Custody transfer of natural gas: cooperation leads to success

AGA and API helped make it possible, and suppliers responded with flowmeters that conform to standards

By Jesse Yoder, Ph.D.

Custody transfer is flow's fastest growing application, with the possible exception of multiphase flowmeter applications, which also tend to be oil-and-gas related. Custody transfer occurs when a fluid's ownership passes from one entity to another. The need for custody transfer should be fairly obvious. The exploration and production (E&P) company is typically not the same as that which delivers to end-users.

Multiple custody-transfer points occur along the way, as gas travels in many cases thousands of miles from source to destination. In these cases, the E&P hands off to a gas distribution company. The distribution company then sells the gas to a utility that distributes it to individual buildings and homes.

The main flowmeter types used for natural-gas custody transfer are:

- Differential Pressure (DP) with primary elements
- Turbine
- Ultrasonic
- Coriolis

Because natural-gas custody transfer is such an important transaction, involved parties abide by objective criteria that determine how the transfer takes place. In the United States, these criteria are mainly determined by the American Gas Association (AGA) and the American Petroleum Institute (API). The AGA in particular has the lead in publishing reports governing natural-gas custody transfer, using different types of flowmeters. Given the different technologies involved, distinct reports exist for each type of flowmeter used.

DP flowmeters with primary elements

The history of DP flow measurement goes back to the late 1800s. Max Gehre received one of the first patents on orifice flowmeters in 1896. The first commercial orifice-plate flowmeter appeared in 1909, and was used to measure steam flow. Shortly thereafter, the oil-and-gas industries began using orifice-plate flowmeters due to ease of standardization and low maintenance. In 1912, Thomas Weymouth of the United Natural Gas Co. did experimental work on measuring natural gas using orifice flowmeters.

Increased orifice meter use captured the attention of several engineering organizations, including the AGA, API and the American Society of Engineers (ASME). The National Bureau of Standards (NBS) also got involved. In 1930, a joint AGA/ASME/NBS test program generated a coefficient-prediction equation based on extensive tests. In 1930, the AGA issued its first report, AGA-1, on use of DP flowmeters with orifice plates for custody-transfer purposes.

In 1935, tests performed at Ohio State University in conjunction with the National Bureau of Standards were the basis for flow equations used by AGA and ASME since then. As a result, the AGA published its second report on orifice-plate metering, AGA-2.

Work in the United States was combined with that in Europe in the late 1950s, and resulted in the issuance of ISO Standards R541 for orifices and nozzles and R781 for Venturis. A third AGA report on orifice metering for custody transfer, called AGA-3, was published in 1955 and reissued in 1992.

Turbine flowmeters

Turbine flowmeters are widely used for liquid and gas flow measurement. One early use was to measure fuel on World War II military planes. A decade later, the gas industry had come to accept them for gas flow measurement. In 1981, the AGA issued its report, "Measurement of Fuel Gas by Turbine Meters." Since then, turbine meters have been widely used for gas-flow measurement, including custody-transfer applications. They are also widely used to measure liquid flows, including both water and hydrocarbon flows.

Turbine meters have a spinning rotor mounted on bearings in a housing. The rotor has propeller-like blades that spin due to the current force as a fluid passes over it. Flow rate is proportional to the rotor's rotational speed. Different means can detect rotor speed, including a mechanical shaft and an electronic sensor.

Ultrasonic flowmeters

The ultrasonic flowmeter market grew rapidly the past several years and the single most important reason is use of multipath ultrasonic meters for natural-gas custody transfer. The initial surge began in 1995, when Groupe Europeen de Recherches GaziSres (GERG), published Technical Monograph 8 — Present status and future research on multipath ultrasonic gas flowmeters. This technical document laid out criteria for instruments that measure natural-gas flow for custody transfer. Its publication gave a major boost to sale of multipath ultrasonic flowmeters for natural gas in Europe.

After the GERG document appeared in Europe, ultrasonic suppliers worked with AGA to obtain approval of a similar document in the United States. AGA-9, published in June 1998, lays out criteria for natural gas buyers and sellers when using ultrasonic flowmeters for natural-gas custody transfer. Its publication again increased sales of multipath ultrasonic flowmeters. This trend continues today.

Ultrasonic flowmeters also measure process and flare gas. Ultrasonic meter use for gas flow measurement evolved substantially from the late

1970s when it was first attempted. Use of wetted sensors means greater accuracy. Insertion meters measure flare gas in stacks, and ultrasonic flowmeters are used widely in the chemical and refining industries. While the growth of ultrasonic meters to measure process and flare gases is not as rapid as that of multipath meters for natural-gas custody transfer, it is still an important factor in the overall growth of ultrasonic meters.

Coriolis flowmeters

The AGA approved a report on Coriolis flowmeter use for natural-gas custody transfer in 2003. This report is called AGA-11. Even though it often takes some time for end-users to adopt a new technology, this report has provided a significant boost to the use of Coriolis flowmeters for natural-gas flow measurement.

The API issued a draft standard titled, "Measurement of Single-Phase, Intermediate, and Finished Hydrocarbon Fluids by Coriolis Meters," added to the API Library in July 2012. A second draft standard called "Measurement of Crude Oil by Coriolis Meters" has also been approved by the API.

More than any other meter, Coriolis meters have line-size limitations. Due to the nature of the technology, Coriolis meters get large and unwieldy once they reach the 6-inch size. Even 3-inch and 4-inch meters are quite large. Over 67% of Coriolis meter revenues are 2 inches in diameter or less.

Despite the challenges involved, suppliers in the past several years have manufactured Coriolis flowmeters for line sizes of 8 to 16 inches. Rheonik (now owned by GE Measurement) has long had large-line-size Coriolis meters. Now other companies have Coriolis flowmeters for line sizes above 6 inches, including Endress+Hauser, KROHNE and Micro Motion.

Endress+Hauser and Micro Motion mainly have bent-tube meters, while KROHNE's large size meters are straight tube. While the straight tube meters are long, they are less bulky than the bent tube meters of the corresponding size. Currently Coriolis meters are available for 8, 10, 12, 14 and 16-inch line sizes. Most of these meters are aimed at the custody-transfer market for oil & gas applications.

Custody transfer plays an important role in flow measurement. By its means contracting parties find mutually agreeable conditions for transferring fluids ownership from one to another. The work of AGA and API helped make it possible, and suppliers responded with flowmeters that conform to AGA and API requirements. That led to users having custody-transfer applications. Cooperation among agencies, suppliers and end-users has helped make custody transfer among the fastest growing flowmeter markets.

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