By Jesse Yoder, Ph.D. & Belinda Burum

Custody Battles

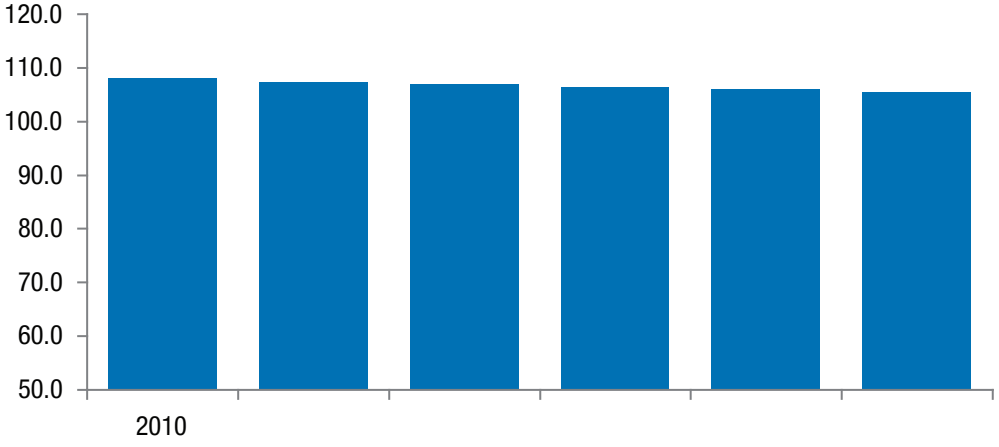
Positioning for Market Share In Custody Transfer of Oil & Gas

Custody-transfer measurement of oil and gas is becoming an increasingly important topic for both suppliers and end-users in today's energy-hungry world. The price of a barrel of crude oil has risen to over $100 per barrel. And even though natural gas prices haven't risen to the same degree as oil, the search for natural gas has gained importance with the increase in oil prices. Natural gas is now widely seen as a cleaner and less-expensive alternative to oil as an energy source. At the same time, new drilling technologies have made it possible to extract natural gas from many new locations beneath the earth.

Custody transfer occurs as a product changes ownership from one person or company to another. A typical example of custody transfer in flow measurement occurs when a natural gas production company sells natural gas to a utility or gas distribution company. The point of transfer is at a metering station that includes highly accurate flowmeters and an appropriate amount of upstream and downstream piping. Other equipment may include flow computers, analytical equipment, and pressure and temperature transmitters.

Even though custody-transfer flowmeters are sometimes sold as standalone items, they are also sometimes sold as part of a larger system incorporating multiple instruments. In many cases, the instrumentation comes mounted on a skid, which can be transported directly to the point of use. A similar concept is that of a meter run, which is familiar to suppliers and end-users of differential-pressure (DP) flowmeters using orifice plates. A meter run includes a DP flow transmitter, an orifice flange assembly, and upstream and downstream piping. Like a metering skid, a meter run is sold as a completed system that is ready to begin operation when it is taken to a custody-transfer location.

Shipments of Turbine Gas Flowmeters Worldwide: 2010 to 2015 (Millions of Dollars)



Source: The World Market for Gas Flow Measurement, 2nd Edition (Flow Research, June 2011)

The Role of AGA In Custody-Transfer Measurement

Metering skids and meter runs are typically used when high measurement accuracy is required. The three types of flowmeters most commonly incorporated into these metering skids or stations and meter runs are differential-pressure, turbine, and ultrasonic flowmeters. This has a lot to do with approvals issued by the American Gas Association (AGA, aga.org). The AGA has studied custody transfer extensively and has run many tests in custody-transfer situations using different types of flowmeters. This knowledge has been incorporated into a series of reports that essentially lay out the criteria for acceptable custody-transfer measurement.

The first AGA report was called AGA-1, and it was issued in 1930. AGA-1 dealt with the use of DP flowmeters with orifice plates used for custody transfer. This was the ancestor of what is today known as AGA-3, a report that was first released in 1955, then reissued in 1992. An approval for the use of turbine meters for custody transfer did not come until 1981. This report was called AGA-7, and it was reissued in 2006.

AGA's approval for the use of ultrasonic flowmeters for custody transfer did not come until 1998 in a report called AGA-9. This mainly has to do with the evolution of ultrasonic technology. Even though ultrasonic flowmeters were first introduced commercially in 1963, it took many years for the technology to evolve into the highly accurate and reliable meters of today. Initially, much ultrasonic technology was in clamp-on form, and many end-users did not fully understand how position the transducers correctly or the impact of bubbles and impurities in the flowstream on the measurement. Eventually, inline transit-time flowmeters were developed with wetted transducers that could be placed directly in the line. This eliminated the uncertainty that the pipe wall introduced for clamp-on meters and made possible a more stable and accurate measurement. This paved the way for the development of multi-path ultrasonic flowmeters.

In 1995, a group called Groupe Europeen de Recherche GaziSres (GERG, *gerg.info*) published Technical Monograph 8, which laid out the criteria for using ultrasonic flowmeters for

custody transfer. This publication laid the groundwork for AGA-9, published subsequently in 1998.

Turbine Flowmeters

When AGA-7 was first published in 1981, turbine meters were "the new kid on the block." Their main competitor for highly accurate flow measurement was the differential-pressure meters using orifice plates. These meters had been in use for 50 years or so.

Turbine meters offer significantly more rangeability than orifice-plate meters, and in many ways their measurement is more stable than that of DP flowmeters. Turbine meters use a rotor that spins in proportion to flowrate, but they do not require the use of a primary element, such as an orifice plate, like DP flowmeters. Orifice plates are subject to wear, can be knocked out of position, and are even sometimes installed backwards. Orifice plates are inexpensive, but they introduce an element of uncertainty that is not present with turbine meters.

After the publication of AGA-9 in 1998, it took a number of years for ultrasonic meters to really take hold for custody-transfer applications. During this time, turbine meters have been able to maintain their wide usage for gas flow applications. One reason is that they have some advantages over ultrasonic and orifice-plate meters. Turbine meters have a significant cost advantage over ultrasonic meters, including in the larger line sizes. Their price may also compare favorably to differential-pressure flowmeters, especially in cases where one turbine meter can replace several DP meters due to the wider rangeability of turbine meters. Users who are already familiar with turbine technology and don't want to spend the extra money required to invest in a new technology are likely to stay with turbine meters.

During this time, turbine meter suppliers have continued to improve their technology, making them more reliable and competitive with ultrasonic meters. Some of these improvements involve making the moving parts themselves more reliable. By making the ball bearings out of more durable material, such as ceramic, turbine suppliers have been able to add significantly to the life of the bearings. This is important, since some customers select new-technology meters over turbine meters because turbine meters have moving parts. Other important improvements address uni-directionality, pressure drop, fouling, the need to lubricate turbine meters manually, and other traditional turbine issues.

Three years ago, Elster (*elster.com*) launched the first bidirectional turbine meter, the SM-RI-2. According to Elster, the pressure drop of this meter can be half that of conventional turbine meters. The Elster turbine meter is auto-lubricating, and has a flow capacity that matches ultrasonic gas meter capacities for the

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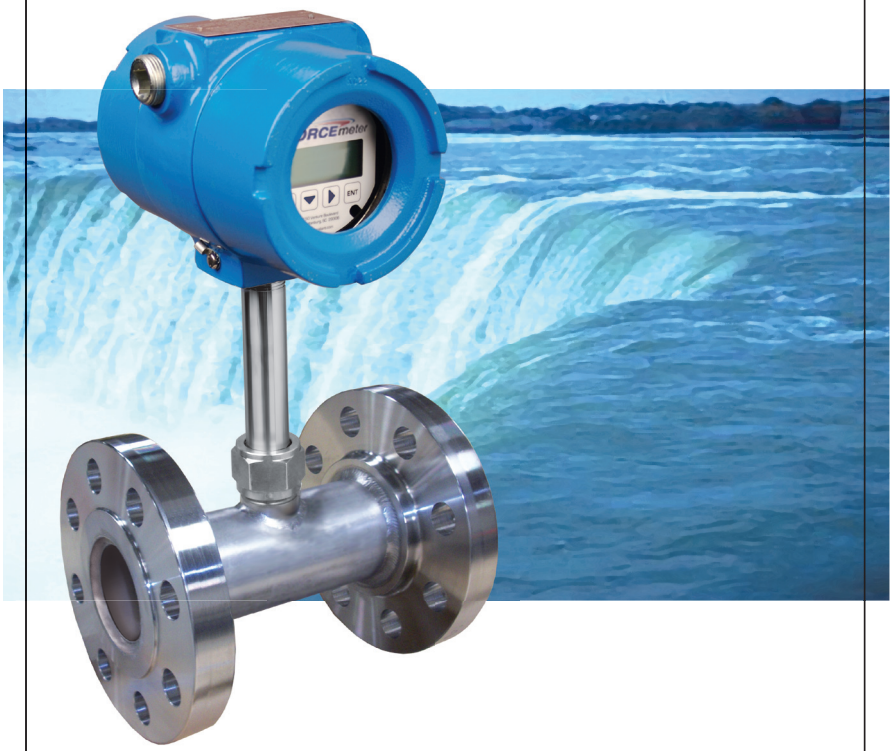
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same size. Elster claims its TurbinScope diagnostic tool is a breakthrough for examining performance under real operating conditions, without removing the meter from the process. The analytical package can discover misreading due to installation effects, turbine blade damage, and bearing damage, and other problems specific to turbine meters such as spindown.

Cameron (*c-a-m.com*) offers the NUFLO gas turbine meter that features a carbide bearing and does not require lubrication. It has a pulse output that can serve as input to readout devices that compute flowrate and accumulated throughput. The meter has a low inertia rotor that is designed to be sensitive to gas flow. Low-cost precalibrated replacement turbine cartridges are available for servicing.

IDEX/Faure Herman's (faureherman.com) HELIFLU turbine flowmeters use a helical blade technology that makes them insensitive to density and viscosity, allowing them to measure higher viscosities than traditional meters. According to Faure Herman, its titanium rotor is more mechanically robust and lighter than stainless steel. The HELIFLU is designed for liquid applications, including liquid petroleum gas (LPG).

Honeywell/RMG (*honeywell.com*) offers the TRZ 3 for measuring the flow of industrial gases, such as nitrogen, carbon dioxide, and propane. Gas can flow either vertically or horizontally. Rotor materials include either delrin or aluminum alloy.

Ultrasonic Flowmeters

Initially, the main suppliers of ultrasonic flowmeters for custody transfer of gas were Elster-Instromet (*elster-instromet.com*) and Emerson Daniel (*daniel.com*). FMC Technologies (*fmctechnologies.com*) also introduced a custody-transfer ultrasonic meter. More recently, SICK (*sick.com*) has gained significant presence in this field, and now KROHNE (*krohne.com*) has joined the fray. All these companies have been active in developing new products at the same time the turbine meter companies were developing their own enhanced products. Elster is a leader in both the ultrasonic and turbine markets.

Emerson Daniel also offers turbine meters for gas flow measurement, but Daniel focuses more on liquid hydrocarbon applications than on gas for its turbine meters. Daniel introduced its 3812 ultrasonic meter for non-custody transfer in May. The meter combines improved electronics with advanced digital signal processing to make the flowmeter less sensitive to changes in the flow profile, and also less sensitive to solids or entrained air. According to Emerson Daniel, these improvements result in more accurate, reliable, and stable flow measurement.

In the area of ultrasonic custody transfer of natural gas, Emerson Daniel's main product is the SeniorSonic flowmeter. This is a four-path ultrasonic flowmeter designed for high-accuracy applications.

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The accompanying Mark III electronics provide extremely fast data processing. All transducers are sampled 32 times per second, and the measurement is updated every ¼ second. Daniel also offers the JuniorSonic ultrasonic flowmeter for non-custody transfer applications.

SICK Maihak's FLOWSIC600, the company's "new generation" of ultrasonic gas flowmeters features a compact design with extractable transducers and bi-directional measurement. This meter features sealed, titanium transducers that operate at three different frequencies. As a result, the FLOWSIC600 can measure a wide variety of types of gas, including wet gas and dry gas, as well as corrosive or intrinsically noisy gas. In addition to its custody-transfer meters, SICK offers a range of ultrasonic meters for different applications, including check metering, allocation metering offshore, and metering of industrial gases.

The most recent product release in this field is Elster's Q.Sonic Plus. This meter was developed by a virtual 40-man team over a 2.5-year period and announced in North America in May 2011 at the AGA Conference in Nashville, Tenn. It contains a symmetrical layout of four swirl paths with double reflection and two single-reflection paths, for a total of six paths. This configuration gives it the ability to measure swirl and makes it sensitive to changes in flow profile. The Q Sonic Plus meter is designed for gas transmission lines, including shale gas, and can operate with both upstream and downstream applications.

A False Dilemma?

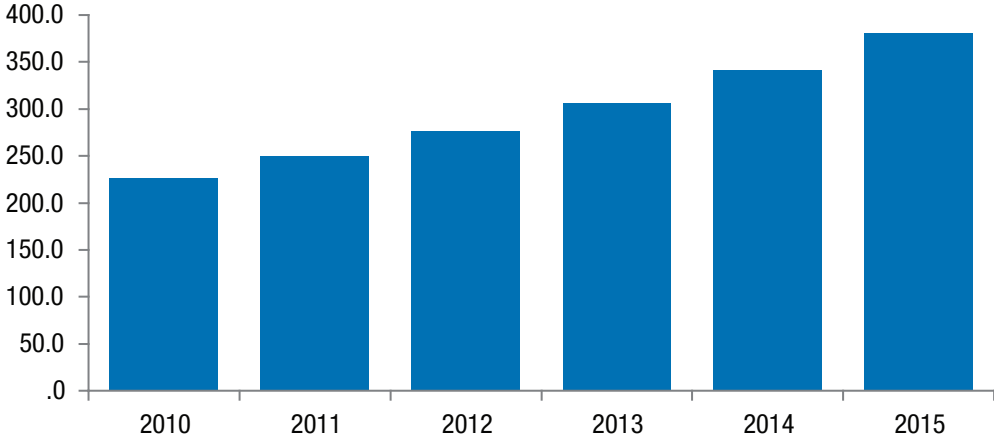
For those who feel they must choose between turbine and ultrasonic flowmeters for high accuracy measurement, Elster offers a third alternative – ultrasonic and turbine. Elster has introduced a configuration in which turbine and ultrasonic flowmeters are combined in series. This arrangement provides online comparison of two independent measuring principles. By combining the two meters, diagnostic capability is greatly enhanced and redundancy is increased. There is some debate about which meter should come first and which one should be second, but this only adds to the interest of this novel solution.

Ultrasonic Meters Still Have the Upper Hand

Despite all the improvements in turbine meters over the past 10 years, ultrasonic flowmeters still have the upper hand in the battle for custody-transfer supremacy. Ultrasonic flowmeters have no moving parts, virtually no pressure drop, are highly reliable, extremely accurate, and provide a stable measurement. Turbine meters can also achieve very high accuracy, but they still have significant pressure drop and also have moving parts.

Further evidence that ultrasonic flowmeters have the advantage was provided by oil and gas producers in the Middle East who were interviewed onsite by Flow Research about their use of flowmeters for custody-transfer applications. While these companies were still buying turbine meters for replacement purposes, they were nearly unanimous in specifying ultrasonic over turbine flowmeters for new projects. In the end, it is the end-users who will decide who wins this battle, and as of now the end-users are voting for ultrasonic flowmeters. FC

Shipments of Ultrasonic Gas Flowmeters Worldwide: 2010 to 2015 (Millions of Dollars)



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The content of this article is based in part on a new series of studies by Flow Research titled "The World Market for Gas Flow Measurement, 2nd Edition." For more information on these studies, visit www.gasflows.com.