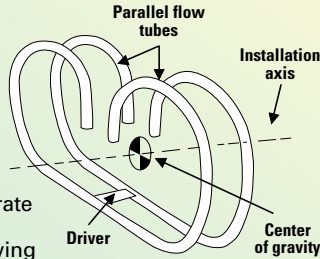


Tech Insights

“How It Works” Technology Guide†

Coriolis See ColeParmer.com

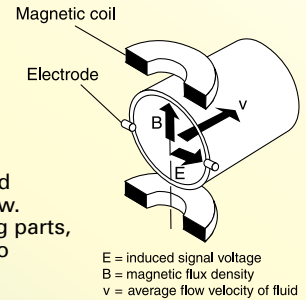
Coriolis offers true mass flow measurement through either of two designs: a single tube or two parallel tubes (shown). An oscillation is induced in the tube(s) at a reference frequency. Based on Newton’s Second Law of Motion ($F = m \times a$), the oscillation frequency will change with changes in mass flow rate. Among the most accurate of technologies available, these are suitable for a wide and growing range of gas and liquid applications. These devices provide multi-parameter data on mass, density, and temperature.



Applications	Pharmaceutical, natural gas measurement, very hot or cold abrasive slurry
Advantages	Extreme accuracy, no pressure drop, tracks mass flow, high turn-down ratio
Disadvantages	Initial expense, clogging can occur, larger in overall size

Magnetic 658-661

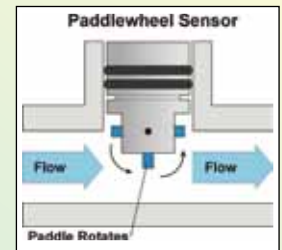
There are two magnetic design styles: insertion and full-bore. Coils in the meter produce a magnetic field. When a conductive fluid is passed through the field, a voltage is produced through an electrode in the meter wall or insertion probe; this generated voltage is proportional to the flow. The technology offers no moving parts, and the full-bore designs offer no intrusions into the flow stream.



Applications	Water/wastewater, pulp and paper, mining, food and beverage, chemical
Advantages	No obstruction of flow path, no pressure drop, no moving parts, can handle heavy slurries
Disadvantages	Fluid must be conductive, must ground pipe

Paddle Wheel 646-651

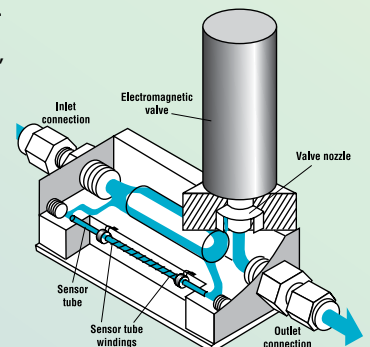
This can include meters with rotating paddle wheels, propellers, or even—for purposes of simplified classification—oscillating disks (multi-jet types). The rotating component is designed to provide a pulse when passing either a magnetic or optical sensor. The frequency of the pulses is proportional to the velocity of the fluid at one point in the pipe or channel. These designs offer relatively high accuracy for their low cost; some insertion versions are very easy to install.



Applications	Oil and gas industries, utilities
Advantages	Fast response time, easy to maintain, inexpensive
Disadvantages	Difficult to install, moving parts, requires full pipe

Gas Mass (Thermal Dispersion) 624-632

A side-stream flow of gas is directed through a capillary. The capillary includes two external heater-sensor coils, one downstream from the other. Gas flow carries heat from the upstream coil to the downstream coil. The resultant temperature-dependent resistance differential at each coil is measured. The gradient at the coils is linearly proportional to the instantaneous flow rate.

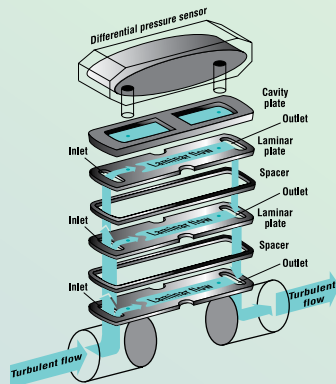


Applications	Chemical line monitoring, purging instrument air lines, filtration loading
Advantages	No moving parts; measures the mass of gas, not volume, so it’s very accurate
Disadvantages	Gas must be dry and free of particulates, fairly slow response time

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Differential Pressure 633-634

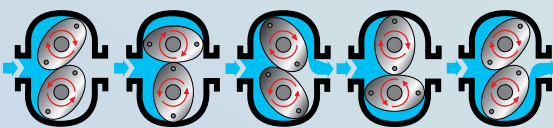
A flow-restrictive orifice or laminar flow element evaluates the pressure drop through the restriction. The pressure drop between upstream and downstream points is proportional to the rate of flow. This technology works well where no moving parts are desired or where an ultra-fast response time is required.



Applications	Pharmaceutical, specialty chemical manufacturing
Advantages	Very high accuracy; multiple calibrations, outputs, and size
Disadvantages	Water or gases only, no particulates, needs power

Gear 652

These oval counter-synchronized rotors (gears) are interlocked to rotate with the passing of liquid. The amount of fluid passing through the oval gears is well controlled giving these meters a very high level of accuracy. These meters are one of few suited to high-viscosity fluids. Designs are typically rugged and simple, allowing for installation in the most aggressive environments.



Applications	Hydraulics, food and beverage, pulp and paper industry, fuel industry
Advantages	Flow measurement is independent of fluids viscosity, no straight pipe runs required, high accuracy
Disadvantages	Slight accuracy degradation with thin fluids



Flowmeters

Introduction

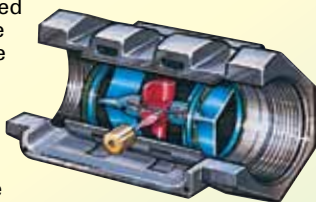
KEY INFORMATION

Tech Insights

"How It Works" Technology Guide¹

Turbine 639-645

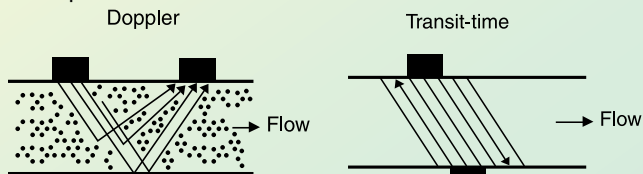
This mechanism includes a bladed rotor that is positioned along the centerline of the flow stream. The rotating component is designed to provide a pulse when passing either a magnetic or optical sensor. The frequency of the pulses is proportional to the velocity of the fluid. Some designs offer high levels of accuracy and can often handle slightly higher viscosity fluids than basic propeller-type designs. Some turbine designs meet sanitary guidelines (where stipulated by the manufacturer).



Applications	Oil and gas, utilities
Advantages	High accuracy, millisecond response time, high pressure and temperature capabilities
Disadvantages	Moving parts can wear or become clogged, not good for low flows

Ultrasonic 653-656

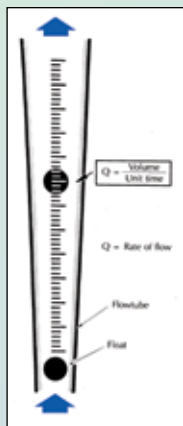
These designs measure the frequency shift of an ultrasonic signal that is sent through the fluid. Doppler technologies utilize particles or aeration in the fluid as a reflective mechanism to gauge the velocity of the fluid. Transit-time technologies rely on a frequency difference in forward and reverse signals sent through a clean liquid to gauge the velocity of the fluid; the fluid must not have solids or aeration, as they will distort the sonic pulses. These are ideal technologies to create flow profiles through an existing process, when modifying piping is not possible.



Applications	Water and wastewater, mining, oil industry
Advantages	Very high accuracy, can be used to measure corrosiveness of slurry fluid flow, no pressure drop, no obstruction of flow path, no moving parts, low maintenance costs
Disadvantages	Higher initial setup costs, fluid must contain particulates, not good for low-flow applications

Variable Area 593-621

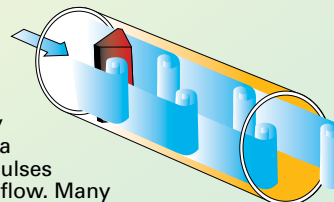
The variable area flowmeter, also known as a rotameter, consists of a float—usually a sphere—enclosed in a tube. The float responds to change in velocity of the fluid—gas, air, or liquid—by moving up or down the flow tube. The variable area principle of operation is: fluid flow velocity raises a float in a tapered tube, increasing the area for passage of the fluid. The greater the flow, the higher the float rises. The height of the float is directly proportional to the flowrate. To determine flow, simply read the graduated markings at the center of the float. Variable area flowmeters can be used in laboratory and industrial applications, and when compared with other types of flow instrumentation are the most economical means of indicating flow rate measurement when taking into account practicality and accuracy.



Applications	Laboratories, water and wastewater, food and beverage
Advantages	Easy to set up and use, low set up cost, very low maintenance, can be used for liquids and gases
Disadvantages	Low accuracy, not all meter material can withstand caustic media, no data output or recording capabilities

Vortex 662

Using a pressure sensor, this meter measures the pressure pulses from vortices that come from the fluid passing a bluff body bar across the flow stream. A simple analogy of this phenomenon is that of a flag waving in the wind. The pulses are proportional to the rate of flow. Many users find the technology appealing because it has no moving parts. Because the meter body and vortex bar can be molded as one, this design is ideal for making meters for use in aggressive or high-purity applications.



Applications	Utilities, water and wastewater
Advantages	Low to medium initial setup costs, very low maintenance when used in clean flow conditions
Disadvantages	Low to medium pressure drop due to obstruction in flow path

Conversion Factors

Additional conversion factors and correction factors for variable area flowmeters can be found on pages R-1 to R-3 in the back of this catalog.

Multiply to get	→	←	to get Divide
Volume			
cc/min	1		mL/min
ft ³ /hr	0.125		GPM
ft ³ /hr	0.035315		LPH
ft ³ /hr	472		mL/min
ft ³ /min	28.31		LPM
ft ³ /min	0.471947		LPS
ft ³ /min	1.699		m ³ /hr
GPH	0.134		ft ³ /hr
GPH	63.1		mL/min
GPM	7.48051		ft ³ /min
GPM	3.785		L/min
GPM	0.227		m ³ /hr
LPH	0.264172		GPH
LPS	951.019		GPH
mL/min	0.06102		inch ³ /min
oz/min	29.57		mL/min
Mass			
g/hr	0.0022046		lb/hr
g/min	0.1322775		lb/hr
g/min	0.035274		oz/min
lb/hr	453.592		g/hr
oz/min	28.3495		g/hr

Technical Assistance?

Contact our expert Application Specialists to assist you. Call 1-847-549-7600 or go online to e-mail or chat live.



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Application/Selection Guide

Cole-Parmer offers a wide variety of flowmeters and flow controllers for any application. For special or unique applications, use the helpful "Application Parameter" table at right to narrow your selection.



- [Coriolis](#) See ColeParmer.com
- [Differential Pressure Technologies](#) 633-634
- [Displays/Totalizers/Controllers](#) 657
- [Gas Mass \(Thermal Dispersion\)](#) 624-632
 - [Flowmeters](#) 624-628
 - [Controllers](#) 629-631
- [Gear](#) 652
- [Magnetic](#) 658-661
 - [Insertion style](#) 658-659
 - [Full-bore](#) 658, 660-661
 - [Sanitary](#) 661
- [Paddle wheel](#) 646-651
 - [Open channel](#) 651
 - [Insertion](#) 646-648
 - [In-line](#) 649-651
- [Pelton Wheel](#) 635-638
 - [For liquids](#) 635-638
 - [For gases](#) 636, 638
- [Sight Flow Indicators](#) 622-623
- [Switches](#) 663-664
- [Turbine](#) 639-645
- [Ultrasonic](#) 653-656
 - [Doppler](#) 654-656
 - [Transit-time](#) 653, 655
- [Variable Area, Correlated](#) 611-621
 - [Glass tube, metal components](#) 611-619
 - [Glass tube, PTFE components](#) 618-620
- [Variable Area, Direct Reading](#) 593-610
 - [100% PTFE designs](#) 609
 - [Acrylic bodies](#) 593-600
 - [Glass tube, metal components](#) 596, 604-609, 611-613
 - [Glass tube, PTFE components](#) 608, 610
 - [Polysulfone](#) 601
 - [Spring-loaded designs](#) 602-604
- [Variable Area, Multitube systems](#) 611-613
- [Vortex](#) 662

Application Parameter	Gases	Liquids	Flowmeter type	Page(s)			
Low-flow measurement/control (some types as low as 1 sccm air and 0.1 mL/min water, max of range)	•	•	Gas Mass	624-632			
			Differential pressure	633-634			
			Indicators/switches	622-623, 663-664			
			Turbine	640			
			Variable area	593-621			
			Pelton Wheel	635-638			
			Vortex	662			
			Gear	652			
			Paddle wheel	646-651			
			Magnetic	658-661			
			Ultrasonic	653-656			
			High-flow measurement/control (some types as high as 2300 scfm gas and 2600 GPM liquid)	•	•	Gas Mass	624-629, 631-632
						Differential pressure	633-634
Indicators/switches	622-623, 663-664						
Variable area	593-621						
Pelton Wheel	635-638						
Vortex	662						
Paddle wheel	646-651						
Magnetic	658-661						
Turbine	640						
Ultrasonic	653-656						
High pressure (500 psi and above)	•	•				Gas Mass	627-630, 632
						Switches	664
						Variable area	602
			Gear	652			
			Turbine	642-644			
			Ultrasonic	653-656			
High temperature (200°F and above)	•	•	Differential pressure	633-634			
			Variable area	601-607, 609, 614-615, 616-617			
			Ultrasonic	653, 655-656			
			Turbine	643			
			Magnetic	658, 660			
			Paddle wheel	646-648, 650			
			Gear	652			
			High-accuracy measurement (error at or below 1%)	•	•	Differential pressure	633-634
Pelton Wheel	635-638						
Gas Mass	624-632						
Gear	652						
Paddle wheel	646-650						
Magnetic	658-661						
Turbine	640-644						
Ultrasonic	653, 655-656						
Aggressive or pure fluids	•	•	Gas Mass	627-630			
			Turbine	639-645			
			Switches	663-664			
			Variable area	604-605, 608-610, 618-620			
			Gear	652			
			Paddle wheel	650-651			
			Magnetic (aggressive only)	658-661			
			Ultrasonic	653-656			
Liquids with heavy particulates or slurries	•	•	Magnetic	658-661			
			Ultrasonic	654-656			
High-viscosity fluids	•	•	Gear	652			
			Magnetic	654-656			
No wired power available	•	•	Differential pressure	633-634			
			Sight flow indicators	622-623			
			Turbine	641-645			
			Variable area	593-621			
			Gear	652			
			Paddle wheel	650-651			
			Ultrasonic	654			
Intrinsically safe	•	•	Variable area	593-621			
			Turbine	641-642, 644			
Large pipe sizes (3" or larger)	•	•	Ultrasonic	653-656			
			Magnetic	659-661			
			Paddle wheel	646-648			
Sanitary (meets 3A standards)	•	•	Turbine	642-643			
			Magnetic	661			

KEY INFORMATION

Application/Selection Guide

Flowmeter Parameter Guide

Flowmeter Type	Best Accuracy	Media Type		Gas Flow Rate	Liquid Flow Rate	Viscosity	Max Pressure	Analog Output	Serial Communication	Pages
		Liquid	Gases							
Variable Area	±2% FS	Yes	Yes	0.1mL/min to 2200 LPM	0.002mL/min to 500 LPM	Water-like only	Typically 200 psig (varies)	Alarm units only	No	593-621
Gas Mass	±0.2% FS	No	Yes	0.01mL/min to 1000 LPM	—	—	Maximum 100 psig	Yes	Yes	624-632
Differential Pressure	±1% FS	Yes	Yes	0.02mL/min to 500 LPM	0 to 10 LPM	Water-like only	Maximum 100 psig	Yes	Yes	633-634
Pelton Wheel	±0.5% FS	Yes	Yes	20mL/min to 500 LPM	13mL/min to 10 LPM	Water-like only	Maximum 500 psig	Yes	Yes	635-638
Turbine	±0.5% of reading	Yes	No	—	0.11 to 17,791 LPM	Water-like only	Maximum 5000 psig	Yes	No	639-645
Paddle Wheel	±1% FS	Yes	No	—	0.03 to 26,411 LPM	Water-like only	Maximum 1500 psig	Yes	No	646-651
Gear	±0.5% of reading	Yes	No	—	0.01 to 227 LPM	Up to 100,000 cps	Maximum 5000 psig	Yes	No	652
Ultrasonic	±0.5% of reading	Yes	No	—	Varies w/ pipe size	Slurries	Varies w/type	Yes	Yes	653-656
Magnetic	≤0.3% of flow rate	Yes	No	—	0.38 to 22,620 LPM	Slurries	Maximum 259 psig	Yes	Yes	658-661
Vortex	±0.75% of flow rate	Yes	Yes	84 to 8228 LPM	Varies w/density	Up to 7.5cps	275 psig	Yes	Yes	662

Why Cole-Parmer should be your source for flowmeters

For more than 50 years, Cole-Parmer® has delivered solutions to our customers. With an unparalleled depth and breadth of flowmeter technologies, Cole-Parmer also has a solution to meet your needs. Our extraordinary customer service and technical expertise combine to support you before, during, and after your purchase. Whether your order is big or small, you can expect the same exceptional service and support.

Need a customized flowmeter? Ask about our Custom Ordering Solutions. We can customize just about any flowmeter to meet your specific application—from using different materials of construction to configuring the instrument for various electrical outputs. We also carry flowmeters with the regulatory and agency approvals that meet your requirements: FDA, UL, CSA, ETL, CE, 3A, FM, NSF, and ATEX. Plus, a team of technically-trained Application Specialists is available to help you choose the correct flowmeter and answer any of your questions. Products recommended by our Applications Specialists have a 99.97% customer satisfaction rate! What's more, our InnoCal® metrology lab can calibrate your flowmeter to ensure its accuracy. For information on calibration, see below.

