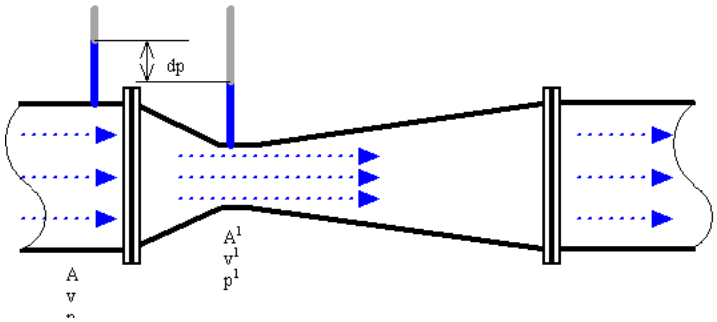
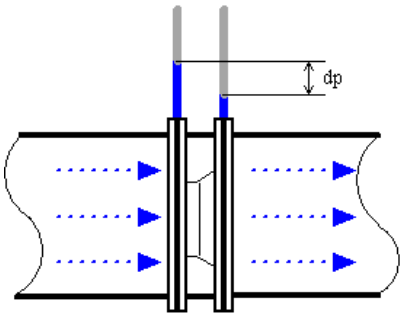
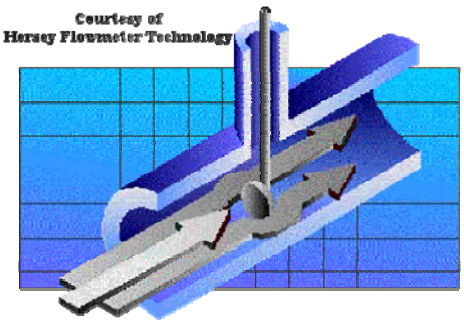
SELECCIÓN DE CAUDALIMETROS

Tablas de Fabricantes







SELECCION DE CAUDALIMETROS

Application

Technology	Vapor or Gas	Clean Liquids	Corrosive Liquids	Dirty Liquids	Viscous Liquids	Slurries	Hi-Temp Service	Semi-Filled Pipes	Open Channel
KEY ● Best for this application ◑ OK with some exceptions ◍ OK for some applications but check first ✕ Do not use in this service									
Magnetic	✕	●	●	●	◍	●	◑	◑	◑
Thermal Mass	●	◑	◑	◑	◑	◑	◑	✕	✕
Ultrasonic - Transit Time	◑	●	◑	◑	◑	✕	✕	✕	◑
Ultrasonic - Doppler	✕	✕	◑	●	◑	◑	✕	✕	✕
Vortex Shedding	●	●	◍	◍	◑	✕	◑	✕	✕
Turbine	●	●	◑	◑	◍	✕	◍	✕	◑
Variable Area	●	●	◍	◍	◍	✕	◍	✕	✕
Postive Displacement	●	●	◑	✕	●	✕	◑	✕	✕
Differential Pressure	●	●	◑	◑	◑	◑	◑	✕	✕

Flowmeter Selection Guide

Technology	*Fluid Type*						*Pressure Loss*	*Max Temp F*	*Max Press psi*	*Pipe Diam's Req'd*	*Typical Turndown*	*Typical Accuracy*	*Sizes inches*	*Notes*
	Clean Liquid	Dirty Liquid	Viscous Liquid	Slurry	Gas	Steam								
Magnetic	▨	▨	▨	▨			None	450	750	10	30 to 1	.5% Rate	.1 to 96	Fluid must be conductive
Coriolis	▨	▨			▨		Medium	500	1500	None	40 to 1	.25% Rate	.1 to 8	Very accurate, MV, Mass
Ultrasonic	▨	▨			▨		None	350	500 or pipe rat'g	5 to 30	25 to 1	.75% Rate	1 +	Fastest growing technology
Vortex	▨				▨	▨	Low	450	1500	10 to 20	20 to 1	1% Rate	2 to 12	Great steam flowmeter
Turbine	▨				▨		Low	500	3000	10 to 20	10 to 1	.5% Rate	.25 to 24	Largest # of meters sold
Diff. Pressure	▨				▨	▨	Medium	750	3000	10 to 30	5 to 1	2% FS	Any	Orifice, Venturi, Pitot, Flow elmt's
Pos Displacement	▨		▨		▨		High	450	1500	None	15 to 1	.5% Rate	.25 to 16	Oval, Piston, Rotary Vane
Variable Area	▨				▨		Low	600	1500	None	10 to 1	2% FS	1/8 to 4	No power req'd, Metal Tube
Open Channel	▨						Low	200	N/A	None to 20	10 to 1	2% FS	2 +	Plant effluent, Flumes/Weirs
Thermal					▨		Low	500	1500	None to 30	30 to 1	1% FS	1/8 +	Small MFC's to large ducts

Intended Service ▨
Possibly Applicable
Not Applicable

This guide represents an overview of flowmeter selection and a thorough evaluation of each application should be done to ensure proper selection.

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Flowmeter Selection Table

	Material Phase											
Flowmeter	**Clean Liquid**	**Viscous Liquid**	**Slurry**	**Gas**	**Solid**	**Turndown**	**Pressure Loss**	**Upstream Straight Pipe Dia (Guide)**	**Downstream Straight Pipe Dia (Guide)**	**Typical Accruacy (% FSC)**	**Relative Cost**	**Notes**
Coriolis	Y	Y	?	Y	?	20:1	H	None	None	0.5	M	U' Tube are better than 'S' tube models but are however more expensive.
Dall Tube	Y	?	?	Y	N	3:1	M-H	15	5	1	H	Similar to venturi but cheaper to manufacture.
Magnetic	Y	Y	Y	N	N	10:1	N	5	3	2	H	Must be conductive
Orifice Plate	Y	?	?	Y	N	3:1	H	20	5	1 to 2	L	Limitation of accuracy is due to differential pressure sensing element.
Pitot Tube	Y	N	?	Y	N	3:1	M	30	5	1 to 5	L	Pitot tube only provides point measurement of fluid flow in pipe.
Positive Displacement	Y	Y	N	Y	N	10:1	H	None	None	1		On dirty duty filter required. Turndown may be higher on Gas service.
Solids Flowmeter	N	N	N	N	Y	20:1	NA	NA	NA	2	H	
Target Meter	Y	Y	?	Y	N	4:1	H	20	5	1 to 5	L	
Thermal Mass Flow	Y	?	?	Y	N	20:1	M-H	5	3	1	M	On dirty duty filter required.
Turbine	Y	?	N	?	N	10:1	H	15	5	0.25		Maitnenance costs high due to need to overhaul.
Ultrasonic	Y	?	Y	?	?	10:1	N	15	5	2 to 3	M	Cost depends on size? Clamp on meters difficult to get good / clean pipe connection.
Variable Area	Y	?	?	Y	N	5:1	M	None	None	5 to 10	L	Generally these instruments provide local indication only.
Venturi	Y	?	?	Y	N	3:1	M	15	5	0.5 to 1	H	Limitation of accuracy is due to differential pressure sensing element.
Vortex	Y	N	N	Y	N	10:1	H	20	5	1	M	
Wier / Flumes	Y	?	?	N	N	100:1	M	See Link	See Link	2-5%	H	

Y- Yes
N- No
?- Sometimes

H- High
M- Medium
L- Low
N- None

Table 1
A Comparison of Flowmeter Options

Attribute	Variable-area	Coriolis	Gas mass-flow	Differential-Pressure	Turbine	Oval Gear
Clean gases	yes	yes	yes	yes	yes	—
Clean Liquids	yes	yes	—	yes	yes	yes
Viscous Liquids	yes (special calibration)	yes	—	no	yes (special calibration)	yes, >10 centistokes (cst)
Corrosive Liquids	yes	yes	—	no	yes	yes
Accuracy, ±	2-4% full scale	0.05-0.15% of reading	1.5% full scale	2-3% full-scale	0.25-1% of reading	0.1-0.5% of reading
Repeatability, ±	0.25% full scale	0.05-0.10% of reading	0.5% full scale	1% full-scale	0.1% of reading	0.1% of reading
Max pressure, psi	200 and up	900 and up	500 and up	100	5,000 and up	4,000 and up
Max temp., °F	250 and up	250 and up	150 and up	122	300 and up	175 and up
Pressure drop	medium	low	low	medium	medium	medium
Turndown ratio	10:1	100:1	50:1	20:1	10:1	25:1
Average cost*	$200-600	$2,500-5,000	$600-1,000	$500-800	$600-1,000	$600-1,200

*Cost values can vary quite a bit depending on process temperature and pressures, accuracy required, and approvals needed.

SELECCION DE CAUDALIMETROS

Table 1: Flowmeter Evaluation Table

FLOWMETER	PIPE SIZE, in. (mm)	GASES (VAPORS)					LIQUIDS																	TYPICAL Accuracy, uncalibrated (Including transmitter)	TYPICAL Reynolds number ‡ or viscosity	TEMPERATURE °F (°C)	PRESSURE psig (kPa)
					PRESS			VISCOUS																				
		STEAM	CLEAN	DIRTY	HIGH	LOW	CLEAN	HIGH	LOW	DIRTY	CORROSIVE	VERY CORROSIVE	FIBROUS	SLURRIES	ABRASIVE	REVERSE FLOW	PULSATING FLOW	HIGH TEMPERATURE	CRYOGENIC	SEMI-FILLED PIPES	NON-NEWTONIANS	OPEN CHANNEL				
SQUARE ROOT SCALE: MAXIMUM SINGLE RANGE 4:1 (Typical)**																											
Orifice																											
Square-Edged	›1.5 (40)	√	√	X	√	√	√	X	?	X	?	X	X	X	SD	?	√	√	X	?	X	±1-4% URV	R_D › 10,000	Process temperature to 1000°F (540°C): Transmitter limited to -30-250°F (-30-120°C)	To 4,000 psig (41,000 kPa)
Honed Meter Run	0.5-1.5 (12-40)	√	√	X	√	√	√	?	?	X	?	X	X	X	SD	?	√	√	X	?	X	±1% URV	R_D › 10,000		
Integrated	‹0.5 (12)	?	√	X	√	√	√	X	?	X	?	?	X	X	SD	?	?	X	X	?	X	±2-5% URV	R_D › 10,000		
Segmental Wedge	‹12 (300)	√	√	√	√	√	√	?	√	?	?	X	?	?	SD	?	√	√	X	?	X	±0.5% URV	R_D › 500		
Eccentric	›2 (50)	?	?	√	√	√	?	X	?	?	?	X	?	X	SD	?	√	√	X	?	X	±2-4% URV	R_D › 10,000		
Segmental	›4 (100)	?	?	√	√	√	?	X	?	?	?	X	?	X	SD	?	√	√	X	?	X	±2-4% URV	R_D › 10,000		
V-Cone	0.5-72 (12-1800)	√	√	?	√	√	√	?	√	?	?	X	?	?	X	?	?	?	X	?	X	±0.5-1% of rate	R_D : 8,000-5,000,000	700 (370)	≤600 (4,100)
Target***	‹0.5(12)	?	√	√	√	√	√	?	√	√	?	X	X	X	?	X	?	?	X	?	X	±0.5-5% URV	R_D › 100	Process temperature to 1000°F (540°C): Transmitter limited to -30-250°F (-30-120°C)	To 4,000 psig (41,000 kPa)
Venturi	›2 (50)	√	√	?	√	√	√	?	√	?	?	X	√	?	X	?	?	?	X	?	X	±0.5-2% URV	R_D › 75,000Ł		
Flow Nozzle	›2 (50)	?	√	?	√	√	√	X	?	?	?	X	X	X	X	?	?	?	X	?	X	±1-2% URV	R_D › 50,000Ł		
Low Loss Venturi	›3 (75)	√	√	X	√	√	√	X	?	X	√	X	X	X	X	?	?	?	X	?	X	±1.25% URV	R_D › 12,800Ł		
Pitot	›3 (75)	X	√	X	√	√	√	X	?	X	?	X	X	X	X	X	?	?	X	X	X	±3-5% URV	R_D › 100,000Ł		
Averaging Pitot	›1 (25)	√	√	SD	√	√	√	X	?	SD	?	X	X	X	SD	X	?	?	X	X	X	±1-2% URV	R_D › 40,000Ł		
Elbow	›2 (50)	X	√	?	√	√	√	X	?	?	?	X	X	X	√	X	?	?	X	?	X	±5-10% URV	R_D › 10,000Ł		
Laminar	0.25-16.6 (6-400)	?	√	X	√	√	√	√	?	X	?	X	X	X	X	√	X	X	X	X	X	±1% of rate	R_D ‹ 500	150 (66)	≤30 (225)
LINEAR SCALE TYPICAL RANGE 10:1 (Or better)																											
Magnetic*	0.1-72 (2.5-1800)	X	X	X	X	X	√	?	√	√	√	√	√	√	√	√	√	?	X	?	?	?	±0.5% of rate	R_D › 4,500	360 (180)	≤ 1,500 (10,800)
Positive Displacement																											
Gas	‹12 (300)	X	√	X	?	√	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	±1% of rate	-	250 (120)	≤ 1,400 (10,000)
Liquid	‹12 (300)	X	X	X	X	X	√	√	?	X	?	X	X	X	X	X	X	?	X	X	X	X	±0.5% of rate	No R_D limit ≤ 8,000 cS	600 (315)	≤ 1,400 (10,000)
Turbine																											
Gas	0.25-24 (6-600)	SD	√	X	√	√	X	X	X	X	X	X	X	X	SD	SD	?	?	X	X	?	±0.5% of rate	-	-450-500 (268-260)	≤ 3,000 (21,000)
Liquid	0.25-24 (6-600)	X	X	X	X	X	√	X	?	X	?	X	X	SD	SD	SD	?	?	X	X	?	±0.5% of rate	R_D › 5,000, ≤15 cS	-450-500 (268-260)	≤ 3,000 (21,000)
Ultrasonic																											
Time of Flight	›0.5 (12)	X	SD	SD	SD	SD	√	?	?	X	√	√	?	?	√	√	X	?	X	X	?	±1% of rate to ff15% URV	R_D › 10,000	-300-500 (-180-260)	Pipe rating
Doppler	›0.5 (12)	X	X	X	X	X	X	?	?	√	√	√	√	√	√	√	X	X	X	?	X	±1% of rate to ff15% URV	R_D › 4,000	-300-500 (-180-260)	Pipe rating
Variable-Area (Rotameter)	≤3 (75)	?	√	X	X	√	√	X	?	X	?	?	X	X	X	?	?	?	X	X	X	±1% of rate to ff10% URV	No R_D limit, ‹ 100 cS	Glass: 400 (200) Metal: 1,000 (540)	Glass: 350 (2,400) Metal: 720 (5,000)
Vortex Shedding	1.5-16 (40-400)	√	√	?	√	√	√	X	?	?	?	X	X	X	X	X	?	?	X	X	X	±0.75-1.5% of rate	R_D › 10,000, ‹ 30 cP	400 (200)	≤ 1,500 (10,500)
Vortex Precession (Swirl)	‹16 (400)	√	√	?	√	√	√	X	?	X	?	X	X	X	X	X	?	X	X	X	X	±0.5% of rate	R_D › 10,000, ‹ 5 cP	536 (280)	Pipe rating
Fluidic Oscillation (Coanda)	›1.5 (40)	X	X	X	X	X	√	X	X	?	?	X	X	X	X	?	?	?	X	X	X	±2% of rate	R_D › 2,000, ‹ 80 cS	350 (175)	≤ 720 (5,000)
Mass																											
Coriolis	0.25-6 (6-150)	?	?	?	√	√	√	√	√	?	?	?	√	?	?	?	?	X	√	X	±0.15-10% of rate	No R_D limit	-400-800 (-224-427)	≤ 5,700 (39,900)
Thermal Probe	‹72 (1800)	X	√	?	√	√	√	?	√	√	?	?	?	?	X	?	?	X	X	?	X	±1-2% URV	No R_D limit	1,500 (816)	Pipe rating
Solids Flowmeter	‹24 (600)	X	X	X	X	X	X	SD	X	?	X	X	SD	SD	X	SD	SD	X	√	X	X	±0.5% of rate to ff14% URV	-	750 (400)	≤ 580 (4,000)
Correlation																											
Capacitance	‹8 (200)	X	X	X	X	X	X	√	√	√	√	√	√	√	X	?	?	X	?	?	X	No data available	No data available	300 (149)	≤ 580 (4,000)
Ultrasonic	›0.5 (12)	X	X	X	X	X	X	?	√	√	√	√	√	√	X	?	X	X	X	?	X	±6% of ??	No data available	-300-250 (-180-120)	Pipe rating

cP = centi Poise
cS = centi Stokes
SD = Some designs

? = Normally applicable (worth consideration)
√ = Designed for this application (generally suitable)

URV = Upper Range Value
X = Not applicable

‡ According to other sources, the minimum Reynolds number should be much higher

* Liquid must be electrically conductive
** Range 10:1 for laminar, and 15:1 for target
*** Newer designs linearize the signal

SELECCION DE CAUDALIMETROS

Table 2: Orientation Table For Flow Sensors

TYPE OF DESIGN	DIRECT MASS-FLOW SENSOR	DIFFERENTIAL PRESSURE-FLOW SENSOR	VOLUME DISPLACEMENT-FLOW SENSOR	VELOCITY-FLOW SENSOR	EXPECTED ERROR FROM VISCOSITY CHANGE	TRANSMITTER AVAILABLE	LINEAR OUTPUT	RANGEABILITY	PRESSURE LOSS THRU SENSOR	APPROX. STRAIGHT PIPE-RUN REQUIREMENT⑤ (UPSTREAM DIAM./DOWNSTREAM DIAM.)	FLOW RANGE⑨
Orifice (plate or integral cell)		√			H	√	SR	3:1 ②	H	20/5	gpm—m^3/hr ③ / SCFM—Sm^3/hr
Segmental Wedge		√			M	√	SR	3:1 ②	A	20/5	gpm—m^3/hr
V-Cone Flowmeter		√				√	SR	3:1 to 15:1②	M	2/5	gpm—m^3/hr / ACFM—Sm^3/hr
Target Meters		√			A	√	SR	15:1	M	20/5	gpm—m^3/hr ④ / SCFM—Sm^3/hr
Venturi Tubes		√			H	√	SR	3:1 ②	M	15/5	gpm—m^3/hr ③ / SCFM—Sm^3/hr
Flow Nozzles		√			H	√	SR	3:1 ②	A	20/5	
Pitot Tubes		√			M	√	SR	3:1 ②	M	30/5	gpm—m^3/hr ④ / SCFM—Sm^3/hr
Elbow Taps		√			M	√	SR	3:1 ②	N	25/10	gpm—m^3/hr ③ / SCFM—Sm^3/hr
Laminar Flowmeters		√				√	√	10:1②	H	15/5	gpm—m^3/hr / SCFM—Sm^3/hr
Magnetic Flowmeters				√	N	√	√	30:1⑦	N	5/3	gpm—m^3/hr
Positive Displacement Gas Meters			√			SD	√	10:1 to 200:1	M	N	SCFM—Sm^3/hr
Positive Displacement Liquid Meters			√		M	SD	√	10:1⑦	A	N	gpm—m^3/hr
Turbine Flowmeters			√	√	H	√	√	10:1⑧	A	15/5	gpm—m^3/hr / SCFM—Sm^3/hr
Ultrasonic Flowmeters											
Time of Flight			√	√	N	√	√	20:1	N	20/5	gpm—m^3/hr ③
Doppler			√	√	N	√	√	10:1	N	20/5	SCFM—Sm^3/hr
Variable Area (Rotamater)					A	√	√	10:1	M	N	gpm—m^3/hr / SCFM—Sm^3/hr
Vortex Shedding	SD			√	A	√	√	10/1⑥	A	20/5	gpm—m^3/hr
Fluidic Oscillation (Coanda)				√	A	√	√	12/1⑥	H	20/5	ACFM—Sm^3/hr
Mass Flowmeters Coriolis	√				N	√	√	20:1	M/H	N	lbm—kgm/hr / SCFM—Sm^3/hr
Mass Flowmeters Thermal Probe	√			SD	N	√	√	20:1⑦	M	20/5	gpm—m^3/hr / SCFM—Sm^3/hr
Solids Flowmeters	SD					√	√	5:1 to 80:1	-	5/3	lbm—kgm/hr
Weirs, Flumes					M	√	SD	100:1	M	4/1	gpm—m^3/hr ③

= Non-standard Range
L = Limited
SD = Some Designs
H = High
A = Average
M = Minimal
N = None
SR = Square Root

① = The data in this column is for general guidance only.
② = Inherent rangeability of primary device is substantially greater than shown. Value used reflects limitations of differential pressure sensing device when 1% of rate accuracy is desired. With multiple-range intelligent transmitters, rangeability can reach 10:1.
③ = Pipe size establishes the upper limit.
④ = Practically unlimited with probe type design.
⑤ = Varies with upstream disturbance.
⑥ = Can be more with high Reynolds number services.
⑦ = Up to 100:1.
⑧ = More for gas turbine meters.
⑨ = Higher and lower flow ranges may be available. Check several manufacturers.

General Guidelines for Flow Meter Selection

Flow Meter	Recommended Service	Turndown	Typical Pressure Loss	Typical Accuracy FS = Full Scale	Required Upstream pipe, diameters	Effects from changing viscosity?
Turbine	Clean, viscous liquids	20 to 1	High	+/- 0.25% of rate	5 to 10	High
Positive Displacement	Clean, viscous liquids	10 to 1	High	+/- 0.5% of rate	None	High
Electromagnetic (Mag-Meter)	Clean, dirty, viscous, conductive liquids and slurries	40 to 1	None	+/- 0.5% of rate	5	None
Variable Area (VA, Rota-meter)	Clean, dirty, viscous liquids	10 to 1	Medium	+/- 1 to 10% FS	None	Medium
Thermal Mass Flow (TMF)	Clean dirty viscous liquids some slurries	10 to 1	Low	+/- 1% FS	None	None
Coriolis Mass Meter	Clean, dirty. viscous liquids, some slurries	10 to 1	Low	+/- 0.5% of rate	None	None
Orifice Plate	Clean, dirty, liquids some slurries	4 to 1	Some	+/- 2 to 4% FS	10 to 20	High
Pitot tube	Clean liquids	3 to 1	Very low	+/- 3 to 5% FS	20 to 30	Low
Ultrasonic (Doppler)	Dirty, viscous, liquids and slurries	10 to 1	None	+/- 5% FS	5 to 30	None
Ultrasonic (Transit Time)	Clean, viscous, liquids some dirty liquids (depending on brand)	40 to 1	None	+/- 1 to 3% FS	10	None
Venturi	Some slurries but clean, dirty and liquids with high viscosity	4 to 1	A little	+/- 1% FS	5 to 18	High
Vortex	Clean, dirty liquids	10 to 1	Medium	+/- 1% of rate	10 to 20	Medium