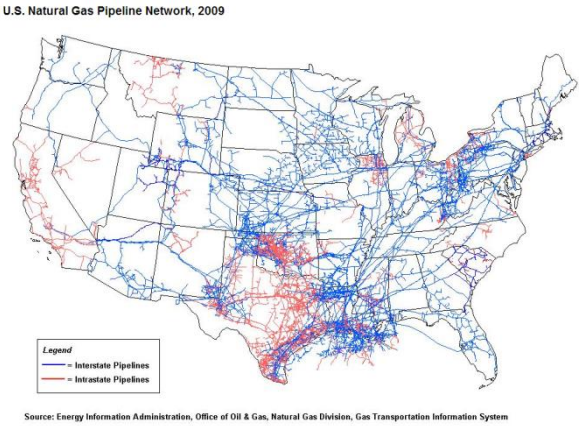
Highly Accurate Metering for Natural Gas Pipelines

By Robert McDavid
Source: Turbines, Inc.

With 2.4 million miles of distribution and transmission pipelines across the United States, natural gas stakeholders face an on-going and significant challenge to determine accurately and reliably what is flowing through their networks. Within that system, there are more than 17,400 points of transfer, including those between the producer and the pipeline company or the pipeline company to local distribution providers and end-users (commercial, industrial, residential, and energy generation) – the latter of which represent the majority of these transfer points.



An important part of this infrastructure is the expansion of pipelines from thousands of drill sites to mainline pipelines. Retrieving this gas – as opposed to flaring it – is essential to further reaping the economic benefits of natural gas volumes in shale and fracking plays throughout the U.S.

Gas Measurement

In order to measure the flow of gas throughout the distribution network, gas metering stations are located at strategic points to provide information on the quantity and composition of the gas within the pipeline. The gas metering stations determine the energy content in the gas, compounds mixed into the gas (e.g. hydrogen sulphide), water content, and flow rate. Volumetric measurement is, perhaps, the most important function of the gas metering station. Without it, energy content could not be accurately determined locally thus leaving the financial value of the gas in question.

Unlike the main distribution network, there is growing need for "midstream infrastructure" that increases pipeline capacity and reach to drilling sites that are currently using tankers or railcars to transport the gas and oil.

According to the Interstate Natural Gas Association of America (INGAA), at $5 to $6 per million British thermal units (MMBtu), gas prices are "sufficiently high to encourage substantial gas supply development, but not high enough to limit market growth…. this growth, when combined with regional shifts in supply and demand over time, creates a positive environment for midstream infrastructure development.[1]"

The same concern for a lack of infrastructure also applies to flaring, where the financial loss of burning instead of capturing the gas is important to the land owner and the environmental impact a concern to local and national

[1] http://www.ingaa.org/File.aspx?id=21498

regulators. The lack of available pipelines and constraints on existing pipeline capacity are the two most significant factors for flaring.

In North Dakota, flaring accounts for nearly 28% of total U.S. flaring[2]. Certainly, some portion of this flaring activity can be captured into the pipeline as infrastructure matures in these remote areas. However, some flaring activity will always occur, particularly in test wells, though tough restrictions are being sought to constrain flaring from wells that are not connected to gas-collecting systems. The reduction of flaring, extension of pipeline infrastructure to remote plays, and steady climb in natural gas prices are making the economics of accurate volumetric measurement very attractive.

With annual consumption of more than 25 trillion cubic feet[3], the inability to capture this gas is compounded by the smallest miscalculation due to a systematic error in the meter or uncertainty in the calculation of actual flow rate. This will have a significant impact on stakeholders throughout the supply chain – equally from a revenue and expense perspective. The potential enormity of the delta between the profit and loss makes it imperative that the most accurate flow measurement technology is used at all critical junctures in the distribution network, including those that providing access to gas that's currently wasted.

Metering Technology

Flow measurement technologies typically used on gas metering stations include ultrasonic, orifice, and turbine flow meters, depending upon the requirements of the producer or pipeline company.

Among all the commonly used metering technologies available in the market, turbine meters are inherently better suited and the most economical for measuring and monitoring gas flows at the drill sites and at non-custody transfer applications than competing technologies. While orifice meters also provide accurate flow information, they can be expensive to maintain due to the measuring of the bore edge portion of the meter that changes over time, thus necessitating frequent replacement of the plate. Typically, orifice meters are used for line sizes between 2" to 12", and are often found in the transmission portion of the network; whereas, turbines are typically found in the distribution and midstream portions of the network, which utilizes small diameter pipes ranging in size from ½" to 2". Smaller diameter pipes used in these situations are significantly less expensive to build than mainlines – ranging from $20,000 to $70,000 per inch-mile, as opposed to $155,000 for larger diameter piping[4]

Turbine meters are ideal for pipeline monitoring and metering requirements at flows ranging from 200 – 300 million cubic feet/day (m3/day) to higher volumes of approximately 2,000 m3/day, which is typical for offloading gas to pipelines. At lower volumes, the investment in a custody transfer or fiscal meter is prohibitive, and most likely unnecessary for the needs of the producer.

Industrial-strength gas turbine meters often consist of an axial stainless steel rotor, mounted on stainless steel shaft and shielded ball bearings, which spin within the body of the meter. Gases flowing through the meter spin the rotor at a rate that is directly proportional to the flow rate of the gas moving through the pipe – with higher flows leading to

[2] http://northdakotapipelines.com/natgasfacts/
[3] http://www.eia.gov/totalenergy/data/monthly/pdf/sec4_2.pdf
[4] http://www.ingaa.org/File.aspx?id=21498

higher speeds. As the rotor spins, a magnetic sensor mounted directly above it in the housing picks up its speed by counting the rate at which each rotor blade passes beneath it.

Turbine meters can also be custom designed to fit varying applications, using a variety of materials selected for the particular temperature, pressure, flow rate, and flow medium requirements of each application. Materials are selected for durability, corrosion resistance, piping requirements, and value.

In addition, gas turbine meters can maintain standard accuracy across a specified flow range of no less than +/- 1.0%, repeatability of +/- 0.1%, and linearity of +/- 1.0 % (density dependent). Depending upon its location and seasons, gas turbine meters can work under operating conditions of -100°F to +300°F. The ACFM range of turbine meters depends upon the line size, but generally is between 0.5 to 250 ACFM, which equates to 21 to 10,195 m3/day.

While Turbine meters are available from a number of manufacturers and distributors, not all of them are created with precision manufacturing and verifiable calibrations. Partnering with a trusted turbine meter supplier is of paramount importance because the quality, reliability, accuracy, and longevity of the metering solution require a commitment to full-service design, manufacture, calibration, and ongoing service.

As mentioned previously, faulty or inaccurate measurement can have enormous financial implications. Therefore, it's of the upmost importance that a gas utility company insists upon receiving independent calibration for each meter. With in-house and third-party verification, manufacturers of high-quality meters can provide a unique *K*-factor[5] pertaining to each meter. (This is an essential because the *K*-factor is a reference for which flow monitors are adjusted in order to assure that the specific accuracy is actually obtained while in service.)

An important part of this process is the replication of field-conditions with laboratory calibration equipment. By conducting this exercise, turbine manufacturers can provide a highly accurate, NIST traceable calibration certification that demonstrates the true performance and useable flow range of each individual meter.

Effective Monitoring

Highly accurate metering must be accompanied with a local monitor to accurately compute and display the corrected volume of gas going into the distribution network or being flared off. Monitors must be able to receive temperature and pressure information in order to continuously calculate the effect of gas compressibility on computed volumes.

Real-time correction for pressure and temperature has an immediate impact on the accuracy of the flow measurement. Flow monitors can calculate the compensated flow based upon these factors, which improves the accuracy of the metering system.

Local monitoring on drilling sites where power comes from on-site generators means that flow monitors must be battery-powered with months of accurate uptime. The flexibility to not require an electrical connection also saves cost as lines don't need to be run from the power plant to the meter.

[5] The *K*-factor is an expression of the number of output pulses recorded by the flow meter per engineering unit of volume flow passing through the meter. A unique K-factor is documented by means of NIST-traceable factory calibration.

Conclusion

Investment in competitively priced precise flow measurement technology, like a turbine metering system with a compensated flow monitor, has quantifiably positive implications throughout the pipeline network. As downward pressures on natural gas prices mount, pipeline companies and utilities need accurate and economical solutions to the metering challenges they face. A properly calibrated and compensated turbine metering system can deliver accurate gas measurement over a broad flow range while maintaining system integrity, safety, and accurate revenue generation.

About the Author: Robert McDavid is the Director of Global Sales Strategies for Turbines, Inc. Turbines, Inc. serves a range of industries and applications, from oil and gas, to cryogenic liquids, to custody transfer. Turbines, Inc.'s high-quality products, fast and reliable order fulfillment, and commitment to customer and technical support, have made them an industry leader in reliable flow metering.