



TECHNICAL GUIDANCE

TRANSMITTER DIRECTLY MOUNTED!
SIMPLE AND EASY INSTALLATION

Integral V-Cone Flowmeter VD series

OUTLINE

VD series Integral V-Cone Flowmeter is a differential pressure type flowmeter. Unlike existing Orifice system, all necessary components for measuring flow rate of various fluids are combined and assembled for immediate start-up just by installing onto process piping and connecting with 2 core wiring. Connection and installation of bypass piping, 3 way valve and transmitter is not necessary.

FEATURES

- ❑ Wide application
V-Cone can measure almost all process fluids, i. e., liquids, slurries, gases and steam.
- ❑ Short straight runs
By the unique flow restriction theory, the required straight runs both for upstream and downstream are much shorter than those for traditional orifice plates. Effective for space and cost saving for plant construction.
- ❑ Wide range ability
V-Cone sensor offers 14:1 range ability which is much wider than orifice and Vortex flowmeters.
- ❑ Low permanent pressure loss
The signal stability of **V-Cone** is more stable than that of orifice plates. Thus, the required P and per manent pressure loss are also much lower than orifice system. This saves total energy consumption in plants.
- ❑ Durable against wear and sticking
V-Cone has "Self-Cleaning" capability because the fluid runs off from the beta edge of the Cone.
- ❑ Size availability
15mm (1/2") to 300mm (12") are ready to select to cover almost all possible line sizes.
- ❑ Easy installation and handling
Bypass piping has been already done which saves installation and maintenance costs dramatically.

RECOMMENDED APPLICATIONS

- ❑ Steam lines
- ❑ Various gas lines
- ❑ Burning gas lines
- ❑ Water and other liquids
- ❑ Slurries
- ❑ Others



STANDARD SPECIFICATION

- Available size : 15mm (1/2") to 300mm (12")
- Process connection : Flange connection
JIS10KRF or ANSI#150
Other flanges on request
- Material
 - V-Cone Sensor : 304SS
 - Piping : 304SS
 - 3 way valve : 316SS
 - Transmitter fluid contact : 316SS
 - Seal : TEFLON and Viton
- Measuring Fluid : Steam, Liquids or Gases
- Temp. and Press. Range

Type of fluid		Steam	Liquids	Gases
Fluid temp. °C	General purpose	~190	-40~120	-40~120
	Press. tight Ex-proof	~190	-20~120	-20~120
Fluid Press,	kgf/cm ² G	~10	~14	-0.5~9.9
	MPa	~0.98	~1.37	-0.05~0.97

- AMB Temp.
 - General purpose : -20~80°C
 - Press. tight Ex-proof : -20~60°C
- Storage Temp. : -40~90°C
- Flow direction : Horizontal (Left to right or Right to left)
- Range ability : Standard 14:1
- Accuracy
 - Liquid : ±1.0%F.S.
 - Steam and Gases : ±1.5%F.S.

● Required straight runs

Process piping condition	Up stream	Down stream
Single plane elbow at up and/or down stream Reducer at up stream	Min. 0D	Min. 3D
Other fittings or valves at up and/or down stream	Min. 2D	Min. 5D

D : Nominal diameter of V-Cone sensor

MEASURING PRINCIPLE

The V-Cone is a differential pressure type flowmeter. Theories behind differential pressure type flowmeters have existed for over a century. The principal theory among these is Bernoulli's theorem for the conservation of energy in a closed pipe. This says that for a constant flow, the pressure in a pipe is inversely proportional to the square of the velocity in the pipe. Simply, the pressure decreases as the velocity increases. For instance, as the fluid approaches the V-Cone meter, it will have a pressure of P1. As the fluid velocity increases at the constricted area of the V-Cone, the pressure drops to P2, as shown here.

Both P1 and P2 are measured at the V-Cone's taps and the difference is ΔP :

$$\Delta P = P_1 - P_2$$

The ΔP created by V-Cone will increase and decrease exponentially with the flow velocity. As the constriction takes up more of the pipe cross-sectional area, more differential pressure will be created at the same flowrates. The ratio between the open pipe area and the open area at the largest cross-section of the cone is the Beta ratio. The equation for the Beta ratio of a V-Cone is:

$$\beta = \frac{\sqrt{D^2 - d^2}}{D}$$

where

- β = Beta ratio
- D = inside diameter of the pipe.
- d = outside diameter of the cone.

If Q represents the flowrate, the equation of flow for a differential pressure type flowmeter is:

$$Q = kY\sqrt{\frac{\Delta P}{\rho}}$$

OPTIONAL UNITS

Panel instruments

a. IR-6000

DIN48 × 48, Indication.
Totalization, High and low alarm,
DC24V Power supply



b. IR-4500

DIN96 × 48, Indication.
Totalization (Alternative),
High and low alarm,
DC24V Power supply



c. IR-3500

Indication, high and low alarm



d. IR-3400

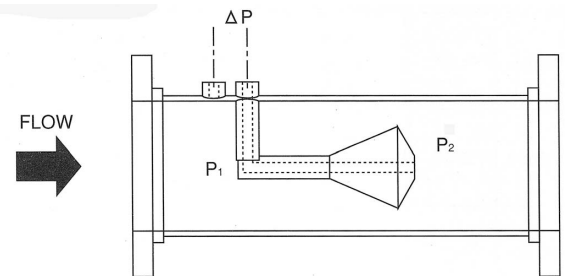
Indication only



Where

- Q = flowrate in actual cubic feet per second.
- k = constant that can change according to a particular flowmeter, dimensionless (see below for the equation for k for the V-Cone).
- Y = gas expansion factor, dimensionless.(Y=1 for noncompressible applications)
- ΔP = differential pressure in pounds per square foot.
- ρ = fluid density in pounds per cubic foot.

For the V-Cone:



$$k = \frac{\pi}{4} \sqrt{2G_c} \frac{D^2 \beta^2}{\sqrt{1-\beta^4}} C_d$$

where

- k = V-Cone meter constant, dimensionless.
- G_c = gravitational constant in feet per second squared.
- D = inside diameter of the pipe in feet.
- β = Beta ratio of the V-Cone, dimensionless.
- C_d = calibrated coefficient of discharge, dimensionless.

Mass V-Cone flowmeter

In measuring the saturated steam, we recommend to use VM series with density compensation function built in.

POSSIBLE MEASURING RANGE

Table 1 : For Saturated Steam Flow Measurement

Flow unit (kg/h)

STEAM PRESS. (TEMP.)		1kgf/cm ² 0.1 MPa (120°C)	2kgf/cm ² 0.2 MPa (134°C)	3kgf/cm ² 0.3 MPa (144°C)	4kgf/cm ² 0.4 MPa (152°C)	5kgf/cm ² 0.5 MPa (159°C)	6kgf/cm ² 0.6 MPa (165°C)	7kgf/cm ² 0.7 MPa (171°C)	8kgf/cm ² 0.8 MPa (175°C)	9kgf/cm ² 0.9 MPa (180°C)	10kgf/cm ² 1.0 MPa (184°C)
SIZE	15mm 1/2"	26.8 35 62.5	32.6 45 92.3	37.4 55 117	26.3 65 146	26.9 75 176	27.9 90 200	28.6 100 224	30.2 150 252	30.4 150 283	30.3 200 311
	20mm 3/4"	46.3 60 108	37.7 80 160	43.3 100 203	45.5 100 253	46.5 150 305	48.2 200 347	49.4 200 389	52.2 200 437	50.2 250 490	52.4 300 540
	30mm 1"	74.3 95 175	60.4 100 257	69.4 150 327	72.9 200 408	74.5 250 491	77.3 300 559	79.2 300 627	83.7 350 704	80.5 400 790	84.1 450 870
	40mm 1 1/2"	121 200 428	147 300 631	169 350 803	178 450 1000	181 550 1210	188 650 1370	193 70 1540	204 850 1730	196 950 1940	204 1000 2130
	50mm 2"	197 350 702	239 500 1030	275 600 1320	289 800 1640	295 950 1980	306 1000 2250	313 1500 2520	332 1500 2830	319 1500 3180	332 1500 3500
	65mm 2 1/2"	278 500 996	338 700 1470	388 850 1870	408 1000 2330	417 1500 2800	432 1500 3190	442 2000 3580	468 2000 4020	450 2000 4510	470 2500 4970
	80mm 3"	426 800 1530	519 1000 2260	596 1500 2880	626 1500 3580	639 2000 4320	663 2500 4920	678 2500 5510	719 3000 6190	691 3500 6940	722 3500 7650
	100mm 4"	740 1500 2670	901 2000 3920	1040 2500 4990	1100 3000 6220	1120 3500 7500	1190 4000 8540	1190 4500 9570	1260 5000 10700	1210 6000 12100	1250 6500 13300
	125mm 5"	1140 2000 4040	1380 3000 5970	1590 3500 7570	1670 4500 9480	1700 5500 11300	1760 6000 12900	1810 7000 14400	1890 8000 16300	1840 9000 18200	1900 10000 20100
	150mm 6"	1690 3000 5980	2050 4500 8800	2350 5500 11200	2470 7000 14000	2520 8000 16800	2620 9500 19200	2670 10000 21500	2840 10000 24100	2730 15000 27000	2840 15000 29800
	200mm 8"	2840 5500 9960	3450 7500 14700	3960 9000 18700	4160 10000 23300	4250 15000 28000	4410 15000 31900	4520 15000 35800	4780 20000 40200	4590 20000 45100	4800 25000 49700
	250mm 10"	4470 8500 15500	5440 10000 22900	6250 15000 29100	6570 15000 36300	6710 20000 43700	6960 25000 49800	7130 25000 55800	7540 30000 62600	7250 35000 70200	7580 40000 77400
300mm 12"	6420 10000 22000	7810 15000 32500	8970 20000 41300	9420 25000 51500	9630 30000 62000	9990 35000 70600	10300 40000 79200	10900 45000 88900	10500 50000 99700	10900 55000 110000	

Table 2 : For Air Flow Measurement

Flow unit (Nm³/h)

PRESS.		ATM.	1kgf/cm ² 0.1 MPa	2kgf/cm ² 0.2 MPa	3kgf/cm ² 0.3 MPa	4kgf/cm ² 0.4 MPa	5kgf/cm ² 0.5 MPa	6kgf/cm ² 0.6 MPa	7kgf/cm ² 0.7 MPa	8kgf/cm ² 0.8 MPa	9kgf/cm ² 0.9 MPa	10kgf/cm ² 1.0 MPa	
SIZE	15mm	1/2"	(25.5) (30) (36.7)	33.3 35 72.6	28.8 40 103	33.3 60 144	37.3 70 181	27.3 80 198	29.5 100 248	31.6 150 266	33.5 150 314	35.3 150 3450	37.1 200 381
	20mm	3/4"	(31.7) (40) (63.6)	40.6 60 125	49.9 75 179	57.5 100 250	43.1 150 314	47.2 150 345	51.1 200 430	54.6 200 461	57.9 250 545	61.1 300 599	64.1 300 661
	30mm	1"	(51.0) (70) (102)	65.2 90 202	80.0 150 288	61.7 200 404	69.1 250 505	75.7 250 556	81.8 300 692	87.5 350 743	92.9 400 878	98.0 450 965	104 500 1060
	40mm	1 1/2"	(87.2) (100) (251)	159 200 497	130 300 706	151 400 992	168 500 1240	184 650 1360	199 850 1700	213 900 1820	226 1000 2150	238 1000 2370	250 1000 2610
	50mm	2"	(142) (200) (412)	260 350 816	212 500 1160	245 800 1620	271 1000 2030	300 1000 2230	324 1500 2780	347 1500 2990	368 1500 3530	388 2000 3880	407 2000 4280
	65mm	2 1/2"	(202) (250) (585)	244 500 1150	299 800 1640	346 1000 2300	387 1500 2880	424 1500 3170	458 2000 3950	490 2000 4240	520 2500 5010	548 2500 5500	575 3000 6070
	80mm	3"	(311) (450) (900)	374 800 1770	459 1000 2530	530 1500 3550	593 2000 4440	650 2500 4890	703 3000 6080	751 3000 6530	797 3500 7710	841 4000 8480	882 4500 9350
	100mm	4"	(357) (750) (1560)	649 1500 3090	796 2000 4390	920 3000 6160	1040 4000 7710	1140 4500 8490	1230 5000 10500	1310 5500 11300	1390 6000 13400	1470 7000 14700	1540 8000 16200
	125mm	5"	(544) (1000) (2370)	987 2000 4700	1220 3000 6660	1410 4500 9370	1580 5500 11600	1730 6500 12800	1870 8000 15900	2000 8500 17100	2120 10000 20200	2230 10000 23500	2340 10000 24600
	150mm	6"	(809) (1500) (3510)	1480 3000 6940	1810 5000 9850	2090 6500 13800	2340 8500 17300	2570 9500 19000	2770 10000 23700	2970 10000 25400	3450 15000 30000	3320 15000 33000	3480 15000 36400
	200mm	8"	(1360) (3000) (5850)	2490 5500 11500	3050 8000 16400	3530 10000 23000	3950 15000 28800	4320 15000 31700	4670 20000 39500	5000 20000 42400	5000 25000 50100	5590 25000 55100	5870 30000 60700
	250mm	10"	(2150) (4500) (9110)	3920 8500 18000	4810 10000 25600	5560 15000 36000	6220 20000 44900	6820 25000 49500	7370 30000 61500	7880 30000 66100	8370 40000 78100	8820 40000 85800	9260 45000 94600
300mm	12"	(3090) (6500) (12900)	5630 10000 25500	6700 15000 36300	7980 20000 51000	8930 30000 63800	9790 35000 70300	10700 40000 87300	11400 45000 93800	12100 55000 111000	12800 60000 122000	13400 65000 134000	

NB : Accuracy guaranteed range ability will be 10:1 for the flow rate indicated in brackets ().

Table 3 : Full Span for Water Flow Measurement (15°C, 0.5kg/cm²G)

Flow unit(m³/h)

SIZE	mm	Inch	Flow unit(m³/h)	
			Standard Span	Maximum Possible Span
15mm	1/2"		2.2	5.6
			2.5	6.6
			3.8	9.7
20mm	1/4"		4.0	9.7
			4.8	11.5
			5.0	13.5
25mm	1"		12	38
			15	38
			20	62
40mm	1 1/2"		28	89
			40	89
			43	136
50mm	2"		74	237
			103	237
			113	361
65mm	2 1/2"		168	533
			200	533
			283	890
80mm	3"		350	890
			350	1380
			446	1380
100mm	4"		639	1960
			800	1960
			800	1960

REMARKS

□ Table 1~3 indicate maximum flow rate with guaranteed accuracy under specified size and pressure.

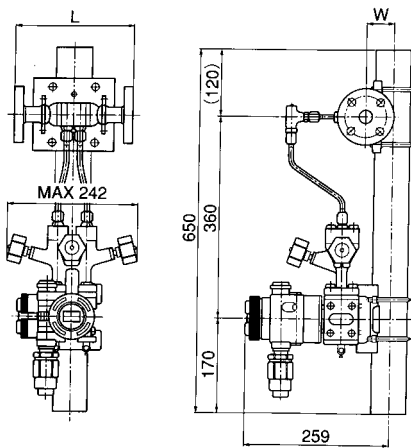
- Upper line : Minimum Possible Span
- Middle line : Standard Span
- Lower line : Maximum Possible Span

Accuracy guaranteed range ability is 14:1 of full scale Span (10:1 in some occasion)

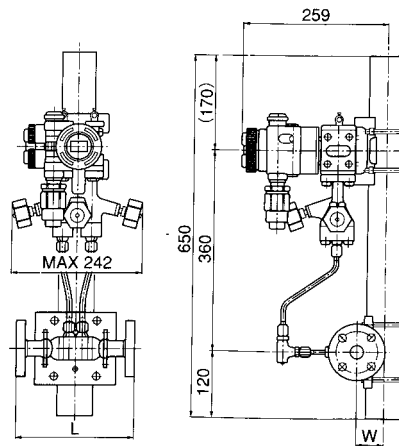
□ Sizing, Differential pressure and pressure loss calculation with specified condition is available on request. Refer to ORDERING INFORMATION and contact Tokyo Keiso.

DIMENSIONS

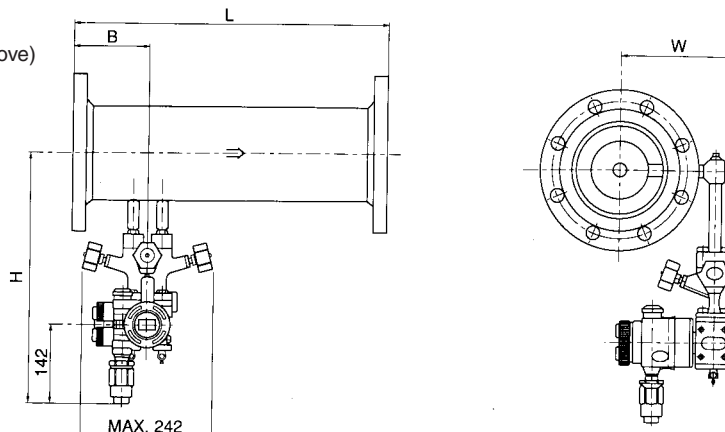
◆ Fig. a For STEAM and LIQUIDS
Size 15~40mm (1/2~1-1/2")
Flow direction: Left to Right or Right to Left



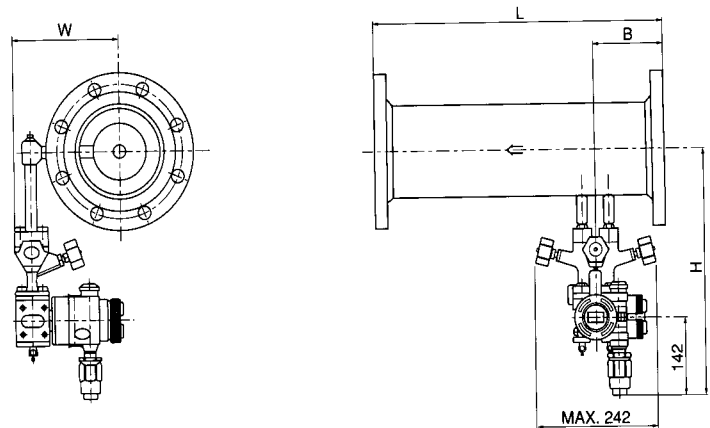
◆ Fig. b For GASES
Size 15~40mm (1/2~1-1/2")
Flow direction: Left to Right



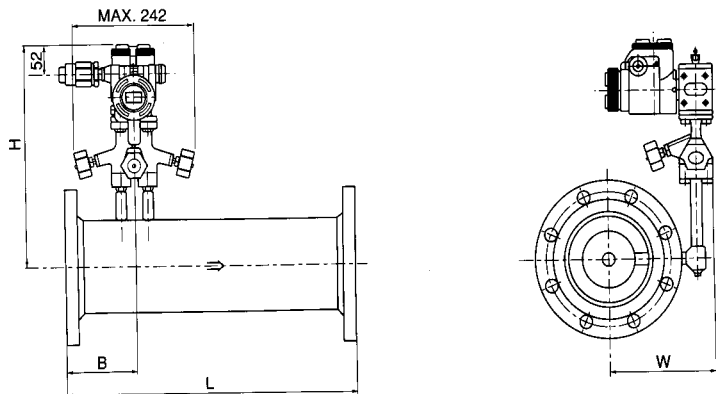
◆ Fig. c For STEAM and LIQUIDS
Size 50mm and above (2" and above)
Flow direction: Left to Right



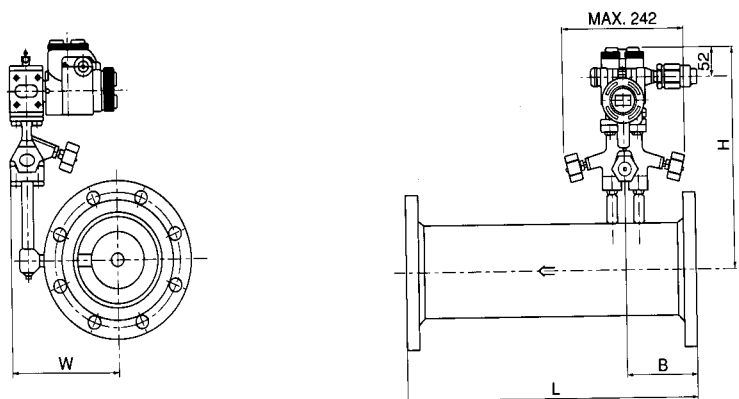
◆ Fig. d For STEAM and LIQUIDS
Size 50mm and above (2" and above)
Flow direction:Right to Left



◆ Fig. e For GASES
Size 50mm and above (2" and above)
Flow direction:Left to Right



◆ Fig. f For GASES
Size 50mm and above (2" and above)
Flow direction:Right to Left



Size		L (mm)	B (mm)	W (mm)	H (mm)				Fig.
(mm)	(")				With 3 way valve		Without 3 way valve		
					STEAM LIQUID	GASES	STEAM LIQUID	GASES	
15	1/2	203	—	44	—	—	—	—	a.b
20	3/4	203	—	47	—	—	—	—	a.b
25	1	203	—	50	—	—	—	—	a.b
40	1 1/2	254	—	57	—	—	—	—	a.b
50	2	305	116	132	336	381	246	291	c-f
65	2 1/2	305	116	138	344	389	254	299	c-f
80	3	356	116	146	351	396	261	306	c-f
100	4	406	129	174	376	421	286	331	c-f
125	5	559	135	187	391	436	301	346	c-f
150	6	559	135	201	401	446	311	356	c-f
200	8	660	154	241	436	481	346	391	c-f
250	10	711	154	268	461	506	371	416	c-f
300	12	762	160	294	486	531	396	441	c-f

REMARKS

- 1) Fig.a-f indicate dimension for "With 3way valve" versions.
- 2) Pressure tight cable glands are provided for pressure tight ex-proof versions.

ORDERING INFORMATION

Specify the following for order/inquiry;

CUSTOMER	
CONTACT	

Model code selection

□□-VD-□□□□-□□

Refer to MODEL CODEL and specify.

Process condition

Tag No.				
Fluid name				
Temp.	()	<input type="checkbox"/> °C	<input type="checkbox"/> ()	
Press.	()	<input type="checkbox"/> kg/cm ² G	<input type="checkbox"/> kPa (gauge)	
		<input type="checkbox"/> ()		
Viscosity	()	<input type="checkbox"/> cP	<input type="checkbox"/> mPa·s	<input type="checkbox"/> ()
Sp. Gr. (Density)	()	<input type="checkbox"/> kg/m ³	<input type="checkbox"/> kg/Nm ³	
		<input type="checkbox"/> ()		
Humidity (Only for steam)	()	<input type="checkbox"/> %	<input type="checkbox"/> Saturated	
Process flow rate	Nor	Max	Min	<input type="checkbox"/> m ³ /h <input type="checkbox"/> Nm ³ /h
Full scale	()			<input type="checkbox"/> kg/h <input type="checkbox"/> ()

Other instructions

- General purpose
- Low pressure loss required (Allowable pressure loss _____ kPa)
- Other special instruction, if any

* Specification subject to change without notice


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