



Technology Solutions

TEK-FLO MASS 1300D

Steam Quality Meter



FLOW



Introduction

Tek-Flo Mass 1300D Flo Meter utilize two different Flo Meter technologies in combination; vortex and differential pressure. The design has blended the two separate flow metering principles into one meter body such that the two meters do not have adverse effects on each other's performance. This combination allows for the prediction of the fluid density, volumetric flow rate and mass flow rate without any fluid density information being required from an external source.

This ability to predict fluid density allows the meter to provide several valuable measurements. With wet gas and steam applications the Flo Mass meter will provide an accurate total mass flow measurement. In steam service, the meter is able to provide a reliable steam quality (steam dryness) measurement. The Flo Mass meter is also able to calculate the density of gas mixtures.

Measuring Principle

The Flo Mass Principle of Operation With a single phase flow, a Vortex Meter measures the actual volumetric flow rate (Q). The Vortex Meter reads the vortex shedding frequency off the bluff body (f) and relates it via the meter factor (K) to the volume flow rate (Q), see equation 1. This volumetric flow rate measurement is density insensitive.

$$(1) \quad Q = \frac{f}{K}$$

With a single phase flow, a differential pressure (DP) flow meter measures the volumetric flow rate once the density is supplied from an external source. The DP meter volume flow rate calculation is density (p) sensitive. Equation 2 shows the Cone DP Meter volumetric flow equation, where E and A_t are fixed geometry terms, C_d is the discharge coefficient, and ΔP_t is the Cone Meter DP primary signal.

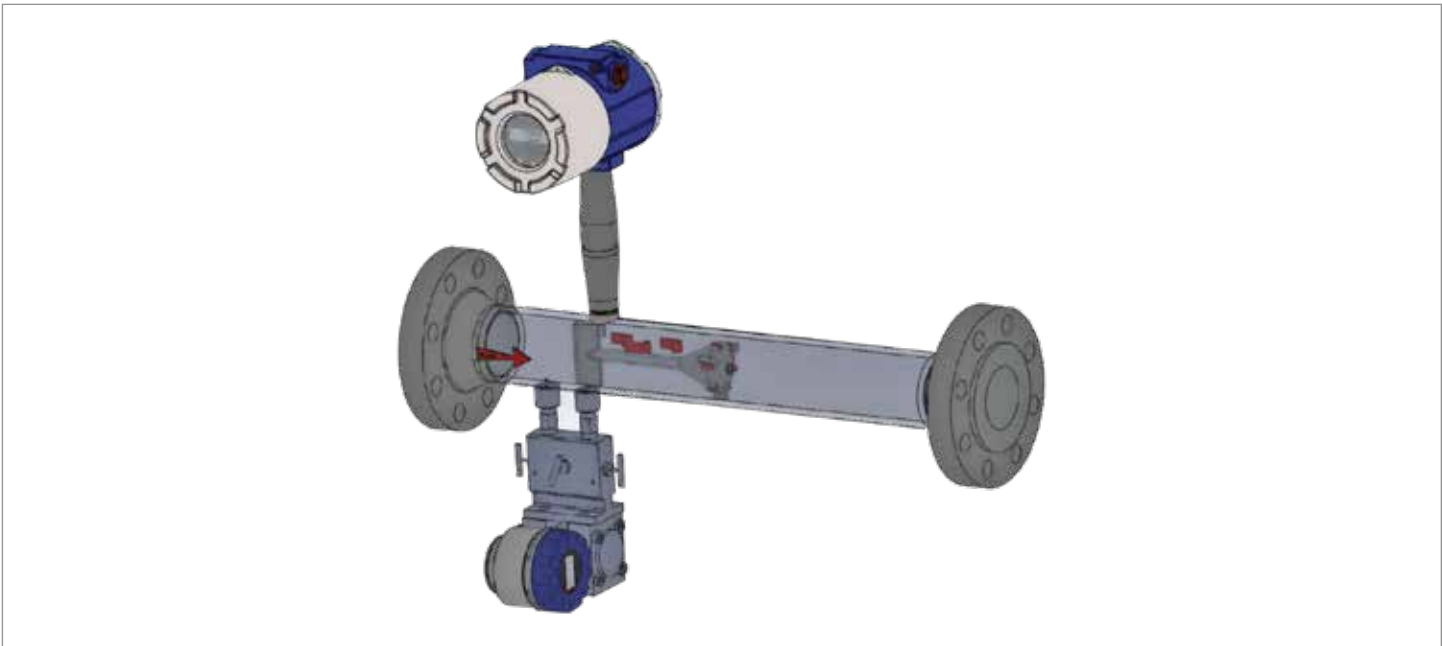
$$(2) \quad Q = EA_t C_d \sqrt{\frac{2\Delta P_t}{\rho}}$$

As described by Boden's work in the 1950's, if a density sensitive meter (Cone DP Meter) is cross referenced with a density insensitive meter (Vortex Mteter) the density can be derived internally by the system, i.e. see equation 3.

$$(3) \quad \rho = 2\Delta P_t \left\{ \frac{K}{f} EA_t C_d \right\}^2$$

The Flo Mass flow rate calculation is now calculated via equation 4, where the vortex meter volumetric flow prediction (Q) and this internal density prediction (p) are used. No external density measurement is required.

$$(4) \quad m = \rho Q$$



Features

- Can provide a measurement of fluid density, volumetric flow rate and mass flow rate without any fluid information being required from an external source.
- In steam service, the meter is able to provide a reliable steam quality (steam dryness) measurement as well as mass flow measurement.
- Able to calculate the density of changing gas mixtures. For example, natural gas is typically a composition of many different gases which can vary over time and vary by application.
- More cost effective than current steam quality and wet gas meters on the market.
- Advanced diagnostic software is able to continually monitor and verify the meter's primary flow element health and confirm output uncertainty.
- Able to use with liquids, gases, and steam.
- Multi-variable options available for temperature and pressure measurement.
- Multiple readings from a single installed device reduces initial cost, installation cost and cost-of ownership over the lifetime of the instrument.
- Mass flow equations for additional diagnostic information and verification. - real gas, ideal gas, AGA 8, API 2540.
- Energy Monitoring—ability to compute and output energy consumption with select fluids, like Steam, water, and heat transfer fluids.
- Easy to install and commission.
- Reliable—no moving parts, no fluid to sensor contact.
- Temperature up to 750°F (400°C).
- Pressure up to 1500 psi.
- Inline configuration for pipes from 2" - 12" (DN 50 to DN 300).
- Field configurable ranges, outputs and displays.
- Remote electronics option available for use in harsh environments or locations with limited access.
- HART protocol communications - Standard.
- Modbus, BACnet, Power over Ethernet (PoE) communications available.

Vortex Meter Options

- Flo Mass Model 1300D-VTP

The Model 1300D-VTP offers you flow computer functionality in a compact field device. This multi-variable instrument incorporates temperature and pressure sensors to provide an instantaneous reading of the compensated mass flow rate of gases, liquids and steam. In addition to outputs for totalized mass and alarm settings, the field-configurable electronics deliver up to three analog 4-20 mA outputs of five process measurements, including volumetric flow rate, mass flow rate, pressure, temperature and density.

- Flo Mass Model 1300D-VT

The Model 1300D-VT integrates a precision 1000 Ohm platinum RTD temperature sensor that can be used to calculate and output a compensated mass reading. This device is typically used to measure flow rates of saturated steam.

- Flo Mass Model 1300D-V

The Model 1300D-V delivers a direct reading of volumetric flow rate generally the most cost-effective solution for liquid flow monitoring in applications ranging from general water flows to hydrocarbon fuel flow measurement.

Verification System

- Flo Mass Meter DP Cone Meter Verification System–DP Health Check™

DP Health Check is a comprehensive verification system for Differential Pressure (DP) meters. The Flo Mass meter's Cone DP Meter sub-system can operate with DP Health Check. Utilizing a third pressure port downstream of the cone and reading three DPs, DP Health Check analyses not just the traditional single DP reading, but the entire pressure field. The additional information expands the capability of the Cone Meter, offering a full diagnostic suite. DP Health Check creates a smart Cone Meter allowing for condition based maintenance operations.

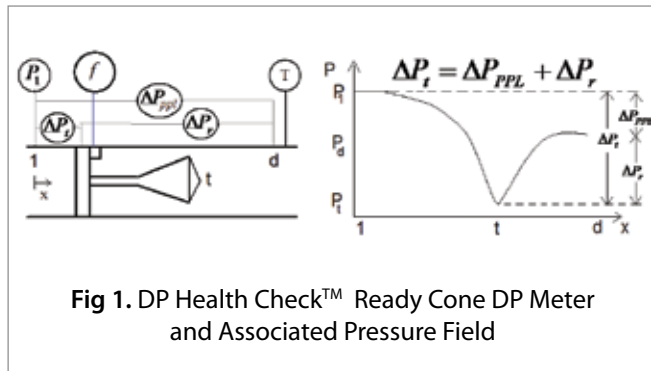


Fig 1. DP Health Check™ Ready Cone DP Meter and Associated Pressure Field

DP Health Check creates seven diagnostic checks, i.e. one DP integrity check, three separate inter-compatible flow rate predictions, and three DP ratios compatible with the baselines. The HMI (Human-Machine Interface) is designed for simplicity: the seven diagnostics are plotted as four points on a graph with a 1x1 box. All points inside the box shows the meter is functioning normally (see Fig 2). Any points out-side the box shows a potential metering issue. Figs. 3 and 4 show response to varying saturated steam quality and single phase DP reading error respectively. Pattern recognition technology allows the source of the problem to be directly identified.

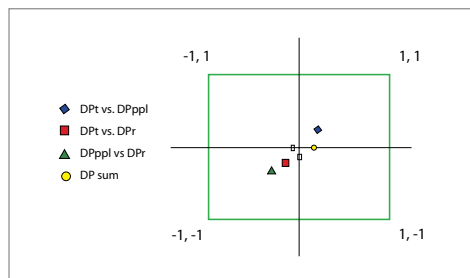


Fig 2. Display for Correctly Operating Meter

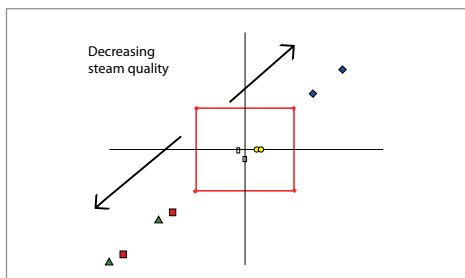


Fig 3. Display for Varying Quality Saturated Steam Flow

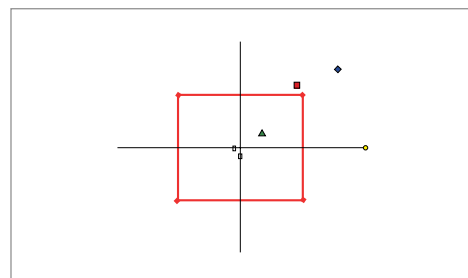
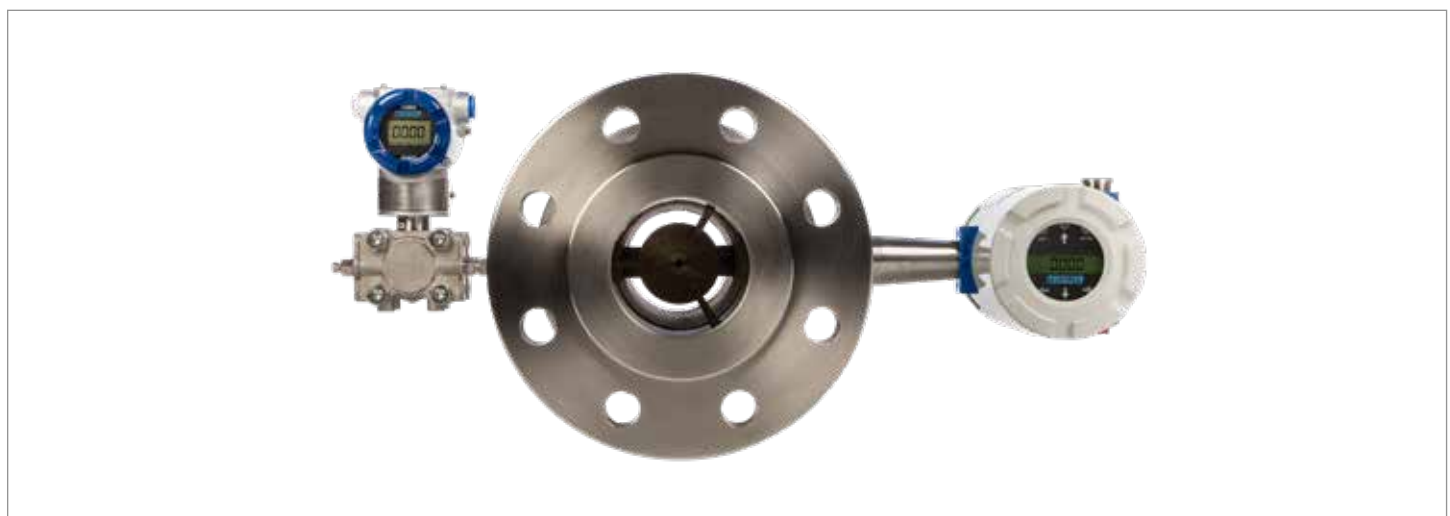


Fig 4. Display for Drifting DP Transmitter

Specifications

- Performance Specifications

Performance Specifications				
Mass Flow Rate accuracy for Dry Gas/Steam based on 50-100% of pressure range.				
Accuracy	Multi Parameter Flo Mass Meter			
	Process Variables	Liquids	Dry Gas/Steam	Wet Gas/Steam
	Volumetric Flow Rate	± .7% of Rate	± 1.5% of Rate	± 3% of Rate
	Mass Flow Rate	± 1% of Rate	± 1% of Rate	5% to 10% of Reading*
	Temperature	± 2°F (± 1°C)	± 2°F (± 1°C)	± 2°F (± 1°C)
	Pressure	± .3% of Full Scale	± .3% of Full Scale	± .3% of Full Scale
	Calculated Density**	± .3% of Reading	± .5% of Reading	N/A
	Predicted Density***	± .75% of Reading	± 1% of Reading	± 4% of Reading
	Steam Quality	N/A	± 5% of Reading	± 5% of Reading
* Depending on percentage of liquid content & velocity ** Calculated density is performed with a known fluid temperature & pressure *** Predicted density is a function inherent to the combined technologies of vortex and differential pressure flow metering				
Repeatability	Mass Flow Rate	± .2% of rate		
	Volumetric Flow Rate	± .1% of rate		
	Temperature	± .2°F (± .1°C)		
	Pressure	± .05% of full scale		
	Density	± .1% of reading		
Stability Over 12 Months	Mass Flow Rate	± .2% of rate		
	Volumetric Flow Rate	± negligible		
	Temperature	± .9°F (± .5°C)		
	Pressure	± .1% of full scale		
	Density	± .1% of reading		
Response Time	Adjustable from 1 to 100 seconds			



• **Operating Specifications**

Operating Specifications				
Any Gas, Liquid or Steam compatible with 316L SS, C276 Hastelloy or A105 Carbon Steel.				
Process and Ambient Temperature	Process Standard Temperature (code ST): -330 to 500°F (-200 to 260°C) Process High Temperature (code HT): to 750°F (400°C) Ambient Operating: -40 to 140°F (-40 to 60°C) Ambient Storage: -40 to 185°F (-40 to 85°C)			
	Pressure Transducer Ratings			
	Full Scale Operating Pressure		Max. Over-Range Pressure	
	psi	bar	psi	bar
	30	2	60	4
	100	7	200	14
	300	20	300	40
	500	35	1000	70
	1500	100	2750	175
Power Requirements	DCH option: 12-36 VDC, 300mA, 9W max, (multiple outputs) AC option: 100-240 VAC, 50/60Hz line power, 5W (multiple outputs)			
Display	Alphanumeric 2 line x 16 character LCD digital display Six pushbuttons for full field configuration Pushbuttons can be operated with magnetic wand without removal of enclosure covers Display can be mounted in 90° intervals for better viewing			
Output Signals	Analog: 4-20 mA Alarm: Solid state relay, 40 VDC Totalizer Pulse: 50 millisecond pulse, 40 VDC Volumetric or Loop Powered Mass: One Analog, One Totalizer Pulse, HART Multivariable option: Up to Three Analog Signals, Three Alarms, One Totalizer Pulse, HART Multivariable option: Modbus, Ethernet, or BACnet process monitoring			

• **Physical Specifications**

Physical Specifications	
Wetted Materials	Standard 316L Stainless Steel, plus <ul style="list-style-type: none"> • Optional Carbon Steel or Hastelloy C • DuPont Teflon® based thread sealant on models with pressure transducer
Approvals Pending	FM, FMC: <ul style="list-style-type: none"> - CLASS I, DIV. 1, GROUPS B,C,D - CLASS II/III, DIV. 1, GROUPS E,F,G - Type 4X and IP66, T6, Ta = -40 to 60°C ATEX <ul style="list-style-type: none"> - II 2 G Ex d IIB + H2 T6 - II 2 D EX tD A21 IP66 T85°C, Ta = -40 to 60°C IECEx <ul style="list-style-type: none"> - Ex d IIB + H2 T6 - Ex tD A21 IP66 T85°C, Ta = -40 to 60°C

Sizing Considerations

Piping Conditions

- One 90° elbow before meter - upstream diameters 10D & 5D
- Two 90° elbows before meter - upstream diameters 15D & 5D
- Two 90° elbows before meter, out of plane - upstream diameters 30D & 10D
- Reduction before meter - upstream diameters 10D & 5D
- Reduction before meter - upstream diameters 10D & 5D
- Expansion before meter - upstream diameters 20D & 5D
- Partially open valve - upstream diameters 30D & 10D

Velocity Range

- Maximum velocity, liquid: 30 ft/sec (9 m/sec)
- Minimum velocity, liquid: 1 ft/sec (0.3 m/sec)
- Maximum velocity, gas or steam: See Table Below
- Minimum velocity, gas or steam ft/sec (m/sec):

$\frac{5}{\sqrt{\text{density (Lb/ft}^3\text{)}}}$	$\frac{6.1}{\sqrt{\text{density (Kg/m}^3\text{)}}}$
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Pressure Drop Equation*

$\Delta P = 0.00024 p V^2$ English Units (ΔP in psi, p in lb/ft^3 , V in ft/sec)

$\Delta P = 0.000011 p V^2$ Metric Units (ΔP in bar, p in kg/m^3 , V in m/sec)

* Vortex only, does not include pressure drop created by primary element.

Water Minimum and Maximum Flow Rates

Rate	Size	GPM min	GPM max
Nominal Pipe Size (in)	0.5	0.9	22
	0.75	1.4	40
	1	2.2	67
	1.5	5.5	166
	2	9.2	276
	3	21	618
	4	36	1076
	6	81	2437
	8	142	4270
	10	224	6715
12	317	9501	

Rate	Size	m ³ /hr min	m ³ /hr Max
Nominal Pipe Size (mm)	15	0.2	5
	20	0.3	9
	25	0.5	15
	40	1.3	38
	50	2.1	63
	80	4.7	140
	100	8.1	244
	150	18	554
	200	32	970
	250	51	1525
300	72	2158	

- Gas or Steam Max Velocity

Rate	Size	FT/SEC Max
Nominal Pipe Size (in)	0.5	175
	0.75	250
	1	250
	1.5	300
	2	300
	3	300
	4	300
	6	300
	8	300
	10	300
	12	300

Rate	Size	FT/SEC Max
Nominal Pipe Size (mm)	15	53
	20	76
	25	76
	40	90
	50	90
	80	90
	100	90
	150	90
	200	90
	250	90
	300	90

Normal Pipe Sizes

- Typical Saturated Steam Minimum and Maximum, Flow Rates (lb/hr)

Nominal Pipe Size (in)											
Pressure	0.5	0.75	1	1.5	2	3	4	6	8	10	12
5 psig	6.5 52	12 122	20 265	49 650	82 1087	183 2431	318 4231	722 9594	1264 16806	1988 26429	2813 37395
100 psig	15 271	27 639	46 1386	112 3405	187 5690	419 12729	728 22156	1652 50233	2893 87998	4550 138386	6438 195803
200 psig	20 493	37 1163	62 2525	151 6203	253 10365	565 23184	983 40354	2229 91494	3905 160279	6141 252055	8689 356635
300 psig	24 716	45 1688	74 3664	182 9000	304 15040	680 33642	1184 58556	2685 132763	4704 232575	7397 365747	10466 517499
400 psig	28 941	51 2220	85 4816	209 11831	349 19770	780 44222	1358 76971	3079 174516	5393 305717	8481 480771	12000 680247
500 psig	31 1170	57 2760	95 5988	233 14711	389 24582	870 54987	1514 95710	3433 217001	6014 380148	9457 597812	13381 845850

• Typical Saturated Steam Minimum and Maximum, Flow Rates (kg/hr)

Nominal Pipe Size (mm)											
Pressure	15	20	25	40	50	80	100	150	200	250	300
0 barg	3	5	8	19	32	72	126	286	500	786	1113
	18	42	91	224	375	838	1459	3309	5797	9116	12898
5 barg	6	11	18	45	75	167	290	658	1153	1813	2565
	95	224	485	1192	1992	4455	7754	17581	30799	48434	68530
10 barg	8	15	24	59	99	222	387	877	1537	2417	3419
	168	397	862	2118	3539	7915	13777	31237	54720	86053	121758
15 barg	9	17	29	71	119	266	463	1050	1840	2893	4094
	241	569	1236	3036	5073	11347	19750	44779	78444	123360	174543
20 barg	11	20	33	81	136	304	529	1199	2100	3303	4673
	314	742	1610	3956	6611	14787	25738	58355	102226	160761	227463
30 barg	13	24	40	99	165	369	642	1455	2548	4007	5669
	463	1092	2370	5822	9729	21763	37880	85884	150451	236599	334766

• Typical Air Minimum and Maximum Flow Rates (SCFM), Air at Standard Process Conditions
70°F, 14.6959 psi

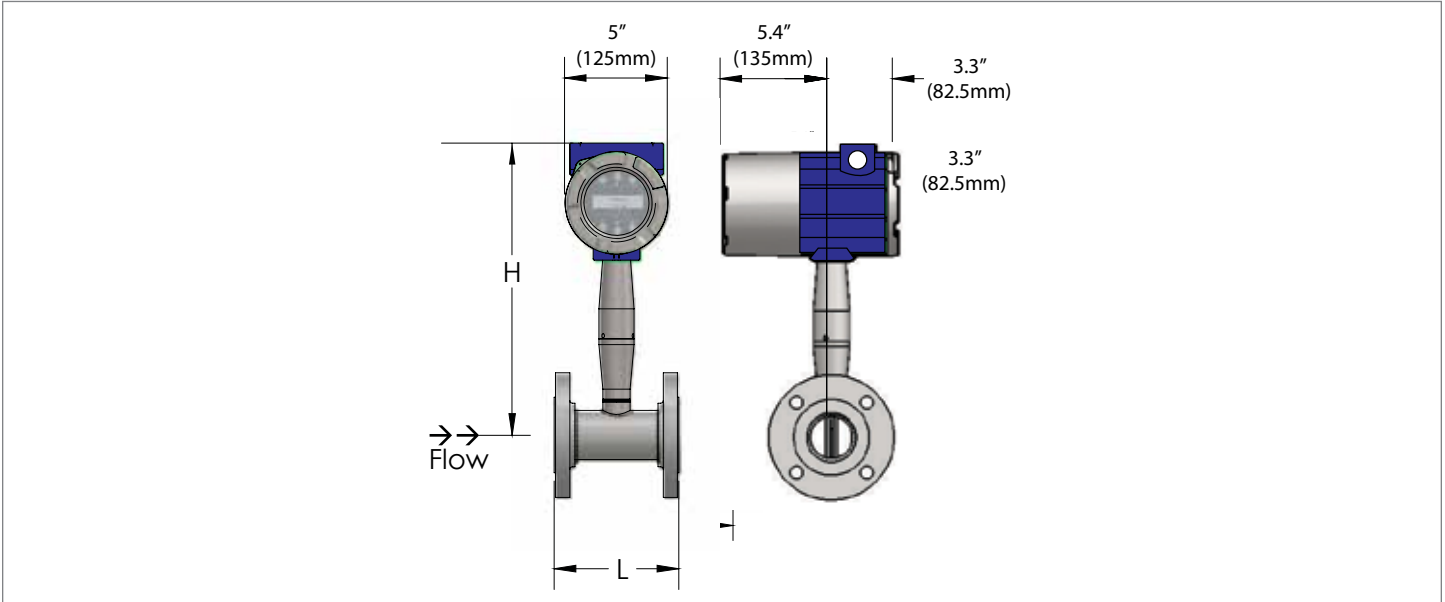
Nominal Pipe Size (in)											
Pressure	0.5	0.75	1	1.5	2	3	4	6	8	10	12
0 psig	1.8	3	5	13	22	50	87	198	347	546	773
	18	41	90	221	369	826	1437	3258	5708	8976	12701
100 psig	5	9	15	38	63	141	245	555	972	1529	2163
	138	325	704	1730	2890	6466	11254	25515	44698	70292	99456
200 psig	7	13	21	52	86	193	335	761	1332	2095	2965
	258	609	1322	3248	5427	12140	21131	47911	83931	131895	186752
300 psig	8	15	25	63	104	234	407	922	1615	2540	3594
	380	896	1944	4775	7978	17847	31064	70431	123375	194025	274529
400 psig	10	18	29	72	120	269	467	1060	1857	2920	4132
	502	1183	2568	6309	10542	23580	41043	93057	163000	256358	362724
500 psig	11	20	33	80	134	300	521	1182	2071	3257	4608
	624	1472	3195	7849	13115	28034	51063	115775	203000	318941	451272

• Typical Air Minimum and Maximum Flow Rates (nm³/hr), Air at Standard conditions of
20°C, 1.0133 BARA

Nominal Pipe Size (mm)											
Pressure	15	20	25	40	50	80	100	150	200	250	300
0 barg	3	5	9	21	36	79	138	313	549	863	1221
	28	66	142	350	584	1307	2275	5157	9034	14207	20102
5 barg	7	13	21	52	87	194	337	764	1339	2105	2979
	165	390	847	2080	3476	7775	13533	30682	53749	84525	119596
10 barg	9	17	29	70	117	262	457	1035	1814	2853	4036
	304	716	1554	3819	6381	14273	24844	56329	98676	155178	219563
15 barg	11	21	34	85	142	317	551	1250	2190	3444	4873
	442	1044	2265	5565	9299	20801	36205	82087	143801	297386	319968
20 barg	13	24	40	97	162	363	632	1434	2511	3949	5588
	582	1373	2979	7318	12229	27354	47612	107949	189105	297386	420775
30 barg	16	29	48	118	198	442	770	1745	3057	4807	6801
	862	2034	4414	10843	18119	40529	70544	159942	280187	440621	623439

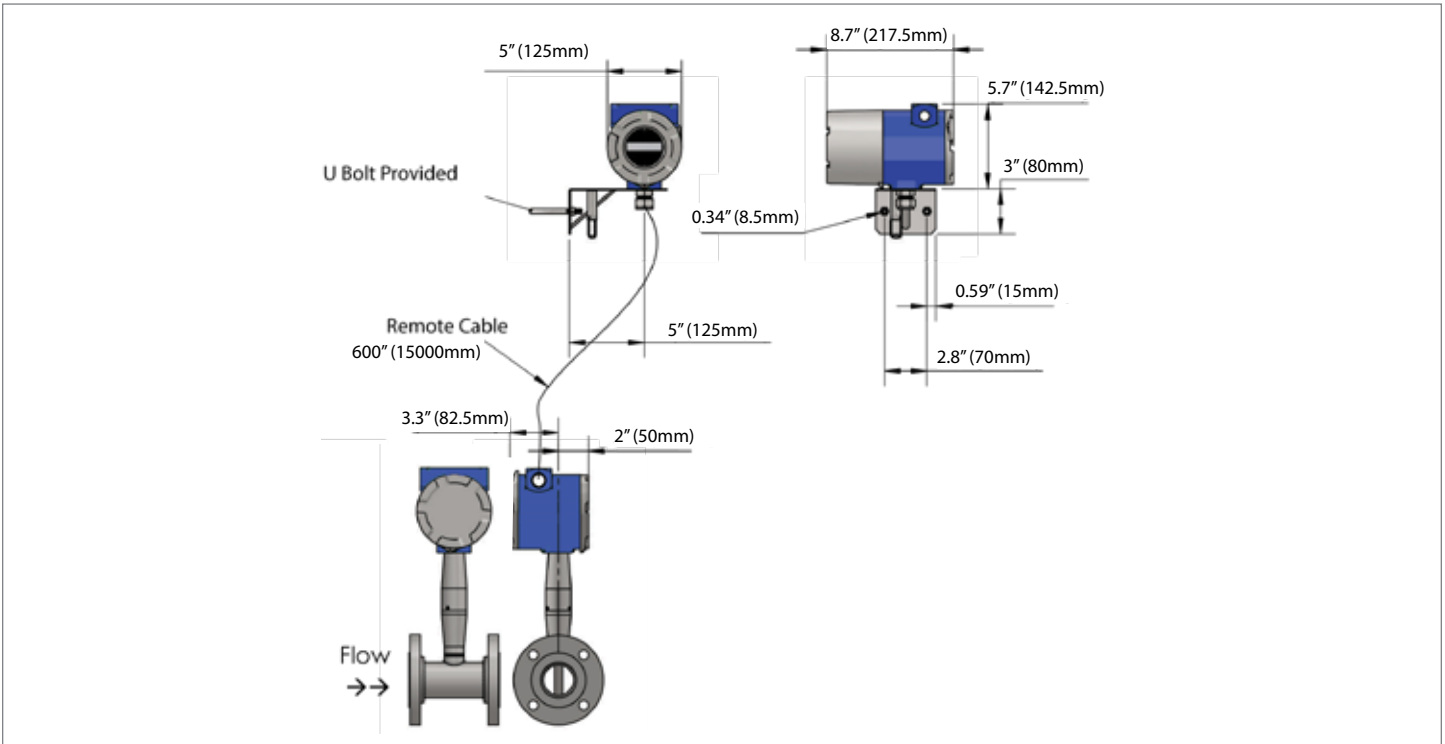
Turn-down is application dependent. Turn-down can exceed 100:1

Dimensional Drawing



- Flow Meter Nominal Size

Flow Meter Nominal Size		
	L	H
2 inch (50 mm)	10.0 in (254 mm)	14.0 in (356 mm)
3 inch (80 mm)	10.0 in (254 mm)	14.6 in (371 mm)
4 inch (100 mm)	12.9 in (327 mm)	15.1 in (384 mm)
6 inch (150 mm)	19.9 in (505 mm)	16.2 in (411 mm)
8 inch (200 mm)	19.9 in (505 mm)	17.2 in (437 mm)
10 inch (250 mm)	29.5 in (749 mm)	18.2 in (462 mm)
12 inch (300 mm)	34.9 in (886 mm)	19.2 in (488 mm)



Model Chart

Example	Tek-Flo Mass 1300D	V	16	C	150	L	DD	DCL	1AHL	ST	P1	AZ	3M	ND	Tek-Flo Mass 1300D-V-16-C-150-L-DD-DCL-1AHL-ST-P1-AZ-3M-ND
Series	Tek-Flo Mass 1300D														Flo Mass Meter
Multivariable Options	*For saturated steam quality prediction must have at least a VT model vortex meter *For wet gas liquid loading prediction must have a VTP model vortex meter	V VT VTP													Mass, Density (No P & T) Steam Qv act, W/Temperature Steam Qv act, W/Pressure
Sizes			16 24 32 48 64 80 96												2-inch Nominal Bore (50mm) 3-inch Nominal Bore (80mm) 4-inch Nominal Bore (100mm) 6-inch Nominal Bore (150mm) 8-inch Nominal Bore (200mm) 10-inch Nominal Bore (250mm) 12-inch Nominal Bore (300mm)
Meter Body Material				C S H											Carbon Steel 316 Stainless Steel Hastelloy
Process Connection					150 300 600 900										ANSI 150# Flange ANSI 300# Flange ANSI 600# Flange ANSI 900# Flange
Electronics Enclosure						L XP									NEMA 4X IP66 Enclosure Remote Electronics NEMA 4X, IP66, Specify cable length in parentheses
Display Options							DD								Digital Display and Programming Buttons
Input Power								DCH AC							12-36 VDC, 300mA, 9W max. (Able to power differential pressure transmitter if wired in series with an adequate power supply) - use with 1AH, 1AM, 3AH, 3AM32, 32R 4-inch Nominal Bore (100mm), 4-inch by 3-inch Nominal Bore Reducing Meter (80mm) 100-240 VAC, 50/60 Hz line power, 5W max. (Able to power differential pressure transmitter with DC power output) - use with 1AH, 1AM, 3AH, 3AM

Output										3AM							3 Analog Signals, 3 Alarms, 1 Totalizer Pulse, 1 Modbus
Temperature Rating											ST						Standard temperature: Process temperature -330° to 500°F (-200° to 260°C)
Process Connection											P0						No Pressure Sensor
											P1						Maximum 30 psia (2 bara), Proof 60 psia (4 bara)
											P2						Maximum 100 psia (7 bara), Proof 200 psia (14 bara)
											P3						Maximum 300 psia (20 bara), Proof 600 psia (41 bara)
											P4						Maximum 500 psia (34 bara), Proof 1000 psia (64 bara)
											P5						Maximum 1500 psia (100 bara), Proof 2500 psia (175 bara)
Differential Pressure Transmitter												TK					Factory supplied differential pressure transmitter
												CX					Customer supplied differential pressure transmitter*
Differential Pressure Transmitter Manifold													3M				3-way SST manifold. Ability to equalize high/low side pressures to set the differential pressure transmitter zero
													5W				5-way SST manifold. Ability to equalize high/low side pressures to set the differential pressure transmitter zero and the ability to check for equalizing valve leaks
													NM				No manifold
Diagnostics														2AZ			Two additional factory supplied differential pressure transmitters
														2CX			with TekValSys DP
														ND			No Advanced Diagnostics

Customer Service & Support



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