A Putman Publication

A supplement to *Processing*

PROCESSING

Inside

OBTAINING HIGH ACCURACY FLOW MEASUREMENT

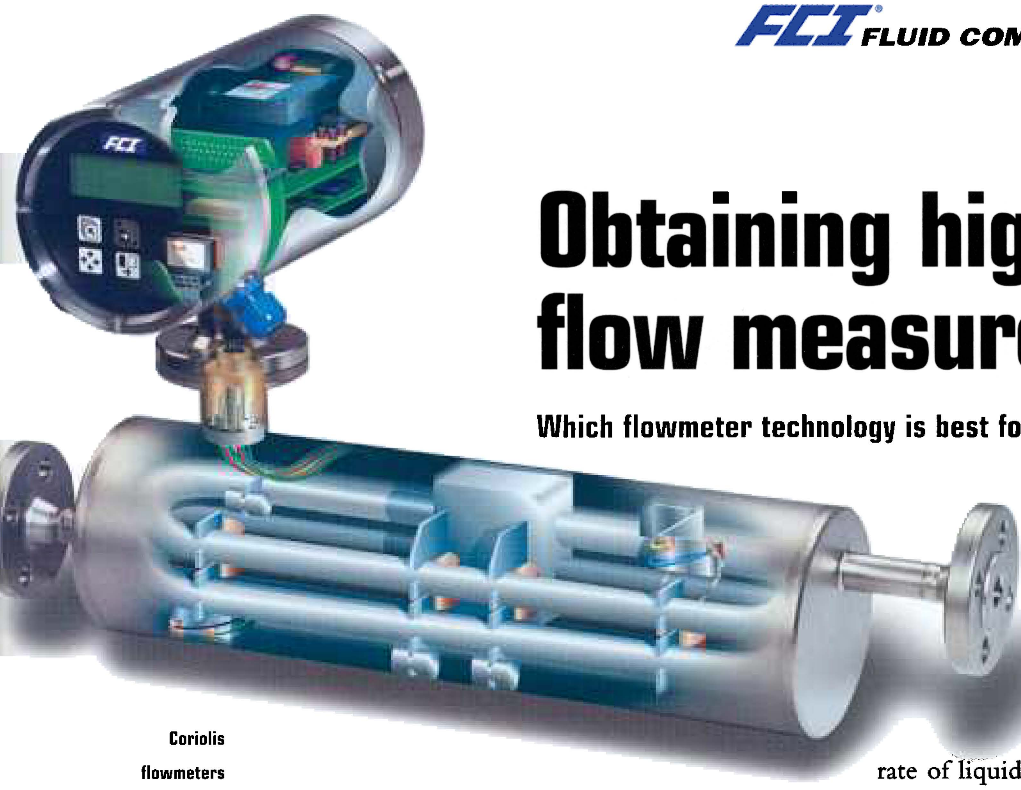
P. 2

Flowmeter HANDBOOK 2001

FLUID COMPONENTS INTL
a limited liability company

Obtaining high accuracy flow measurement

Which flowmeter technology is best for your specific application?



Coriolis flowmeters can be used to measure the mass flow of liquids, slurries, gases or vapors.

Accurate flow measurement impacts process safety, throughput, recipe, quality and cost, affecting bottom line profit or loss. Obtaining accurate flow measurement begins with selecting the best flowmeter technology for your specific application media. There are three basic types of flowmeters: mass, volumetric and velocity. For each type of flowmeter, there are multiple sensing technologies; Coriolis and thermal sensing are both mass flow technologies. Most flow sensing technologies are better suited to a particular media—gas, liquid or slurry—depending on the nature of the application environment (high temperature or pressure, corrosive conditions, etc). The major types of flowmeters can be characterized as follows:

Obtaining accurate flow measurement begins with selecting the best flowmeter for your application.

Mass flow

Thermal mass flowmeters use the thermal dispersion, or heat loss, of a heated sensor in a flow stream to measure mass flow directly. Thermal flowmeters have no moving parts or orifices and provide excellent gas measurement accuracy. Thermal is one of only a few technologies that measure mass flow rate; it is also one of the few technologies that can be used for measuring gas flow in large pipes, ducts, or stacks. Measurement of the fluid temperature may also be provided by thermal technology.

Coriolis mass flow measurement requires fluid flowing through a vibrating flow tube that causes a deflection of the flow tube proportional to mass flow rate. Coriolis flowmeters can be used to measure the mass flow rate of liquids, slurries, gases, or vapors. They provide excellent measurement accuracy. Measurement of fluid density or concentration is also provided by Coriolis technology. They are not affected by pressure, temperature or viscosity and offer accuracy exceeding 0.10% of actual flow.

Volumetric

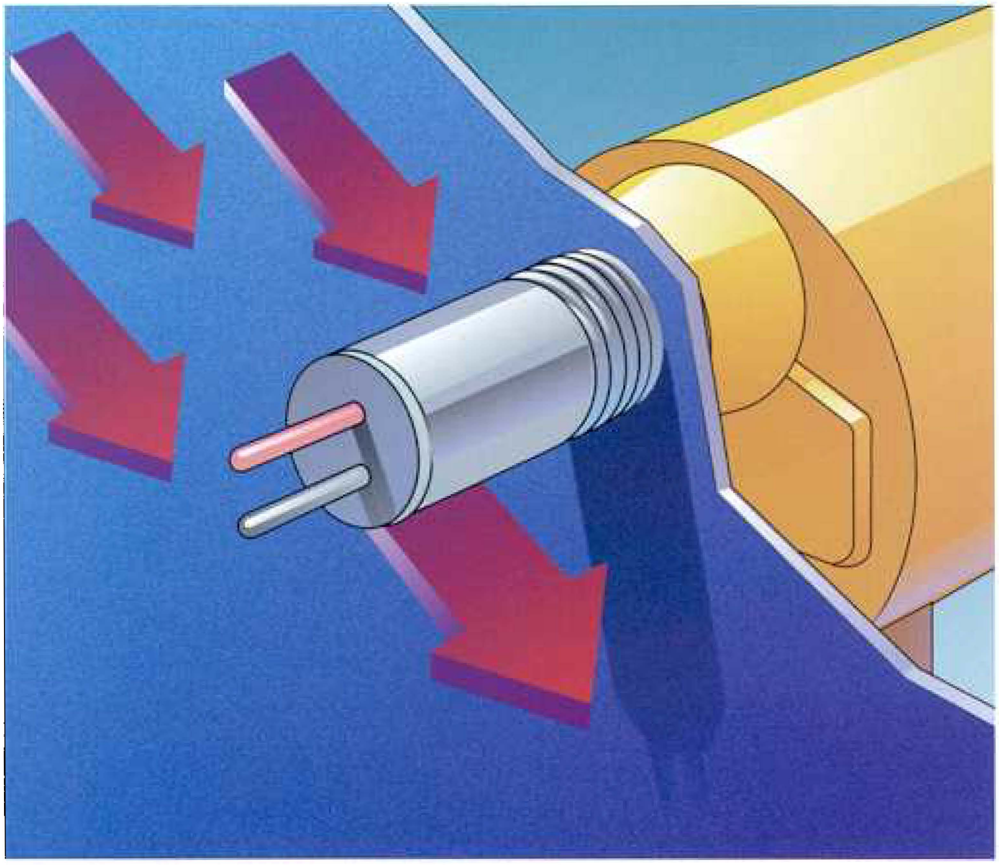
Differential Pressure (DP) flowmeter technology includes orifice plates, venturis, and sonic nozzles. DP flowmeters can be used to measure volumetric flow rate of most liquids, gases, and vapors, including steam. DP flowmeters have no moving parts and, because they are so well known, are easy to use. They create a non-recoverable pressure loss and lose accuracy when fouled. Flow measurement accuracy depends on accuracy of the pressure gauge.

Positive Displacement (PD) flowmeters measure the volumetric flow rate of a liquid or gas by separating the flow stream into known volumes and counting them over time. Vanes, gears, pistons, or diaphragms are used to separate the fluid. PD flowmeters provide good to excellent accuracy and are one of only a few technologies that can be used to measure viscous liquids. However, they create a non-recoverable pressure loss and have moving parts subject to wear.

Velocity

Turbine flowmeters rely on fluid passing through the meter to spin a rotor. The rotational speed of the rotor is related to the velocity of the fluid. Multiplying the velocity times the cross-sectional area of the turbine provides the volumetric flow rate. Turbine flowmeters provide excellent measurement accuracy for most clean liquids and gases. Like PD flowmeters, turbine meters create a non-recoverable pressure loss and have moving parts subject to wear.

Electromagnetic ("magmeter") meters require the velocity of a conductive liquid to be determined by passing it through a magnetic field and measuring the developed voltage. Velocity times area yields volumetric flow rate. Magmeters have no moving parts and do not obstruct the flow stream. They provide good accuracy with conductive liquids flowing into a full pipe. Magmeters can be used to measure the flow rate of slurries.



Thermal mass flowmeters use the thermal dispersion, or heat loss, of a heated sensor in a flow stream to measure mass flow directly.

Ultrasonic transit-time sound velocity or Doppler frequency shift methods are used to measure the mean velocity of a fluid. Volumetric flow rate is determined by multiplying mean velocity times area. Besides being obstructionless, ultrasonic flowmeters can also be non-intrusive if their sonic transducers are mounted on the outside of the pipe. Accuracy is good to excellent for almost all liquids. Pipe fouling will degrade accuracy.

Vortex Shedding requires the frequency of vortices shed from a bluff body placed in the flow stream to be proportional to the velocity of the fluid. Again, velocity times area gives the volumetric flow rate. Vortex flowmeters provide good measurement accuracy with liquids, gases, or steam. They have no moving parts and are fouling tolerant. Vortex meters can be sensitive to pipeline noise and require flow rates high enough to generate vortices.

Mass flow sensing

Mass flowmeters offer a number of advantages, including exceptional accuracy and repeatability, as well as being unaffected by temperature and pressure. The accuracy of mass-based measurement (instead of volume only) provides a level of control in many processes that improves the product and yield. Both thermal and Coriolis technologies are relatively low maintenance with no moving parts, which reduces the need for spares or plant down-time and can result in a lower total cost of ownership of the lifetime of the flowmeter.

Thermal mass flowmeters

In the harsh environment of chemical processing where rugged conditions combine with strict process control and safety requirements, thermal mass flowmeters have a long established record of excellent performance and reliability. Thermal mass flowmeters, because of the direct relationship between flow rate and the cooling effect of a flowing gas, provide a highly accurate and repeatable measurement of gas or air flow rates. Thermal mass sensing reliably provides flow/no-flow sensing, as well as liquid level/interface detection. With a typical accuracy to +1% of reading +0.5% of full scale and repeatability to 0.5% of reading, thermal mass flowmeters support a wide range of applications, including oil/gas, chemical processing, pulp/paper, water and wastewater treatment, electric power and more. Recent design breakthroughs have led to non-intrusive thermal mass sensors that are expanding the use of thermal sensing technology into sanitary applications in food/beverage, pharmaceutical, semiconductors and more.

Coriolis mass flowmeters

Coriolis mass flowmeters are versatile instruments that

Mass flowmeters offer great accuracy and repeatability.

not only measure mass flow, but can also measure volumetric flow, density, temperature and fraction-flow. They offer exceptional accuracy to 0.1% of actual flow and repeatability to 0.05%. Unaffected by variations in pressure, temperature, density, electrical conductivity and viscosity, they are non-intrusive and measure down to the tiniest droplets to detect extremely

Non-intrusive thermal mass sensors are now being used in sanitary applications, such as food & beverage.

low flow rates. Their accuracy is supplemented with a very wide dynamic range (better than 500:1), covering flows of nearly all ranges. In addition to extreme accuracy, Coriolis meters are able to monitor product quality continuously using inline measurement because they also measure the density of a liquid to within 0.002 g/cm^3. When coupled with advanced electronics, and because they measure multiple parameters beyond flow, they can provide the kind of sophisticated integral batch control that is essential in food/beverage, pharmaceutical and other industries with a need for fine tolerance ingredient control.

Selecting a mass flowmeter

When selecting a mass flowmeter or any other type of flowmeter, review the following parameters:

◆ Know the physical characteristics of the media to be measured (viscosity, density, etc.)

◆ Know the process environment: temperature, pressure, corrosive, dust, explosive, etc.

◆ Look for flow range, accuracy and repeatability

◆ Determine the required output signal and communications requirements

◆ Determine the upstream pipe diameters needed for accurate, repeatable measurement

◆ Review installation complexity and routine maintenance costs.

Article written by Sam Kresch, Product Manager, Fluid Components Intl, San Marcos, CA. Call 800-471-2702 for more information on mass flowmeters.