STEAMED UP

Flow Technology Evolves to Support Critical Energy Source

By Jesse Yoder

Steam plays a very important role in our lives today. It is used in the production of paper, in food preparation, for cooling and heating buildings, and as a source of power for ships. Perhaps its most important use is in electricity production.

Steam power plants obtain heat from a variety of sources, including fossil fuels such as coal, oil, or natural gas. Some plants get their power from nuclear fuels. Others get power from waste fuels, municipal solid waste, solar energy, etc. With each of these power sources, heat energy is released. With fossil fuels, this is done through combustion, while nuclear plants use fission. This heat is typically transferred to water. The heated water generates steam.

Steam in a power plant is generated in a system called a boiler. The steam flows to a turbine, where it drives a generator for the purpose of producing electricity. After it passes through the turbine, the steam flows to a condenser. Here the steam is converted back to water so it can be reused as boiler feedwater.

Types of Steam

Steam is often classified into three categories. These types of steam reflect the different temperature and pressure conditions that steam exists under:

- Wet steam is a fluid that contains both steam and condensed hot water. The term "quality" is used to refer to the percent of flow that is steam and water by weight. For example, 85 percent quality refers to a fluid that is 85 percent steam and 15 percent water. Wet steam is also called quality steam, and it is the most difficult type of steam to measure.
- Saturated steam does not contain any water and exists at one pressure and corresponding temperature. Saturated steam is reliant on heat. Adding heat to saturated steam raises the temperature above the boiling point, and removing heat from saturated steam causes water to form.
- Superheated steam exists when the temperature of the steam has been raised above the boiling point. The temperature above the boiling point is called degrees of superheat.

Vortex Flowmeter

Photo Courtesy of Endress-Hauser

Vortex Flowmeters

Steam flow is measured mainly by vortex and differential pressure (DP) flowmeters. However, some new technologies are now being used to measure steam flow, namely Coriolis and ultrasonic flowmeters.

Vortex flowmeters have a small obstruction in the flowstream called a bluff body. The presence of the bluff body in the flowstream generates alternating vortices, which are circular appearing ripples. The velocity of the flow is proportional to the frequency of the vortices. The flowmeter determines vortex frequency by one of several methods, including ultrasonic, thermal, and pressure. Flowrate is calculated, based on vortex frequency and the area of the pipe.

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Vortex flowmeters have a number of advantages. While they are not as accurate as Coriolis flowmeters, they still have good accuracy. Vortex flowmeters also are quite reliable. While they are more intrusive than magnetic and ultrasonic flowmeters, they are less intrusive than DP flowmeters, especially those using orifice plates. Vortex flowmeters offer good accuracy and reliability for a reasonable price.

Use for Steam Flow

Vortex flowmeters are well suited for measuring steam flow, and they are widely used for this purpose. Steam is the most difficult fluid to measure. This is due to the high pressure and high temperature of steam and because the measurement parameters vary with the type of steam, including pressure.

Steam is often measured in process plants and for power generation; magnetic flowmeters cannot measure steam flow. In addition to their ability to tolerate high process temperatures and pressures, vortex meters have wide rangeability. This allows them to measure steam flow at varying velocities. In process and power plants, steam is often measured coming from a boiler.

District Heating

District heating is a growing application for vortex flowmeters. In district heating, a centralized heating system is created that can provide heat for a building, a group of houses, or even an entire town. A similar concept applies to district cooling. In district heating, a volumetric flowmeter is often combined with a temperature sensor and pressure transmitter to measure mass flow. A flow computer can be used to calculate mass flow. Both vortex and ultrasonic flowmeters are used to measure water flow, and steam flow is also measured.

District heating is a growing application in Europe, and it is also beginning to be more widely used in Asia. It has not yet caught on in the United States. However, it is likely that district heating will start being used more widely in the United States, as the cost of energy increases. District heating is already used in Canada.

Multivariable Vortex

Sierra Instruments (*www.sierrainstruments.com*) introduced the first multivariable vortex flowmeter in 1997. This meter includes an RTD temperature sensor and a pressure transducer with a vortex shedding flowmeter. By using the information from these sensors, the flowmeter can determine volumetric flow, temperature, pressure, fluid density, and mass flow. This makes it unnecessary to use a flow computer to make the flow calculation.

This multivariable flowmeter is one of a growing number of multivariable new-technology flowmeters, including multivariable magnetic flowmeters and multivariable DP flowmeters. Multivariable ultrasonic flowmeters are used in district heating applications. Since Sierra brought out the multivariable vortex, several other companies have introduced their own multivariable vortex flowmeters, including Yokogawa (*www.yokogawa.com*) and J-Tec (*www.j-tecassociates.com*).

DP Flowmeters

DP flowmeters are also used to measure steam flow. DP flowmeters consist of a DP transmitter and a primary element. The primary element places a constriction in the flowstream. The constriction creates a pressure drop in the line. DP flowmeters determine flowrate based on the difference in pressure upstream and downstream from the primary element.

Multivariable DP Flowmeter

Photo Courtesy of Rosemount

There are many different types of primary elements. The main types are orifice plates, Venturi tubes, flow nozzles, primary flow elements, and averaging pitot tubes. Other types include wedge elements and V-Cones. There are also a number of different types of orifice plates. Orifice plates are the most widely used type of primary element.

Primary elements create a pressure drop that makes the flow calculation possible. This pressure drop is considered a disadvantage of this method of measuring flow, due to pumping costs. The amount of pressure drop depends on the type of primary element used. Orifice plates typically create the highest amount of pressure loss.

Suppliers of DP transmitters have made important advances to make their products more appealing and to keep up with flow technologies. Just as suppliers of vortex flowmeters have introduced multivariable products, some suppliers have introduced multivariable DP transmitters. These products typically include pressure and temperature transmitters and use these values to compute mass flow. This makes it unnecessary to use a flow computer to perform the mass flow calculation.

Another advance by DP transmitter suppliers is to include an integrated primary element with the multivariable DP transmitter. This makes it possible to calibrate the primary element together with the transmitter prior to shipping. Multivariable DP transmitters, with and without integrated primary elements, are widely used to measure gas and steam flow. The temperature and pressure values are used to compute density, which in turn is used to calculate mass flow.

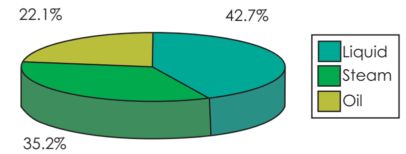
Suppliers of pressure transmitters have made other important advances, including the introduction of high-tier products. High-tier pressure transmitters set new benchmarks in terms of transmitter accuracy and stability. These advances apply to differential pressure, as well as gauge and absolute pressure transmitters.

Emerging Technologies

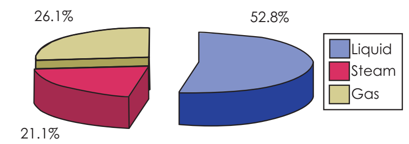
Both ultrasonic and Coriolis flowmeters are beginning to be used to measure steam flow. However, this is a difficult measurement for both technologies. GE Infrastructure Sensing (formerly Panametrics, *www.gesensing.com*) has introduced a clamp-on ultrasonic flowmeter designed to measure steam flow. Expect to see additional steam flow products from both ultrasonic and Coriolis suppliers in the future.

Another type of meter used to measure steam flow is the target meter. However, there are relatively few manufacturers of this type of meter. Target flowmeters are sometimes used for large pipe applications. Besides steam, they are also used to measure the flow of liquids and gases.

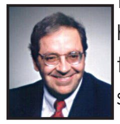
Still, vortex and DP flowmeters own the majority of the market for steam flow measurement. Going forward, watch for further developments in emerging steam flow technologies, along with continued enhancements in DP and vortex flowmeter technologies.



Vortex Flowmeters by Type of Fluid Measured
(Perecent of Dollars Worldwide)
Source: Flow Research Inc.



Pressure Transmitters by Type of Fluid Measured
(Perecent of Dollars Worldwide)
Source: Flow Research Inc.



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