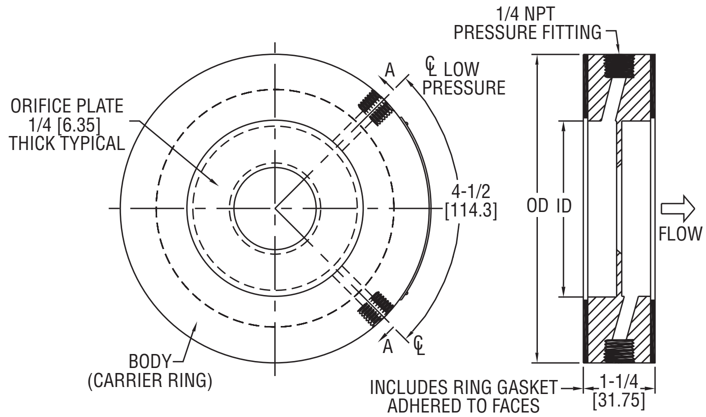
Series TE Orifice Plate Flowmeter

Specifications - Installation and Operating Instructions



The Series TE Orifice Plate Flowmeter offers one-piece PTFE construction similar to the OP and PE Series orifice plates, which incorporate a unique holder or carrier ring containing metering taps and integral gaskets. Available for line sizes from 1/2″ to 24″, the Series TE orifice plate can be used with gases, liquids, corrosive, and high temperature fluids. The Series TE can be easily installed by slipping the unit between standard flanges (orifice flanges are not required). The Series TE was designed for use anywhere there is an application for a conventional flow orifice plate. It can also be used in place of other primary differential producers for efficiency and cost effectiveness.

ACCURACY

The Series TE Flowmeter utilizes the corner tap proportions as defined in ISO 5167. While this code may not be referred to as International Standard until accepted by the ISO Council, the ASME Fluid Meters Research Committee has suggested that the dimensionless coefficient equation developed by the International Standards Organization (ISO) and presented in ISO 5167 is significantly better for the broad spectrum of flow measurement applications throughout process industries.

The coefficient values used in the Series TE Flowmeter bore calculations represent the same confidence level assigned to the flange and radius taps widely accepted in fluid flow measurement.

The accuracy assigned to the coefficient values is ±0.6% full scale for d/D (Beta) values 0.2 to 0.6 and ±0.7% for Beta values 0.7 to 0.75 (i.e. ß of 0.7 would have an uncertainty value of ±0.7% full scale).

Accuracy of the differential signal produced by the Series TE Flowmeter equals that of a properly manufactured and installed flange or radius tap orifice meter.

MOUNTING

The orifice metering primary shall be suitable for installation between standard ANSI 125#/150# PVC or steel flanges mounted on HDPE, PVC or steel pipe. The unit shall be "self centering" within the bolt circle of the flanges. No alignment of the orifice shall be necessary. Drilling and or tapping of the main or flanges will not be allowed or required. The overall laying length shall be 1.25″ including pre-attached ring type 1/8″ thick Buna "N" Gaskets. Flange bolts should be 1.25″ longer than standard flange bolts.

Pipe Requirements: Upstream and downstream pipe requirements are contingent upon two factors: (a) Beta Ratio-ratio of the orifice bore to the pipe ID (d/D); (b) The type of fitting or disturbance upstream of the Series TE Flowmeter. For most applications, 10 pipe dia. upstream & 5 dia. downstream are sufficient. (5 pipe dia. up and 2 dia. down are acceptable for non-critical applications.)

SPECIFICATIONS

Service: Air and compatible gases, corrosives, high temperature fluids, and liquids.
Wetted Material: Monolithic (single piece) constructed entirely of PTFE, Buna-N gaskets.
Accuracy: ±0.6% full scale flow (Beta = .2-.6) ±0.7% for Beta greater than .6.
Temperature: -40 to 200°F (-40 to 93.3°C).
Pressure: 150 psi max (10 bar).
Head Loss: 1-Beta ratio^2 eg: $1 - 0.7^2 = 1 - 0.49 = 51\%$ of the d.p.
Line Sizes: 1/2″ to 24″, special and non-standard sizes available.
Process Connections: 1/4″ female NPT.
Installation: Standard flange 125#/150# rating.
Pipe Requirements: General requirements 10 diameter upstream and 5 diameter downstream.
Weight: Varies with line size. See chart.

Installation Tips: (a) If possible, do not install a valve upstream if it is going to be throttled. Install on the downstream a minimum of 6 diameters from the Series TE Orifice Plate. (b) The use of straightening vanes is not necessary for most applications.

Installation: (a) Insert bolts through bottom half of the flange bolt circle. (b) Slide flowmeter between flanges (make sure arrow on flowmeter faces in the direction of flow). (c) Make sure pressure connections are properly positioned. For horizontal air or gas lines, install with the connections on or under the horizontal center line. They should also be correctly oriented so as to not be blocked by bolts when remainder of bolts are inserted. (d) Add rest of bolts and nuts leaving all bolts loose so the flowmeter is free to move. (e) If necessary, the flowmeter can be centered using a steel ruler to measure the total side to side movement and set flowmeter at half way point all around. (f) Lubricate & tighten bolts diametrically alternating to recommend flange torque. (g) Check to insure the flowmeter is installed with the arrow facing in the same direction as flow.

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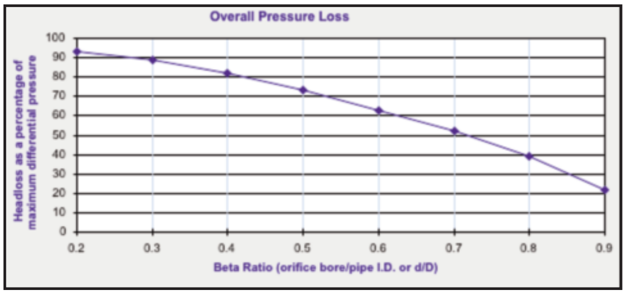
OVERALL PRESSURE LOSS ACROSS SERIES TE ORIFICES



HEAD LOSS
Overall Pressure Loss Across Thin-Plate Orifices
The curved graph shows pressure loss generated by the Series TE.
For example, a 0.7 Beta Ratio (d/D) would show a loss of 51%.

As a quick check reference, you can use the formula:
Head loss =1-Beta Ratio^2
eg: 1-0.7^2 or 1-0.49 = 51% of the d.p.
Source: ASME Research Report on Fluid Meters

Magnehelic® and Capsuhelic® gages from Dwyer read pressure drop across the orifice plates.

For compatible gases a Dwyer® Magnehelic® gage may be used to read the differential pressure. Compatible liquids may be used in conjunction with the Dwyer® Capsuhelic® gage with brass case.

FLOW vs. DIFFERENTIAL PRESSURE RELATIONSHIP
(Based on constant inlet temperature and pressure)

$[Q^2/ Q^1]^2 \times h^1 = h^2$ Solve for new d.p. based on changes in flow

$\sqrt{h^2/h^1} \times Q_1 = Q_2$ Solve for new flow based on changes in d.p.

Where:
Q_1 = Existing Flow
Q_2 = New Flow
h_1 = Existing d.p.
h_2 = New d.p.

If the inlet temperature and pressure fluctuate, use the full formula allowing for input of varying temperature and pressure.

To convert 60°F water flow rates for other fluids:
Pounds per hour (for any fluid) = $Q \times 63.3 \times \sqrt{\gamma_L}$

To convert 60°F water flow rates into flow rates for gases:
Standard cu ft/hour (for any gas) = $Q \times 63.3 \times \sqrt{(\gamma_L)/(\gamma_s)}$

To convert 60°F water flow rates to GPM for other fluids:
(GPM) / ($\sqrt{SG}$ of fluid)

Explanation of Symbols
Q = 60°F Water Flow Rate in GPM
SG = Specific Gravity
γ_L = Specific Weight of Line Fluid in lb/ft^3 at line conditions
γ_s = Specific Weight of Line Fluid in lb/ft^3 at standard conditions (60°F, 14.7 PSIA)

AIR AND GAS FLOW - CONCENTRIC BORE
SCFM BASE CONDITIONS 14.7 psia & 60°F
Conversion formula used to solve for flow rate based on plotting changes in inlet pressure, temperature, and/or differential pressure. This formula is designed for use as a "quick check" reference only as the results may differ from calculation values due to rounding, combining of variables, and making certain assumptions in an effort to keep the formula as abbreviated as possible. Equation source *Flow Measurement Engineering Handbook* by Richard Miller.

Input new h/w as well as new pressures and/or temperatures using the formula below:

$$SCFM = \frac{5.9816 \times (d^2) \times (K) \times (Y) \times \sqrt{h/w} \times \sqrt{(2.703 \times P_L \times SG)/(460 + T_L)}}{\dfrac{2.703 \times 14.7 \times SG}{460 + T_b}}$$

Where:
5.9816 = physical constant
d = bore in inches
D = Pide Inside Diameter (inches)
K = flow coefficient
Y = expansion factor
h/w= differential pressure (inches w/c)
P_L = line pressure (psia)
T_L = line temperature (°F)
T_b = base temperature (°F)
ß = beta ratio (d/D)
SG = specific gravity at line conditions (air=1.00)
SH = specific heat ratio cp/cv (air=1.4)
R_n = Reynolds number at max flow in pipe.

K= C x ((1)/($\sqrt{1\text{-ß}^4}$))
Y= 1- (.41+.35ß^4) ((h/w x .0361)/ (P_L x 1.4))
C= 0.5959 + 0.0312ß$^{2.1}$ – 0.1840ß^8 + 91.71ß$^{2.5}$ $R_n^{-0.75}$

If Reynolds number (R_n) is not known, "C" can be estimated as 0.6015.
For convenience other factors can be combined to form constants as the equation is developed.

WATER AND LIQUID FLOW - CONCENTRIC BORE
GPM BASE CONDITIONS 14.7 psia & 60°F

$$GPM = 44.748 \times (d^2) \times (K) \times (Y) \times (Fa) \times \sqrt{\frac{h/w}{P_L}}$$

Where:
44.748 = physical constant
d = bore in inches
K = flow coefficient (formula below)
Y = expansion factor (water normally = 1.00)
Fa = thermal expansion factor (water normally = 1.00)
h/w= differential pressure (inches w/c)
P_L = density @ line (inlet flowing) conditions
C = discharge coefficient (formula below)

K= C x ((1)/($\sqrt{1\text{-ß}^4}$))
Y= 1- (.41+.35ß^4) ((h/w x .0361)/ (P_L x 1.4))
C= 0.5959 + 0.0312ß$^{2.1}$ – 0.1840ß^8 + 91.71ß$^{2.5}$ $R_n^{-0.75}$

If Reynolds number (R_n) is not known, "C" can be estimated as 0.6015.
For convenience other factors can be combined to form constants as the equation is developed.

MAINTENANCE
After final installation of the Series TE Orifice Plate Flow Flowmeter, no routine maintenance is required. A periodic check of system calibration is suggested. With the exception of gasket replacement, these devices are not field repairable and should be returned if repair is needed (field repair should not be attempted and may void warranty). Be sure to include a brief description of the problem plus any relevant application notes. Contact customer service to receive a return goods authorization number before shipping.

Series TE Orifice Plate Flowmeter - Capacity Structure
• Material PTFE - Gaskets Buna "N"
• Based on 70°F, 14.7 psia (Base Conditions)
• Beta Value Based on Std Sch pipe I.D.
• 1.25″ overall thickness
• Orifice plate thickness is 0.250″

						WATER CAPACITY		AIR CAPACITY - Flow in SCFM		
Model Number	**Weight (lbs)**	**Line Size**	**Bore**	**Beta**	**Inch d/p W/C**	**Inches d.p. W/C**	**Inc Flow in GPM**	**at 14.7 PSIA (0 PSIG)**	**at 20 psig**	**at 100 psig**
TE-A-1	1.00	1/2″	0.200"	0.3	20	20	0.62	2.35	3.63	6.61
TE-A-2	1.00	1/2″	0.310″	0.5	100	100	3.44	12.21	19.58	36.37
TE-A-3	1.00	1/2″	0.430″	0.69	200	320	13.00	32.77	56.15	107.47
TE-B-1	1.00	3/4″	0.250″	0.3	20	20	0.97	3.65	5.66	10.3
TE-B-2	1.00	3/4″	0.400″	0.49	100	100	5.69	20.21	32.44	60.26
TE-B-3	1.00	3/4″	0.580″	0.7	200	320	23.82	59.92	102.91	197.2
TE-C-1	1.00	1″	0.300″	0.29	20	20	1.38	5.24	8.11	14.8
TE-C-2	1.00	1″	0.520″	0.49	100	100	9.63	34.2	54.92	102.09
TE-C-3	1.00	1″	0.720″	0.69	200	320	36.15	91.28	156.51	300
TE-D-1	1.00	1.25″	0.400″	0.29	20	20	2.46	9.31	14.41	26.3
TE-D-2	1.00	1.25″	0.700″	0.51	100	100	17.48	62.09	99.75	185.5
TE-D-3	1.00	1.25″	1.00″	0.72	200	320	71.77	180	309.97	595.2
TE-E-1	2.00	1.5″	0.500″	0.31	20	20	3.85	14.57	22.55	41.16
TE-E-2	2.00	1.5″	0.800″	0.5	100	100	22.73	80.82	129.68	241.5
TE-E-3	2.00	1.5″	1.100″	0.68	200	320	83.95	212.18	363.93	697.39
TE-F-1	2.00	2″	0.600″	0.29	20	20	5.52	20.92	32.38	59.13
TE-F-2	2.00	2″	1.000″	0.48	100	100	35.34	125.74	202.03	375.8
TE-F-3	2.00	2″	1.450″	0.7	200	320	147.74	372.09	639.87	1,227.63
TE-G-1	2.00	2.5″	0.750″	0.3	20	20	8.63	32.71	50.64	92.48
TE-G-2	2.00	2.5″	1.250″	0.5	100	100	55.54	197.54	317.58	590.91
TE-G-3	2.00	2.5″	1.750″	0.7	200	320	216.30	543.99	936.56	1,798.86
TE-H-1	2.00	3″	0.920″	0.3	20	20	12.97	49.17	78.13	139.06
TE-H-2	2.00	3″	1.500″	0.49	100	100	79.94	282.9	454.77	846.21
TE-H-3	2.00	3″	2.150″	0.7	200	320	324.16	816.7	1,404.95	2,696.28
TE-J-1	3.00	4″	1.200″	0.3	20	20	22.03	83.58	129.44	236.48
TE-J-2	3.00	4″	2.000″	0.5	100	100	141.51	503.76	810.06	1,507.64
TE-J-3	3.00	4″	2.800″	0.7	200	320	547.11	1,380.03	2,373.02	4,553.68
TE-K-1	4.00	5″	1.500″	0.3	20	20	34.39	130.48	202.11	369.29
TE-K-2	4.00	5″	2.500″	0.5	100	100	220.80	786.23	1,264.42	2,353.51
TE-K-3	4.00	5″	3.500″	0.69	200	320	853.09	2,152.83	3,701.57	7,103.22
TE-L-1	4.00	6″	1.800″	0.3	20	20	49.46	187.86	291	531.75
TE-L-2	4.00	6″	3.000″	0.49	100	100	317.74	1,331.63	1,820.05	3,387.93
TE-L-3	4.00	6″	4.200″	0.69	200	320	1,226.98	3,097.20	5,325.20	10,219.28
TE-M-1	6.00	8″	2.400″	0.3	20	20	87.95	333.87	517.25	945.28
TE-M-2	6.00	8″	4.000″	0.5	100	100	565.77	2,014.95	3,241.45	6,034.85
TE-M-3	6.00	8″	5.600″	0.7	200	320	2,195.86	5,532.00	9,525.43	18,290.00
TE-N-1	8.00	10″	3.000″	0.3	20	20	137.35	521.58	808	1,476.77
TE-N-2	8.00	10″	5.000″	0.5	100	100	883.04	3,145.50	5,060.38	9,421.74
TE-N-3	8.00	10″	7.000″	0.7	200	320	3,421.26	8,626.42	14,846.80	28,506.17
TE-O-1	10.00	12″	3.600″	0.3	20	20	197.73	750.9	1,163.44	2,126.47
TE-O-2	10.00	12″	6.000″	0.5	100	100	1,271.62	4,530	7,288.16	13,570.33
TE-O-3	10.00	12″	8.400″	0.7	200	320	4,930.86	12,430.00	21,397.00	41,089.02
TE-P-1	15.00	14″	4.000″	0.3	20	20	244.14	927.14	1,436.59	2,625.81
TE-P-2	15.00	14″	6.600″	0.5	100	100	1,537.49	5,477.67	8,812.87	16,409.42
TE-P-3	15.00	14″	9.300″	0.7	200	320	6,052.57	15,251.50	28,262.66	50,437.78
TE-Q-1	18.00	16″	4.500″	0.3	20	20	308.76	1,172.63	1,817.05	3,321.32
TE-Q-2	18.00	16″	7.600″	0.5	100	100	2,038.95	7,264.58	11,688.26	21,764.08
TE-Q-3	18.00	16″	10.700″	0.7	200	320	8,007.74	20,179.85	34,749.32	66,737.64
TE-R-1	22.00	18″	5.200″	0.3	20	20	412.26	1,565.79	2,426.34	4,435.12
TE-R-2	22.00	18″	8.600″	0.5	100	100	2,610.71	9,302.08	14,966.93	27,869.85
TE-R-3	22.00	18″	12.000″	0.7	200	320	10,027.37	25,299.92	43,535.32	83,587.01
TE-S-1	29.00	20″	5.780″	0.3	20	20	509.55	1,935.37	2,999.11	5,482.22
TE-S-2	29.00	20″	9.600″	0.5	100	100	3,252.22	11,588.20	18,645.74	34,720.84
TE-S-3	29.00	20″	13.500″	0.7	200	320	12,742.82	32,115.34	55,303.34	106,215.88
TE-T-1	32.00	24″	7.000″	0.3	20	20	747.18	2,838.14	4,398.25	8,038.99
TE-T-2	32.00	24″	11.700″	0.5	100	100	4,835.93	17,229.62	27,726.33	51,633.81
TE-T-3	32.00	24″	16.300″	0.7	200	320	18,572.50	46,810.53	80,610.19	154,823.78

Note: Differential pressure values should be less than 50% of the inlet absolute pressure.

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