Options for measuring natural gas flow

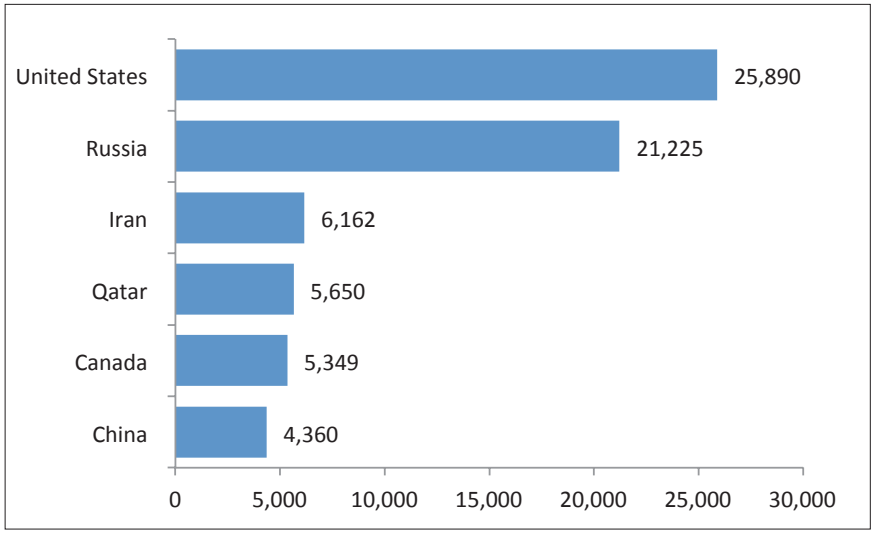
The use and measurement of natural gas is growing as environmental concerns increase

Global warming and the world's emission of fossil fuels has become such a critical issue worldwide that most countries are trying to reduce their greenhouse gas emissions and also search for renewable sources of energy. For many years coal and oil have been the dominant sources of energy in many countries. While Asia, including China, does not have nearly the amount of oil and gas compared to the Americas, Europe, and the Middle East, it does have vast amounts of coal. Though coal is a relatively inexpensive source of energy, it is also one of the worst sources of pollution. Coal is made mainly of carbon, and burning it produces carbon dioxide.

Burning oil also produces carbon dioxide and other greenhouse gases. This has led to government restrictions in the US and other countries, especially on the emission of carbon dioxide, methane, nitrous oxide, and ozone. The Paris Accord represents a worldwide attempt on the part of 197 countries to keep the global rise of temperature this century to less than two degrees Celsius below pre-industrial levels. While the United States initially joined the Paris Accord, President Donald Trump has announced his intention to withdraw the United States from this international agreement.

Coal, oil, natural gas, nuclear, and renewable energy sources are all sources of energy to power industrialised societies. They are all used as sources of energy for power plants, and most vehicles run on gasoline, which is a refined fuel. The harm caused by the collective burning of fossil fuels worldwide was not understood for many years and by the time it came to be understood, much of the damage to the earth's ozone layer had already been done. This is somewhat like smoking in the 1950s and 1960s. By the time medical science fully appreciated smoking as a cause of lung cancer, many people had already practiced this habit for years.

The effects of global warming are all around us. The polar icecaps are melting, the average temperature of the oceans is rising, and abnormally violent weather has become commonplace. Global warming is viewed by many as the most



Top natural gas producers by country in 2014 in billions of cubic feet
Source: US Energy Information Administration (EIA)

serious security threat to many countries. Unless someone figures out a way to reverse this trend, the best hope is to reduce the impact of global warming by slowing down the emissions of fossil fuels.

Renewable energy a promising solution

As the world moves away from coal and oil as sources of energy, it is naturally turning towards renewable energy. This includes wind power, solar energy, biofuels, geothermal power, hydropower, biomass, and others. Each of these types of renewable energy has its advantages and disadvantages, and each has its own set of suitable applications. When the wind is not blowing and the sun is not shining, the value of wind and solar power is limited. This makes the capability of storing energy especially important. On the other hand, there are areas in deserts and in the Middle East where the sun shines relentlessly. These areas are ideal for the deployment of solar power resources. A similar example is true for high-wind areas.

Renewable energy is widely deployed in many areas throughout the world, and is a rapidly growing industry. It is already making a significant contribution to CO_2 and other greenhouse gas emissions throughout the world. The chief problems with the deployment of renewable energy resources are lack of political will and a lack of research funding. The lack of political will has in part to do with the fact that some people have been slow to accept the now overwhelming evidence that human activity affects the ozone layer and the environment. These people are likely to try to block significant investments in renewable energy.

Inadequate amounts of research funding in areas such as wind power and solar energy has meant that these technologies have often not been competitive with fossil fuels. Renewable energy in most cases is more expensive than traditional forms of energy like coal and crude oil. When economies like that of China and even the United States are pushing for faster economic growth, it is often tempting to take short term but less expensive energy solutions instead of more expensive but environmentally-favourable sources of energy. This is a dilemma faced by almost every country on earth.

Natural gas: a cleaner alternative

Natural gas is often seen as a cleaner and more environmentally-friendly alternative to both coal and oil. Burning natural gas emits 50% less CO_2 than coal into the atmosphere. It also emits 20-30% less CO_2 than oil and gas. This makes natural gas the cleanest burning fossil fuel, though it is not as clean as renewable energy sources. Because natural gas is so versatile, and can be used many places where refined derivatives of crude oil are used, it is widely viewed as a kind of "bridge fuel" to renewable energy. Another plus for natural gas is that it is very plentiful, especially in the United States, Russia, and the Middle East. Natural gas as a bridge fuel could last 20 years or more.

Measuring natural gas flow

While many flowmeters can measure gas flow, two of the main types include Coriolis and ultrasonic flowmeters. The growth in both these markets is tied closely to custody transfer applications.

Coriolis meters are benefiting from the market for custody transfer of natural gas

Coriolis flowmeters rely on the momentum of a moving fluid to cause a twisting motion in one or more vibrating tubes that serve as the meter body. The amount of twisting motion is proportional to mass flow. This motion is monitored by the flowmeter, which uses it along with other variables to compute mass flow.

Because Coriolis meters rely on fluid momentum to compute flowrate, they perform better on liquids than gases. This is because liquids are denser than gases. However, a significant percentage of Coriolis flowmeters are used to measure gas flow, and this use is growing. One main use is for custody transfer of natural gas.

Custody transfer of natural gas is a fast-growing market, especially with the increased popularity of natural gas as an energy source. Natural gas changes hands, or ownership, at a number of points between the producer and the end-user. These transfers occur at custody transfer points, and are tightly regulated by standards groups such as the American Gas Association (AGA). Other geographic regions have their own regulatory bodies.

The AGA approved a report on the use of Coriolis flowmeters for custody transfer of natural gas in 2003. The report is called AGA-11. This report helps account for the positive growth rate of Coriolis flowmeters, as they become more widely used for natural gas custody transfer applications.

Emerson Daniel 3416 gas dual transmitter inline ultrasonic flowmeter

Gas flow measurement occurs during upstream production, in midstream transportation, within gas processing plants, and during downstream distribution all the way to the point of use

Even though it often takes some time for end-users to adopt a new technology, this report provided a significant boost to the use of Coriolis flowmeters for natural gas flow measurement.

The American Petroleum Institute (API) has issued a draft standard titled Measurement of Single-Phase, Intermediate, and Finished Hydrocarbon Fluids by Coriolis Meters. This document was 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. Just as the AGA has been active in approving standards for the use of Coriolis flowmeters for gas applications, the API has actively approved standards for using Coriolis meters in petroleum liquid applications.

The chief barrier to the widespread use of Coriolis meters for natural gas applications is line size. The largest Coriolis flowmeter made today can accommodate a line size of 16 inches (406mm). However, Coriolis meters become expensive and unwieldy when built for line sizes above four inches, and those built for line sizes from 8 to 16 inches are very large, unwieldy, and expensive. Even so, their use is growing as end-users are willing to live with these disadvantages in order to achieve the accuracy and reliability of Coriolis meters.

Multipath ultrasonic flowmeters used for custody transfer

Unlike Coriolis meters, which rely on fluid momentum to compute flowrate, ultrasonic flowmeters send a signal across the pipe in both directions. When the ultrasonic signal travels with the flow, it travels more quickly than when it goes against the flow. The flowmeter monitors the "transit time" of the signals travelling with and against the flow, and uses this difference to compute flowrate.

The development of multipath transit time flowmeters, which use more than one ultrasonic signal or "path" in calculating flowrate, has been an important technological development for ultrasonic flowmeters. Each path requires a pair of sending and receiving transducers. By using more than one path, the flowmeter measures flow at multiple locations in the flowstream, leading to greater accuracy.

Multipath flowmeters have been especially important in the use of transit time meters to measure natural gas flow. Suppliers such as Emerson Daniel, Honeywell Elster, and TechnipFMC have introduced four-path, five-path, and six-path transit time meters, respectively, to measure natural gas flow. The American Gas Association approved the use of multipath ultrasonic flowmeters for custody transfer natural gas applications in June 1998. Since that time, there has been a substantial increase in the use of these meters for natural gas measurement, especially for custody transfer applications.

Endress+Hauser Promass 83X/84X Coriolis flowmeter

A company that has entered the ultrasonic market on the liquid side is Schlumberger/Cameron, which purchased Caldon in 2006. Caldon manufactures an eight-path meter that for many years was marketed mainly to the nuclear industry. In the past ten years, the company has been selling its eight-path meter into the petroleum market. Another company selling its ultrasonic meter into the liquid petroleum market is Faure Herman, a division of IDEX. Faure Herman manufactures an 18-path meter.

Other types of flow measurement

Turbine and differential pressure flowmeters are also used for gas flow measurement. One especially interesting area is measuring the flow of stack gas and exhaust gases in power plants, refineries, and other manufacturing plants. In the early 1990s, the US Environmental Protection Association (EPA) put in strict requirements regarding continuous emissions monitoring (CEM). This spawned a great deal of flow measurement activity, chiefly among thermal, ultrasonic, and averaging Pitot tube manufacturers.

Beginning in 2008, the EPA's attention turned more towards monitoring greenhouse gas emissions. Thermal, ultrasonic, and averaging Pitot tube manufacturers have also been active in pursuing this market, although other technologies such as sonar also play a role. The importance of this monitoring activity is likely to increase as greater attention is paid to minimising greenhouse gas emissions into the environment.

Flow measurement occurs all along the process stream

Gas flow measurement occurs during upstream production, in midstream transportation, within gas processing plants, and during downstream distribution all the way to point of use. In addition, it occurs as the byproducts of burning gas are emitted in stack gas, exhaust, and flue gas systems. Considering that natural gas is becoming more a fuel of choice for a wider variety of applications, the prospects for both the use of natural gas and gas flow measurement have never been brighter.

For more information:

Jesse Yoder, PhD, is president of Flow Research, Inc. in Wakefield, Massachusetts (www.flowresearch.com), a company he founded in 1998. He has 30 years of experience as an analyst and writer in process control. He has authored more than 250 market research studies in industrial automation and process control, and has written more than 280 published journal articles on instrumentation topics. He has published in Flow Control, Processing, Pipeline & Gas Journal, InTech, Control, Fluid Handling, and other instrumentation publications. Study topics include Coriolis, magnetic, ultrasonic, vortex, thermal, differential pressure, positive displacement, and turbine flowmeters. He has authored two separate six-volume series of studies on gas flow and oil flow. Dr. Yoder is a regular speaker at flowmeter conferences, both in the United States and abroad. He has most recently written a book with Dick Morley called *The Tao of Measurement*, which was published by ISA in March 2015. Flow Research has recently published a study on ultrasonic flowmeters, which is described at www.flowultrasonic.com.

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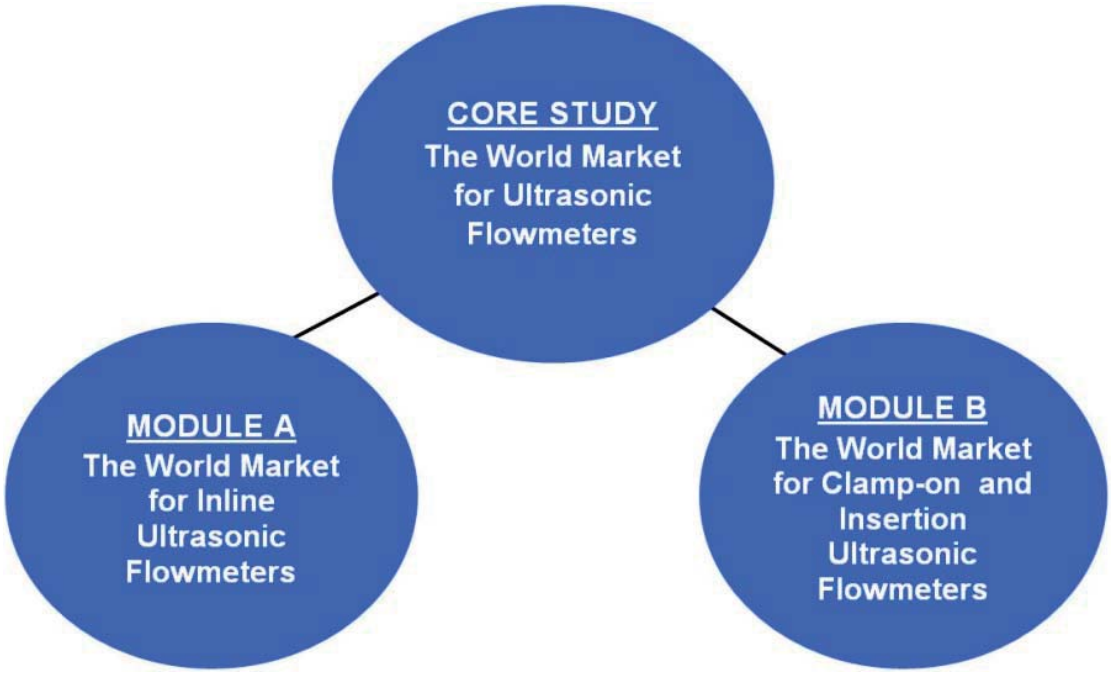

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