperatures, pressures, etc. At a fundamental level, Coriolis meters often serve as the cash registers of the oil and gas marketplace.

On the processing side of the oil and gas industry, Coriolis benefits are the same as in the chemical world. With critical accuracies in density, temperature and mass and volume measurement, Coriolis offers stable, reliable performance. A key application in this area is concentration measurement, where Coriolis sensors reveal fluid concentrations or fluid properties via the real-time fluid density measurement. So, if a process requires fluid density to be X.X g/cc, a Coriolis sensor can provide updates as fast as every 10 milliseconds. This same data can provide data about the concentration of solids or percent of mixture between two different fluids moving through the flow sensor, such as water mixed in produced oil.

While Coriolis flow sensors are used in a wide range of industries to support many applications, chemical, and oil and gas were among the technology’s earliest adopters. Over the years, Coriolis has proven extremely valuable in these industries and continues to gain traction as a go-to flow measurement solution.

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