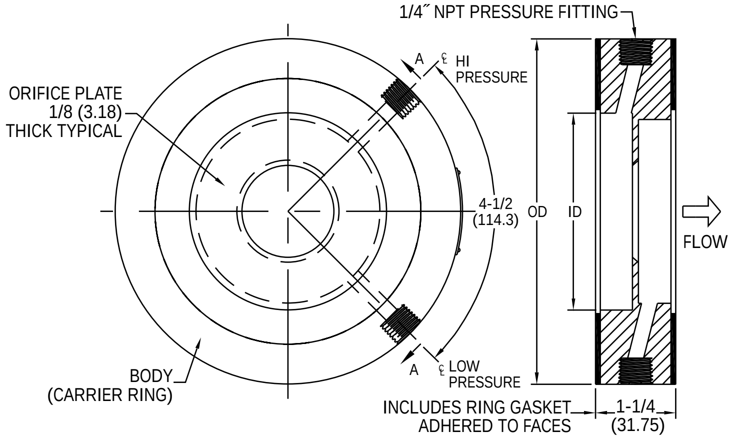
Series OP Orifice Plate Flow Meter

Specifications - Installation and Operating Instructions



The Series OP Orifice Plate Flow Meter is a complete orifice plate flow metering package. It incorporates a stainless steel orifice plate with a unique holder or carrier ring containing metering taps and integral gaskets. It was designed for use wherever 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. Installation is accomplished simply by slipping the unit between standard flanges (orifice flanges are not required). The Series OP is available in line sizes from 1/2″ to 24″ and can be used with compatible liquids and gases.

ACCURACY

The Series OP 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 OP 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 flow 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 flow).

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

SPECIFICATIONS

Service: For metering compatible liquids & gases.
Wetted Material: 304 SS, Buna-N gaskets.
Accuracy: 0.6% of full scale flow. (Beta = .2-.6) ±0.7% for Beta greater than .6.
Temperature: -50 to 200°F (-45 to 93°C).
Pressure: Limited only by pipe and flange rating restrictions.
Head Loss: 1-Beta ratio^2 eg: 1-0.7^2 or 1-0.49 = 51% of the d.p.
Line Sizes: 1/2″ to 24″.
Process Connection: 1/4″ female NPT.
Installation: Standard flange, any rating (orifice flanges not required).
Pipe Requirements: General requirements 10 diameter upstream and 5 diameter downstream of orifice plate.
Weight: Varies with line size. See chart.

MOUNTING

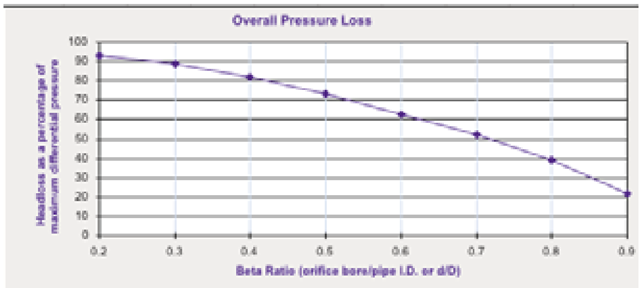
The orifice metering primary shall be suitable for installation between standard ANSI 125/150# flanges (any material) mounted on standard pipe (any material). The unit shall be "self centering" within the bolt circle of the flanges. No alignment of the orifice shall be necessary unless used with 300# or non-standard flange ratings. 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.

Pipe Requirements: Upstream and downstream pipe requirements are contingent upon two factors: (a) Beta Ratio-ratio of the orifice bore to the pipe I.D. (d/D); (b) The type of fitting or disturbance upstream of the Series OP. 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 application.)

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 OP. (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 OP between flanges (make sure arrow on OP faces in the direction of flow). (c) Make sure pressure connections are properly positioned. For horizontal liquid lines, install the OP with the connections on or under the horizontal center line. For horizontal air or gas lines, install with the connections on or above 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 OP is free to move. (e) For non-standard flanges, the OP can be centered using a steel ruler to measure the total side to side movement and set OP at half way point all around. (f) Lubricate & tighten bolts diametrically alternating to recommend flange torque. (g) Check to insure the OP is installed with the arrow facing in the same direction as flow. Flange bolts should be 1.25″ longer than standard flange bolts.

HEAD LOSS



Overall Pressure Loss Across Thin-Plate Orifices

The above curved graph shows pressure loss generated by the Series OP. 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 x 63.3 x $\sqrt{\gamma_L}$

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

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)

Series OP Orifice Plate Flow Meter

- Material 304/304 L- dual certified- 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 0.125˝

					WATER CAPACITY		AIR CAPACITY - Flow in SCFM			
Model Number	Weight (lbs)	Line Size	Bore	Beta	Inches d.p. W/C	Flow in GPM	Inch d.p. W/C	at 14.7 PSIA (0 PSIG)	at 20 psig	at 100 psig
OP-A-1	1.00	1/2"	0.200"	0.32	20	0.62	20	2.35	3.63	6.61
OP-A-2	1.00	1/2"	0.310"	0.50	100	3.44	100	12.21	19.58	36.37
OP-A-3	1.00	1/2"	0.430"	0.69	320	13.00	200	32.77	56.15	107.47
OP-B-1	1.00	3/4"	0.250"	0.30	20	0.97	20	3.65	5.66	10.3
OP-B-2	1.00	3/4"	0.400"	0.49	100	5.69	100	20.21	32.44	60.26
OP-B-3	1.00	3/4"	0.580"	0.70	320	23.82	200	59.92	102.91	197.2
OP-C-1	2.00	1"	0.300"	0.29	20	1.38	20	5.24	8.11	14.8
OP-C-2	2.00	1"	0.520"	0.49	100	9.63	100	34.2	54.92	102.09
OP-C-3	2.00	1"	0.720"	0.69	320	36.15	200	91.28	156.51	300
OP-D-1	2.00	1.25"	0.400"	0.29	20	2.46	20	9.31	14.41	26.3
OP-D-2	2.00	1.25"	0.700"	0.51	100	17.48	100	62.09	99.75	185.5
OP-D-3	2.00	1.25"	1.00"	0.72	320	71.77	200	180	309.97	595.2
OP-E-1	2.00	1.5"	0.500"	0.31	20	3.85	20	14.57	22.55	41.16
OP-E-2	2.00	1.5"	0.800"	0.50	100	22.73	100	80.82	129.68	241.5
OP-E-3	2.00	1.5"	1.100"	0.68	320	83.95	200	212.18	363.93	697.39
OP-F-1	3.00	2"	0.600"	0.29	20	5.52	20	20.92	32.38	59.13
OP-F-2	3.00	2"	1.000"	0.48	100	35.34	100	125.74	202.03	375.8
OP-F-3	3.00	2"	1.450"	0.70	320	147.74	200	372.09	639.87	1,227.63
OP-G-1	4.00	2.5"	0.750"	0.30	20	8.63	20	32.71	50.64	92.48
OP-G-2	4.00	2.5"	1.250"	0.50	100	55.54	100	197.54	317.58	590.91
OP-G-3	4.00	2.5"	1.750"	0.70	320	216.30	200	543.99	936.56	1,798.86
OP-H-1	5.00	3"	0.920"	0.30	20	12.97	20	49.17	76.13	139.06
OP-H-2	5.00	3"	1.500"	0.49	100	79.94	100	282.9	454.77	846.21
OP-H-3	5.00	3"	2.150"	0.70	320	324.16	200	816.7	1,404.95	2,696.28
OP-J-1	7.00	4"	1.200"	0.30	20	22.03	20	83.58	129.44	236.48
OP-J-2	7.00	4"	2.000"	0.50	100	141.51	100	503.76	810.06	1,507.64
OP-J-3	7.00	4"	2.800"	0.70	320	547.11	200	1,380.03	2,373.02	4,553.68
OP-K-1	8.00	5"	1.500"	0.30	20	34.39	20	130.48	202.11	369.29
OP-K-2	8.00	5"	2.500"	0.50	100	220.80	100	786.23	1,264.42	2,353.51
OP-K-3	8.00	5"	3.500"	0.69	320	853.09	200	2,152.83	3,701.57	7,103.22
OP-L-1	10.00	6"	1.800"	0.30	20	49.46	20	187.86	291	531.75
OP-L-2	10.00	6"	3.000"	0.49	100	317.74	100	1,331.63	1,820.05	3,387.93
OP-L-3	10.00	6"	4.200"	0.69	320	1,226.98	200	3,097.20	5,325.20	10,219.28
OP-M-1	14.00	8"	2.400"	0.30	20	87.95	20	333.87	517.25	945.28
OP-M-2	14.00	8"	4.000"	0.50	100	565.77	100	2,014.95	3,241.45	6,034.85
OP-M-3	14.00	8"	5.600"	0.70	320	2,195.86	200	5,532.00	9,525.43	18,290.00
OP-N-1	20.00	10"	3.000"	0.30	20	137.35	20	521.58	808	1,476.77
OP-N-2	20.00	10"	5.000"	0.50	100	883.04	100	3,145.50	5,060.38	9,421.74
OP-N-3	20.00	10"	7.000"	0.70	320	3,421.26	200	8,626.42	14,846.80	28,506.17
OP-O-1	30.00	12"	3.600"	0.30	20	197.73	20	750.9	1,163.44	2,126.47
OP-O-2	30.00	12"	6.000"	0.50	100	1,271.62	100	4,530	7,288.16	13,570.33
OP-O-3	30.00	12"	8.400"	0.70	320	4,930.86	200	12,430.00	21,397.00	41,089.02
OP-P-1	40.00	14"	4.000"	0.30	20	244.14	20	927.14	1,436.59	2,625.81
OP-P-2	40.00	14"	6.600"	0.50	100	1,537.49	100	5,477.67	8,812.87	16,409.42
OP-P-3	40.00	14"	9.300"	0.70	320	6,052.57	200	15,251.50	28,262.66	50,437.78
OP-Q-1	48.00	16"	4.500"	0.30	20	308.76	20	1,172.63	1,817.05	3,321.32
OP-Q-2	48.00	16"	7.600"	0.50	100	2,038.95	100	7,264.58	11,688.26	21,764.08
OP-Q-3	48.00	16"	10.700"	0.70	320	8,007.74	200	20,179.85	34,749.32	66,737.64
OP-R-1	56.00	18"	5.200"	0.30	20	412.26	20	1,565.79	2,426.34	4,435.12
OP-R-2	56.00	18"	8.600"	0.50	100	2,610.71	100	9,302.08	14,966.93	27,869.85
OP-R-3	56.00	18"	12.000"	0.70	320	10,027.37	200	25,299.92	43,535.32	83,587.01
OP-S-1	64.00	20"	5.780"	0.30	20	509.55	20	1,935.37	2,999.11	5,482.22
OP-S-2	64.00	20"	9.600"	0.50	100	3,252.22	100	11,588.20	18,645.74	34,720.84
OP-S-3	64.00	20"	13.500"	0.70	320	12,742.82	200	32,115.34	55,303.34	106,215.88
OP-T-1	78.00	24"	7.000"	0.30	20	747.18	20	2,838.14	4,398.25	8,038.99
OP-T-2	78.00	24"	11.700"	0.50	100	4,835.93	100	17,229.62	27,726.33	51,633.81
OP-T-3	78.00	24"	16.300"	0.70	320	18,572.50	200	46,810.53	80,610.19	154,823.78

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

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.

$K = C \times ((1)/(\sqrt{1-ß^4}))$

$Y = 1 - (.41 + .35ß^4)((h/w \times .0361)/(P_L \times 1.4))$

$C = 0.5959 + 0.0312ß^{2.1} - 0.1840ß^8 + 91.71ß^{2.5}\ R_n^{-0.75}$

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

$$Q\ (GPM) = 44.748 \times d^2 \times K \times Y \times Fa \times \sqrt{(hw)/(P_L)}$$

Where:

44.748= physical constant
- d= bore in inches
- D= Pipe Inside Diameter (inches)
- K= flow coefficient
- Y= expansion factor (Water and most liquids normally=1)
- Fa= thermal expansion factor (Water and most liquids normally=1)
- h/w= differential pressure (inches w/c)
- P_L= density @ Line (flowing) conditions in lbs./ft^3

$C = 0.5959 + 0.0312ß^{2.1} - 0.1840ß^8 + 91.71ß^{2.5}\ R_n^{-0.75}$

ß= Beta Ratio (d/D)

$$K = C \times (1) / (\sqrt{1-ß^4})$$

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 OP Orifice Plate Flow Meter, 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.

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