

The Essential Guide to Process Flow Measurement

ABB manufactures more types of flowmeters than any other manufacturer and is the only manufacturer who can give totally unbiased advice as to which flowmeter is suitable for a given application. This wall-chart details the major flow measurement techniques ABB offers, their capabilities and their suitability for an application.

- Advise*
- Analyze*
- Field*
- Measure*
- Operate*
- Optimize*

Electromagnetic

Service: Electrically conductive liquids or slurries (>0.05µsec/cm).
Design Pressure: Up to 3600 psig (250 bar).
Design Temperature: Up to 360°F (180°C).
Flow Range: 4 cc/min to 1,100,000 gpm (240 cm³/h to 250,000m³/h).
Scale: Linear.
Signal: Analog electronic; digital: Smart protocols; Bus protocols.
Accuracy: up to ± 0.15% of rate; factory calibrated.
Rangeability: up to 1500:1.
End Connections: Flanged, Sanitary, Wafer and Screw Connections available.
Sizes: 1/25" to 120" (1mm to 3m) probe available.
Advantages: Universal industrial flowmeter for conductive liquids. Widely used in the water industry for both clean and dirty water applications excellent for slurry measurements. Unaffected by changes in fluid density viscosity; zero head loss; bi-directional; no flow obstruction; low voltage dc, battery and loop powered versions available.
Limitations: Liquids or slurries only; required minimum electrical conductivity varies with manufacturer.



Partially Full Electromagnetic

Service: Water and effluent duty in partially filled pipelines /channels
 Direct alternative to high maintenance weirs and flumes
Design pressure: Up to 40 bar depending on liner / flange rating
Design temperature: Up to 130°C depending on liner material
Flow Range: Up to 10 m³/sec velocity
Scale: Linear
Signal: Analogue / pulse / datalink / Fieldbus protocols
Accuracy: +/- 1% to +/- 5% of reading, dependent on fill level.
Fill level limits: 10% to 100% of meter (15% to 100% of meter for DN150 size)
Size range: DN150 to DN2000
End connections: Flanged, ANSI or DIN (others on request)
Advantages: No additional pressure loss
 No moving parts
 No maintenance requirements for most applications
 Surface solids do not impede measurement accuracy
 Low installation cost compared to open channel techniques
Limitations: Must be installed in downward slope of 0.5 to 5%; Minimum size 150mm



Level Metering for Weirs and Flumes

Service: Liquids in open channels.
Flow Range: From 1/2 gpm (0.1m³/h) and upward.
Scale: Proportional to the measured head to the 3/2 power for rectangular and trapezoidal weirs and parshall flumes; proportional to the measured head to the 5/2 power for V-notch weirs.
Signal: Analog electronic.
Accuracy: 1% to 5% full scale.
Rangeability: 75:1 rectangular, trapezoidal weirs, Parshall flumes; 50:1 V-notch weirs; Palmer-Bowlius flumes 10:1.
Advantages: Ideal for water and waste flows, flumes have low head loss, low cost.
Limitations: Weirs are more accurate than flumes but require cleaning; flumes are self cleaning.

Mass

Coriolis Effect
Service: Liquids and gases including slurries.
Design Pressure: Up to 1400 psig (100 bar).
Design Temperature: Up to 360°F (180°C).
Flow Range: Up to 11,000 kg/min.
Scale: Linear.
Accuracy: ±0.15% of rate or better.
Rangeability: 40:1 or better.
End Connections: Threaded, Flanged, Sanitary
Sizes: 1/16" to 6" (1.5mm to 150mm).
Advantages: Measures mass flow temperature and fluid density directly. Handles difficult applications.
Limitations: Installation requirements vary with manufacturer. Head loss may be high. Sensitive to fluid pulsation. Care must be taken with 2 phase flow.

Thermal
Service: Gas
Design Pressure: Up to 560 psig (100 bar).
Design Temperature: Up to 570° F (300°C).
Flow Range: Up to 900m³/h. Up to 3 million kg/h (for DN 3000).
Scale: Linear.
Accuracy: ±1% of rate.
Rangeability: 150:1 or better.
End Connections: Threaded, flanged, hose.
Sizes: 1/8" to 10" (3mm to 250mm)
 Probe available for pipes up to 3000mm; bypass type available.
Advantages: Measures mass flow directly. Very low pressure loss. Good for low velocity gas measurement. Unit may be calibrated for any shape of ducting.
Limitations: Affected by significant coatings. Some designs are fragile.



Vortex / Swirl

Vortex Shedding (Bluff body)
Service: Liquids and gases including steam.
Design Pressure: Up to 2400 psig (160 bar).
Design Temperature: Up to 750°F (400°C).
Flow Range: 3 to 10, 586 gpm (0.4 to 2400m³/h) liquid; 100 to 720,000 acfh (20,000m³/h) gases.
Scale: Linear at high Reynolds No.
Signal: Frequency or Analog electronic
Accuracy: ±0.75% of rate or better on liquid; factory calibrated: ± 1% of rate on gas. 20:1.
Rangeability: 20:1.
End Connections: Flanged, Threaded, Wafer or Insert; also can be used as by-pass meter around mainline orifice.
Sizes: 1.2" to 12" (15mm to 300mm)
Advantages: No moving parts: suitable for wide variety of fluids; excellent combination of price and performance. Direct steam mass flow.
Limitations: Straight piping required; sensitive to increasing viscosity below a given Reynolds number.

Swirlmeter
Service: Liquids, gases and steam.
Design Pressure: Up to 1650 psig (110 bar).
Design Temperature: -40°F to 550°F (-40 to 280°C).
Flow Range: 0.3 to 6600 gpm (0.1 to 1800m³/h) liquid; 88 to 706,300 acfh (2.5 to 20,000m³/h) gases.
Scale: Linear at high and low Reynolds No.
Signal: Pulse or analog output.
Accuracy: ±0.5% of rate or better; liquids, gas or steam.
Rangeability: 25:1 turn down average (determined by size, application)
End Connections: Flanged.
Sizes: 0.5" to 16" (15mm to 300mm).
Advantages: No moving parts, 3 upstream pipe diameters, ideal for light gases, works with entrained liquid. Direct steam mass flow.
Limitations: Limited viscosity range.



Variable Area

Service: Liquids and gases including steam (metal tube only).
Design Pressure: Up to 300 psig (20 bar) glass tube, up to 900 psig (64 bar) metal tube.
Design Temperature: Up to 250°F (120°C) glass tube, up to 790°F (420°C) metal tube.
Flow Range: Liquids 0.01 cc/min to 530 gpm (0.6cm³/h to 120m³/h) gases 0.3cc/min to 2000 scfm (5Nm³/h to 3600 Nm³/h) gases.
Scale: Linear.
Signal: Visual; electronic or analog.
Accuracy: ± 1.0% of rate to ± 10% of full scale depending on type, size, and calibration.
Rangeability: 5:1 to 12:1.
End Connections: Female pipe threaded, flanged or sanitary connections.
Sizes: Up to 4" (100mm) also used as a by-pass meter around a mainline orifice for larger pipe sizes.
Advantages: Inexpensive; constant pressure drop; insensitive to viscosity variations below a given threshold; direct indicating; no power required; can be direct mass device; no straight upstream piping required. Versions available with PTFE liners.
Limitations: Requires accessories for data transmission; must be vertically mounted; gas use requires minimum backpressure.



	Clean Liquids	Dirty Liquids	Corrosive Liquids	Viscous Liquids	Abrasive Slurries	Fibrous Slurries	Low Velocity Flows	Vapor or Gas	Hi Temp. Service	Cryogenic Service	Semi-filled Pipes	Non-Newtonians	Open Channel
Magnetic													
Mass													
Oscillatory	<i>Coriolis</i>												
	<i>Thermal</i>												
Turbine	<i>Vortex Shedding</i>												
	<i>Swirlmeter</i>												
Ultrasonic													
Differential Pressure	<i>Transit Time</i>												
	<i>Orifice</i>												
	<i>Venturi</i>												
	<i>Flow Nozzles & Tubes</i>												
	<i>Pilot Tubes</i>												
<i>Wedge</i>													
Variable Area													
Weirs and Flumes Level													

Designed for this Service
 Normally applicable for this service
 Applicable for this service under certain conditions, consult manufacturer
 Not applicable for this service



Orifice

Service: Liquids and gases including steam.
Design Pressure: Determined by transmitter.
Design Temperature: Determined by materials.
Flow Range: From 0.1 cc/min (0.1cm³/m) and upward or gas equivalent.
Signal: Analog electronic or pneumatic.
Accuracy: ± 0.6% of max flow uncalibrated including transmitter; sizes smaller than 2" usually calibrated.
Rangeability: 4:1 for given transmitter span setting.
End Connections: Mounts between flanges.
Sizes: Determined by pipe size.
Advantages: Easy-to-install; uses one transmitter regardless of pipe size; low cost; wide variety of types and material available; easy-to-change capacity.
Limitations: Uses eccentric orifices or segmental plates for very dirty liquids or slurries; quadrant orifice for viscous liquids; venturi, flow tube, pilot, or elbow taps to reduce energy consumption; straight run of upstream and downstream piping required. Some fluid must leave pipe except when chemical seal protectors are used. Accuracy affected by wear.



Venturi

Service: Liquids and gases including steam.
Design Pressure: Determined by transmitter.
Design Temperature: Determined by materials.
Flow Range: From 5 gpm (1m³/h) liquid; 20 scfm (30 Nm³/h) gas; and upward, determined by pipe size.
Signal: Analog electronic or pneumatic.
Accuracy: ± 1% of max flow or better; uncalibrated including transmitter.
Rangeability: 4:1 for given transmitter span setting.
End Connections: Flanged.
Sizes: Up to 72" (1800mm) larger possible
Advantages: Low permanent loss; good for slurries and dirty fluids; uses one transmitter regardless of pipe size. Extremely robust construction.
Limitations: Most expensive D P producer; generally limited to air and water; big and heavy especially in larger pipe sizes. Accuracy affected by wear.



Flow Nozzles and tubes

Service: Liquids and gases including steam.
Design Pressure: Determined by transmitter.
Design Temperature: Determined by materials.
Flow Range: From 5 gpm (1m³/h) liquid; 20 scfm (30 Nm³/h) gas and upwards.
Signal: Analog electronic or pneumatic.
Accuracy: ± 1% full scale including transmitter, flow calibration recommended.
Rangeability: 4:1 for given transmitter span setting.
End Connections: Flanged or mounted between flanges. 3" to 48" (80mm to 1200mm).
Advantages: Economical, low permanent loss; uses one transmitter regardless of pipe size; nozzle commonly used for steam and has higher capacity for same generated D P.
Limitations: Flow tubes lack extensive background data compared to orifice plates; application on viscous liquids limited. Calibration recommended for optimum performance.



Pitot

Service: Liquids and gases.
Design Pressure: Determined by transmitter.
Design Temperature: Determined by materials.
Flow Range: From 5 gpm (1m³/h) liquid; 20 scfm (30 Nm³/h) gas and upwards.
Signal: Analog electronic or pneumatic.
Accuracy: ± 1% full scale or better including transmitter.
Rangeability: 4:1 for given transmitter span setting.
End Connections: Insert probe.
Sizes: Unlimited probe length.
Advantages: Very low cost; uses one transmitter regardless of pipe size; nozzle commonly used for steam and has higher capacity for same generated D P.
Limitations: Doesn't sample full stream; limited accuracy. Low differential pressure for given flow rate.



Wedge

Service: Liquids and gases.
Design Pressure: Determined by transmitter.
Design Temperature: Determined by materials.
Flow Range: From 5 gpm (1m³/h) liquid; 20 scfm (30 Nm³/h) gas and upwards.
Signal: Analog electronic or pneumatic.
Accuracy: ± 0.5% of actual flow when operated in the calibrated range.
Rangeability: 4:1 for given transmitter span setting.
End Connections: Flanged or mounted between flanges. Up to 48" (1200mm).
Advantages: Very economical; easy-to-install; uses one transmitter regardless of pipe size; can be bi-directional; low pressure loss.
Limitations: Minimum upstream piping required. Not good for very low velocity.



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