Wireless Standards Outlook • Flowmeter Diagnostics • Sight-Flow Best Practices

Flow Control

The Magazine of Fluid Handling Syster

March 2009 Vol. XV, No. 3 • www.FlowControlNetwork.com

In Boom

Thermal Flowmeters Buck Woeful Economy on Environmental Monitoring Push

GRAND VIEW MEDIA GROUP

by Jesse Yoder, Ph.D.

A Market Prime for Boom

Thermal Flowmeters Positioned to Gain from Environmental Push

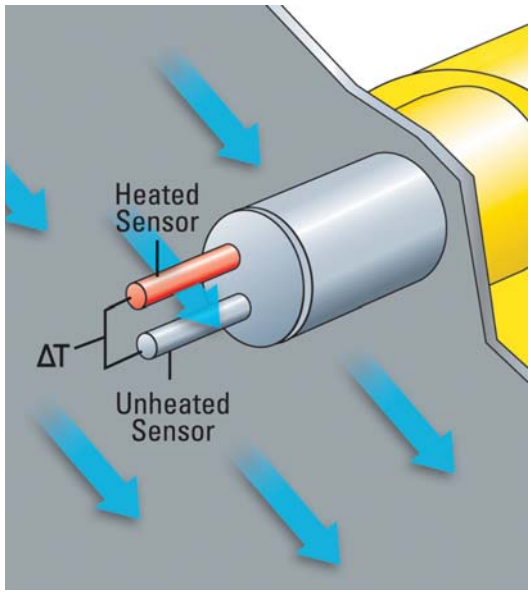
Among the established flow measurement technologies, thermal flowmeters account for fewer units shipped than any other flow technology except for target meters. In perspective, thermal flowmeters, at a market size of under $100 million, represent less than 2 percent of a worldwide flowmeter market that is projected to approach $5 billion in 2009. Yet, despite a global economic slump, thermal flowmeters are suddenly emerging into the spotlight and are primed to show an upswing in demand. Why is this? The answer lies primarily in the trend toward increased environmental monitoring and the suitability thermal flowmeters have for such applications.

How Thermal Flowmeters Work

Thermal flowmeters are used almost entirely for gas flow applications. As the name implies, thermal flowmeters use heat to measure flow. Thermal flowmeters introduce heat into the flowstream and measure how much heat dissipates using one or more temperature sensors. This method works best with gas flow measurement. It is difficult go get a strong signal using thermal flowmeters in liquids, due to considerations relating to heat absorption.

While all thermal flowmeters use heat to make their flow measurements, there are two different methods for measuring how much heat is dissipated. One method is called the constant temperature differential. Thermal flowmeters using this method have two temperature sensors — a heated sensor and another sensor that measures the temperature of the gas. Mass flowrate is computed based on the amount of electrical power required to maintain a constant difference in temperature between the two temperature sensors.

A second concept is called a constant-current method. Thermal flowmeters using this method also have a heated sensor and another one that senses the temperature of the flowstream. The power to the heated sensor is kept constant. Mass flow is measured as a function of the difference between the temperature of the heated sensor and the temperature of the flowstream. Both methods are based on the principle that higher velocity flows result in a greater cooling effect. Both measure mass flow based on the measured effects of cooling in the flowstream.

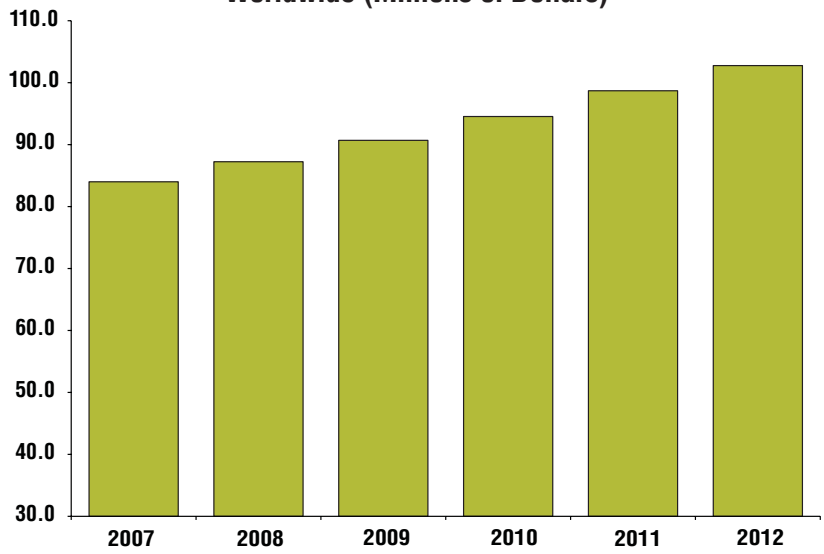


Thermal flowmeters based on the constant-current method use two temperatures sensors, one of which is exposed to a constant power source. Mass flow is measured as a function of the difference between the temperature of the heated sensor and the temperature of the flowstream. Image courtesy of Fluid Components Int'l (www.fluidcomponents.com).

Limitations of Thermal Flowmeters

While thermal flowmeters are uniquely capable of supporting many gas flow applications, they have a limited application for liquids, and they are not a good fit for steam flow measurement. This explains why thermal technologies account for such a small share of the overall flowmeter market, as gas flow accounts for only about 20 percent of total flow applications. And many of these applications are in process gas and other

Total Shipments of Thermal Flowmeters Worldwide (Millions of Dollars)



Source: *Flow Research Inc.*

non-custody transfer applications.

Thermal flowmeters do not have the necessary industry approvals for use with custody-transfer of natural gas in pipelines. This market is dominated by ultrasonic, turbine and differential-pressure flowmeters, all of which possess custody-transfer approvals from the American Gas Association (AGA, www.aga.org). Thermal flowmeters are unlikely to achieve this approval without technological breakthroughs that would increase measurement accuracy to the very high level required for custody transfer.

CEM Boosts Thermal Flowmeters

On the other hand, thermal flowmeters have carved out a unique niche in the flowmeter market due to their ability to help end-users maintain compliance with certain environmental requirements. In the early 1990s, for example, new environmental regulations mandated that companies detect and reduce the emission of sulfur dioxide (SO2) and nitrous oxide (NOX) — both of which were found to be principal causes of acid rain.

By combining a measurement of flowrate with a measurement of the concentration of SO2 and NOX, it is possible to determine how much of these substances are released into the atmosphere. As such, by regulating SO2 and NOX emissions, the U.S. Environmental Protection Agency has developed an entire industry around Continuous Emissions Monitoring (CEM).

In response to the trend toward CEM, thermal flowmeter companies developed multipoint thermal flowmeters. In many cases, continuous emissions monitoring occurs in large stacks that emit pollution from industrial sources. Single-point thermal flowmeters measure flow at a point, making it difficult to accurately compute flow in a large pipe or smokestack. Multipoint thermal flowmeters measure gas flow at multiple points, and use these values to compute flow for the entire pipe, duct or stack. Some multipoint flowmeters have as many as 16 measuring points, which enables them to support some of the large smokestack applications require for CEM. Thermal flowmeters, due to their insertion style, are one of the few types of flowmeters that can accurately measure gas flow in such large pipes.

Here an immersible thermal mass flowmeter is used in a bio gas application. Photo courtesy of Sierra Instruments Inc. (www.sierrainstruments.com).

A New Age of Environmental Awareness

While the need for CEM is ongoing, the 21st century has brought new environmental awareness and requirements. Scientific thinking has evolved substantially in the past 10 years, and while global warming and the need to reduce carbon emissions were once viewed as scientific theory, they are now widely accepted as scientific fact.

In the United States, for example, the Obama administration has made a commitment to reducing greenhouse gas emission 80 percent by 2050. The new administration is also pledging to make the United States a leader in climate change, which figures to make emissions monitoring a fast-growing application segment for the foreseeable future.

Clearly, it is not just in the United States where the effort to reduce greenhouse gas emissions is resulting in market opportunities for thermal flowmeter providers. The Kyoto Accord, for example, has resulted in the creation of several mechanisms that require measurement of greenhouse gases internationally. These include Certified Emission Reductions (CER), which is a credit system designed to aid European Union countries in achieving emission limitation targets covered by the European Union Emission Trading Scheme. Another program is the Clean Development Mechanism (CDM), which allows countries to invest in sustainable development projects that reduce emissions in developing countries.

This new age of environmental awareness, together with the Kyoto Accord and other greenhouse gas initiatives, has resulted in a rewriting of the rules on measuring industrial emissions. There is suddenly a need and demand to measure greenhouse gases in applications that formerly may have gone unnoticed. Many of these applications present opportunities for thermal flowmeters, including the following:

- **Measurement and recovery of landfill gas** – Landfills produce carbon dioxide, methane and a mixture of other gases. These gases are measured as they leave the landfills, extracted from different wellheads, and collected to a common header pipe. The collected gases are disposed of or recovered as a fuel source.
- **Ethanol distillation and refining** – Ethanol production is a complex process involving both fermentation tanks and distillation tanks. Thermal flowmeters measure the flow of air and fuel going into the distillation tanks, and the CO2 leaving the fermentation tanks.
- **Measuring emissions from steam generators, boilers, and process heaters** – Thermal flowmeters measure these emissions, especially NOX and carbon monoxide.
- **Biomass gasification** – Organic industrial waste and food waste can be digested in aerobic conditions in reactor tanks and fermentation towers. The output from this process is called biogas. Biogas includes methane, carbon dioxide, and a mixture of other gases. Thermal flowmeters are used to measure gas flow at multiple points along the way, providing optimal production, control and reporting.
- **Recovery of methane from coal mines** – Methane that is recovered from coal mines often is mixed with air, carbon dioxide, and nitrogen. It is important for accurate flow measurement to calibrate the flowmeter with the actual mixture of gases. Thermal flowmeters are used to measure the amount of extracted gases

Continues on page 20

Thermal Flowmeters – Then to Now

The history of the thermal flowmeter market in southern California reads a little like the beginning of the book of Matthew in the New Testament. According to the first part of Matthew, Abraham begat Isaac, Isaac begat Jacob, and many generations followed. In the case of the thermal flowmeter companies, there were three "father" companies founded in the 1960s and 1970s — Sierra Instruments (*www.sierrainstruments.com*), Fluid Components International (*www.fluidcomponents.com*) and Kurz Instruments (*www.kurz-instruments.com*). In 1988, 1994 and 2002, former employees of these companies formed three more companies. These companies are Eldridge Products (*www.epiflow.com*), Fox Thermal Instruments (*www.foxthermalinstruments.com*), and Sage Metering (*www.sagemetering.com*).

How it All Started

Fluid Components International (FCI), founded in 1964, was the first company in the group to be formed. Mac McQueen and Bob Deane jointly founded FCI. John Olin, Ph.D. and Jerry Kurz, Ph.D. together formed Sierra Instruments in 1973. In 1977, Dr. Kurz formed Kurz Instruments, leaving Dr. Olin with sole ownership of Sierra Instruments.

Even though FCI, Sierra, and Kurz all ended up making thermal flowmeters, they each approached this subject from different perspectives. FCI began by manufacturing thermal flow switches to detect the movement of flow in oil-well pipes in Bakersfield, Calif. While FCI was the earliest of the thermal companies to be founded, it didn't get into the flowmeter business until 1981. That year, FCI began putting more sophisticated electronics on its flow switches, enabling the company to create its first thermal flowmeters for gas flow measurement.

By contrast, Sierra Instruments got into the market by creating air-sampling products and thermal mass flowmeters. The thermal mass flowmeters took the form of portable air-velocity meters and transducers. When Dr. Kurz formed Kurz Instruments in 1977, the thermal flowmeters went to Kurz, while Sierra Instruments retained the air sampling products. These instruments measured particle size and distribution in the air. It was not until 1983 that Sierra got back into the flowmeter market.

The origins of both Sierra's and Kurz's thermal flowmeters go back to their founders' research using hot-wire anemometers. Dr. Kurz and Dr. Olin worked together for Thermo-Systems Inc. (TSI) in Minnesota from 1968 through the early 1970s. They used hot-wire anemometers in their research. Hot-wire anemometers, which consist of a heated, thin-film element, are used in velocity profile and turbulence research. While these fragile instruments are suited for research environments, they are too light for industrial environments, since they break easily. Both Kurz and Olin would later sell industrial thermal flowmeters that worked somewhat like the hot-wire anemometers, but were ruggedized and hardened to fit into more demanding industrial environments.

The Founding Companies Today

Mark McMahon, scientific product manager, Matt Olin, president and CEO, and Scott Rouse, industrial product manager, for Sierra Instruments. Sierra was co-founded in 1973 by Olin's father, John Olin, Ph.D., with Jerry Kurz, Ph.D.

FCI is the only California thermal flowmeter company not located in the Monterey area. Instead, FCI is located in San Marcos, Calif., just north of San Diego.

Of the three companies, Sierra Instruments is the only company among the group to offer mass flow controllers (MFCs), in addition to industrial thermal mass flowmeters. Sierra sells its MFCs into both semiconductor and industrial markets. Sierra also has expanded into the vortex and ultrasonic flowmeter markets. FCI and Kurz mainly remain focused on the industrial thermal flowmeter market.

Each of the thermal flowmeter companies has distinguished itself by focusing on particular industries and applications. FCI emphasizes wastewater treatment applications and flare gas measurement and monitoring. The company also offers solutions for landfill gas recovery, biogas recovery, and ethanol production and refining.

Sierra Instruments has developed thermal flowmeter solutions for air and natural gas flow measurement, including applications with mixtures of different gases. Sierra's thermal flowmeters are used in a range of industries, including pharmaceutical, biotech, petrochemical, and metals processing. Applications include combustion airflow, natural gas fuel flow, custody transfer, and stack gas emissions monitoring.

Jerry Kurz, Ph.D., (center) pictured here with his sons Daniel Kurz (left) and Jerry Kurz, Jr. (right) celebrating Kurz Instruments' 30th anniversary in 2007.

Kurz Instruments is especially active in the power industry. Kurz has developed a series of single-point and multi-point insertion thermal flowmeters for stack-gas and flare-gas monitoring. Kurz's flowmeters are also used in the refining, cement, pulp & paper and other process industries.

New Companies Emerge

The first of the offspring companies was established in 1988 by Mark Eldridge as Eldridge Products. Previously, Eldridge had

Continues from page 17

Stack emissions flow applications are growing in importance due to environmental regulations, and thermal flowmeters are particularly well suited to provide such measurements. Image courtesy of Fluid Components Int'l (www.fluidcomponents.com).

recovered from coal mines.

- **Monitoring of flue gas** – Flues typically are large pipes, stacks, ducts or chimneys that dispose of gases created by a combustion process. Thermal flowmeters measure the flow of gases through flues. This is often required by environmental regulations.
- **Measurement and monitoring of flare gas flow** – Flare systems are used to burn off waste gases from refineries, process plants and power plants. Flares can be a single pipe or a complex network of pipes. Flares are subject to strict environmental regulations. Thermal flowmeters are used to measure the amount of gas flared.

The applications noted here provide a mere sampling of the growing number of scenarios that require measurement of greenhouse gases. Thermal flowmeters are uniquely suited to make these measurements because their insertion technology allows them to handle large pipe sizes and because they can accurately measure different mixtures of gases. The need for these measurements figures to grow substantially in the next 5-10 years. As a result, so will the demand for thermal flowmeters.

***Jesse Yoder**, Ph.D., is president of Flow Research, Inc. in Wakefield, Mass., a company he founded in 1998. He has 22 years of experience as an analyst and writer in process control. Yoder specializes in flowmeters and other field devices, including pressure and temperature products. He has written over 100 market research studies in industrial automation and process control and has published more than 90 journal articles on instrumentation topics. Dr. Yoder can be reached at* jesse@flowresearch.com *or 781 245-3200.*

www.flowresearch.com

Flow Research is currently working on a new market study covering thermal flowmeter technology. The study, titled "The World Market for Thermal Flowmeters", is scheduled to be published in May 2009. For more on this study, visit ***www.flowthermal.com****.*

Mark Eldridge, president (pictured left), and Craig Schieding (pictured right), director of sales and marketing, of Eldridge Products Inc. Eldridge formerly worked for Kurz Instruments prior to founding his own thermal flowmeter company in 1988.

worked for Kurz Instruments. Still located in Monterey, Calif., Eldridge specializes in thermal flowmeters for gas submetering, compressed-air monitoring, and water & wastewater treatment. Eldridge exclusively offers thermal mass flowmeters.

Fox Thermal Instruments was founded in 1994 by Brad Lesko, a former employee of Kurz Instruments. Fox is located in Marina, Calif., which is near Monterey. Fox specializes in thermal flowmeters for compressed-air monitoring, emissions monitoring, and fuel monitoring applications.

Sage Metering is the newest member of the thermal flowmeter club. Bob Steinberg, formerly an employee of Sierra, Kurz, and Eldridge, founded Sage in 2002. Sage is located in Monterey and has developed a number of unique features in its thermal flowmeter line, including a user-friendly transmitter display, a touch screen, and digital electronics. Sage's thermal flowmeters are used in a variety of applications, including biogas, digester gas, and landfill gas monitoring.

Bob Steinberg, president of Sage Metering Inc., worked for Sierra Instruments, Kurz Instruments, and Eldridge Products before staring his own thermal flow company in 2002.

While the focus here has been on thermal flowmeter companies in California, other companies have also entered the thermal flowmeter market. These includes Endress+Hauser (*www.us.endress.com*), ABB (*www.abb.com*), Intek (*www.intekflow.com*), Thermal Instrument Co. (*www.thermalin strument.com*), Tokyo Keiso (*www.tokyokeiso.co.jp*), Magnetrol International (*www.magnetrol.com*), and Bronkhorst (*www.bronkhorst.com*). Expect to see more companies entering this dynamic and exciting market.