Differential Pressure Flowmeter

Operation Instructions

Chongqing Chuanyi Automation Co., Ltd. Flowmeter Branch

An Open Letter to Users of Flowmeter Branch

Dear users,

Thanks for your continued support to Chongqing Chuanyi!

Chongqing Chuanyi has fully implemented GB/T24001-2004 standard. We expect your support and cooperation in our environmental protection activities. It is recommended that you:

1. Understand the Operation Instructions before use. Install and use the instrument in strict accordance with the Instructions to avoid safety accidents.

2. Ensure that the instrument installation, transportation, operation, storage, repair and scrapping meet applicable requirements of laws, regulations and environmental protection.

3. Properly keep combustible, explosive or poisonous dangerous goods, and take corresponding precautions during storage and transportation to prevent fire, explosion or spillage & leakage accidents that cause environmental pollution.

4. During construction, give priority to pollution-free or less-pollution construction equipment and advanced construction methods rather than those prohibited by national or local authority, take necessary measures to reduce the noise pollution, and dispose of wastes on the construction site properly.

5. Give active cooperation during operations, which may affect you in terms of environmental protection, by our service personnel in strict accordance with rules and regulations of the Company as well as relevant requirements.

Let us work together to protect the environment and the Earth!

Dear users,

Welcome to use our products. Before use, please read the Instruction carefully to have a good understanding of correct installation and operation methods of products, thus ensuring the correct installation and operation and the best performance of the flowmeter.

We always insist on the service tenet of "SIC accompanies customers and customers in the heart of SIC". If you encounter any problem during use of the instrument, please contact us. We will assume no liability for performance degradation or damage of the instrument due to repair or replacement of components without authorization.

Customer service center: 023-67032695

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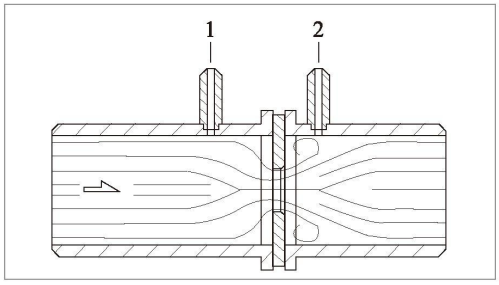
I. Overview

1.1 Scope of Application

Differential pressure flowmeter is a kind of flowmeter that has been widely used for a long time, with the throttling element as its main detection element. It can be used to measure and control the instantaneous flow and cumulative flow of liquid, steam and gas in combination with instruments such as differential pressure transmitter, flow indicator and regulator. This flowmeter is featured with mature technology, wide application scope, simple installation and maintenance, good repeatability and long service life, and is widely used in petrochemistry, natural gas, metallurgy, electric power, water conservancy, food, environmental protection and other industries.

1.2 Measurement Principle of Differential Pressure Flowmeter

When the fluid filled in the pipe flows through the throttling elements (orifice plates, nozzles, etc.) in the pipe, it will locally contract at the throttling part of the throttling element, thus increasing the flow rate and reducing the static pressure. Therefore, a pressure drop or differential pressure is generated ahead of and behind the throttling elements. The greater the flow rate of the medium, the greater the differential pressure generated ahead of and behind the throttling elements. That is, the fluid flow can be judged by measuring the differential pressure.



Pressure tapping points 1 and 2 are set at appropriate positions ahead of and behind the throttling element. Given that the throat diameter of the throttling element is d (mm), the inner diameter D (mm) of the pipe, the area A of the flow-passing section, the velocity v of the fluid on the flow-passing section, the position height h of the fluid, the mass flow Q_m of the fluid, and the density ρ (kg/m^3) of the fluid under working conditions, the velocity and pressure parameters of the fluid on the two pressure tapping sections conform to:

Bernoulli's equation: $$h_1 g + \frac{P_1}{\rho_1} + \frac{v_1^2}{2} = h_2 g + \frac{P_2}{\rho_2} + \frac{v_2^2}{2}$$

Flow continuity equation: $\rho_1 v_1 A_1 = \rho_2 v_2 A_2$

$$Q_m = \frac{C}{\sqrt{1-\beta^4}} \cdot \varepsilon_1 \cdot \frac{\pi}{4} \cdot d^2 \cdot \sqrt{2 \Delta p \rho_1}$$

$$= \frac{C}{\sqrt{1-\beta^4}} \cdot \varepsilon_2 \cdot \frac{\pi}{4} \cdot d^2 \cdot \sqrt{2 \Delta p \rho_2} \quad (\beta = \frac{d}{D})$$

Then,

Where: C-- discharge coefficient; B-- diameter ratio of throttling device; e-- expansibility coefficient

It can be seen from the equation that, when the diameter of the throttling element is d and the fluid density ρ is constant, the flow and static pressure difference Δp are in a square root relationship. The flow can be obtained according to the static pressure difference measured by the differential pressure meter. The flow coefficient in the equation is not derived from the theoretical equation, but is determined by considering the velocity distribution of the fluid on the flow-passing section and the energy loss of the fluid flowing through the throttling element. And the structure of the throttling element is a decisive factor. There are manufacturing standards for the structure of throttling elements at home and abroad, and there are two structure types of throttling elements: standard and non-standard. For the standard differential pressure flowmeter, it is assumed that the uncalibrated differential pressure flowmeter is similar in geometry and dynamics to the differential pressure flowmeter that has been fully experimentally calibrated. That is, the flowmeter meets all the requirements of the standard document (GB/T2624 or ISO5167), and its measurement accuracy is within the measurement error specified in the standard. The relationship between the mass flow and differential pressure can be determined based on the above flow equation. The condition for geometric similarity mainly includes: the compliance of structure type, pressure tapping device, manufacturing and installation of upstream and downstream straight pipe sections of throttling elements, etc. with the provisions of the standard. The condition for dynamical similarity is equal Reynolds number.

1.3 Characteristics and Technical Indicators of Differential Pressure Flowmeter

1.3.1 Features

(1) Many media applicable to measurement and a wide range of working conditions

(2) Mature technology and good reliability

(3) Standard manufacturing and good repeatability

(4) Long service life and easy maintenance

1.3.2 Main technical indicators of differential pressure flowmeter

1.3.2.1 International standard ISO5167 (GB/T2624) adopted for standard design and manufacturing of products

* According to Article 13 of the *Metrology Law of the People's Republic of China* and the relevant provisions in *Rules for Implementation of the Metrology Law of the People's Republic of China*, the Company applied to Chongqing Administration of Technology Regulation for type tests of the differential pressure flowmeters (V-cone flowmeter and orifice plate flowmeter). Those flowmeters have passed the examination and obtained the type approval certificate (No.: XPY [2011] No. 055). Wedge flowmeters and Venturi tube flowmeters have been subject to type tests, passed the examination and obtained the type approval certificate (No.: XPY [2013] No. 067).

1.3.2.2 Scope of application

(1) Orifice plate

<table>
<tr><td>Angle joint pressure tapping</td><td>Flange pressure tapping</td><td colspan="2">D and D/2 pressure tapping</td></tr>
<tr><td colspan="4">12.5≤d</td></tr>
<tr><td colspan="4">50≤D≤1000</td></tr>
<tr><td colspan="4">2≤β≤75</td></tr>
<tr><td colspan="2">5000≤ReD for 2≤β≤45</td><td colspan="2" rowspan="2">1260β 2 D≤ ReD</td></tr>
<tr><td colspan="2">10000≤ReD for 45≤β</td></tr>
<tr><td colspan="4">Note: d and D are in mm.</td></tr>
</table>

(2) ISA1932 nozzle

50mm≤D≤500mm

3≤β≤8

For 30≤β≤44, 70000≤RcD≤10^7

For 44≤β≤80, 20000≤ReD≤10^7

(3) Long-radius nozzle

50mm≤D≤630mm

2≤β≤8

10^4≤ReD≤10^7

(4) Classic Venturi tubes:

The scope of application of qualified classical Venturi tubes depends on the manufacturing method.

Scope of application of Venturi tubes with roughly cast contraction sections:

100mm≤D≤800mm; 30≤β≤75

Scope of application of Venturi tubes with machined contraction sections:

50mm≤D≤250mm: 40≤β≤75

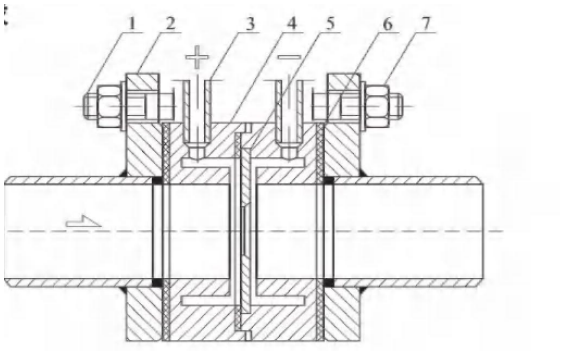
Scope of application of Venturi tubes with roughly welded iron plate contraction sections:

200mm≤D≤W1200mm; 40≤β≤70

II. Installation

Users must pay great attention to whether the throttling device is installed according to the installation conditions and technical requirements, which is closely related to its measurement accuracy.

2.1 Basic Requirements for Installation



Schematic Diagram for Installation of Orifice Plate in Annular Chamber

1-Bolt 2-Flange 3-Pressure tapping pipe 4-Annular chamber 5-Orifice plate 6-Sealing gasket 7-Nut

1. Before the installation of the throttling device, check whether the number and size of the throttling device meet the requirements of the pipe installation position.

2. Install the new pipeline system after the pipe flushing.

3. Pay attention to the direction during installation of the throttling device, with the side marked with "+" in the upstream direction.

4. During installation of the throttling device in the pipe, ensure the perpendicularity and concentricity with the pipe axis. The perpendicularity error shall not exceed ±10, and the concentricity difference shall not exceed $\frac{0.0025D}{0.1+2.3\beta^4}$.

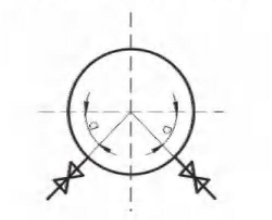
5. All sealing washers used during installation shall not protrude into the inner wall of the pipe.

6. Install the orifice plate tightly, and do not allow the leakage. Carry out the pressure test after installation.

7. Install impulse pipes vertically or obliquely, with an inclination of not less than 1:12. For fluids with higher viscosity, the inclination should also be increased. When the differential pressure signal is transmitted for more than 3m, the impulse pipe shall be inclined in sections, and gas collectors and settlers shall be installed at the highest and lowest points respectively.

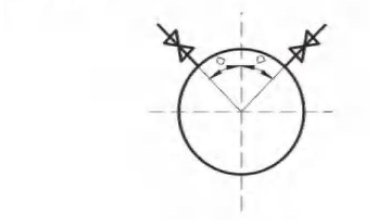
8. In order to avoid the transmission distortion of differential pressure signal, the positive- and negative-pressure impulse pipes shall be laid as close as possible, and anti-freezing measures shall also be taken in severe cold areas.

9. During installation, pay attention to the position of the pressure tap. For installation on a vertical pipe, the position of the pressure tap can be arbitrarily selected on the plane of the pressure tapping device. For installation on a horizontal pipe, the position of the pressure tap is shown in the figure.



a≤45°

a When the measured fluid is liquid



a≤45°

b When the measured fluid is gas

1 Minimum length of pipe section measured upstream and downstream of throttling device: (L_1 and L_2 are multiples of D)

Straight Pipe Sections Required Between Orifice Plates and Pipe Fittings without Flow Regulator

Values expressed in multiples of the pipe inner diameter D

Diameter ratio β	Upstream (inlet) of orifice plate																						Downstream (outlet) of orifice plate	
	Two 90º elbows on any plane of single 90º elbow (S>30D)[a]		Two 90° elbows on the same plane: S-shaped structure 30D≥D>10D)[a]		Two 90º elbows on the same plane: S-shaped structure (10D≥S)[a]		Two 90º elbows on mutually perpendicular planes (5D≥S≥5D)[a]		Two 90º elbows on mutually perpendicular planes (5D>S)[a,b]		90° miter elbow of single 90° tee with or without extension		Two 45° elbows on the same plane of a single 45º elbow (S≥2D)[a]		Concentric reducing pipe (changed from 5D to D within the length of 1.5D~3D)		Concentric diverging pipe (changed from 5D to D within the length of D~2D)		Full-hole ball valve or gate valve fully open		Sudden symmetrical contraction		Diameter of thermometer pocket or thermowell c≤03Dq		Pipe fittings (columns 2~11) and densitometer sleeve	
1	2		3		4		5		6		7		8		9		10		11		12		13		14	
-	A^e	B^r	A^e	B^r	A^e	B^r	A^e	B^r	A^e	B^r	A^e	B^r	A^e	B^r	A^e	B^r	A^e	B^r	A^e	B^r	A^e	B^r	A^e	B^r	A^e	B^r
≤20	6	3	10	g	10	g	19	18	34	17	3	g	7	g	5	g	6	g	12	6	30	15	5	3	4	2
40	16	3	10	g	10	g	44	18	50	25	9	3	30	9	5	g	12	8	12	6	30	15	5	3	6	3
50	22	9	18	10	22	10	44	18	75	34	19	9	30	18	8	5	20	9	12	6	30	15	5	3	6	3
60	42	13	30	18	42	18	44	18	65[μ]	25	29	18	30	18	9	5	26	11	14	7	30	15	5	3	7	3.5
67	44	20	44	18	44	20	44	20	60	18	36	18	44	18	12	6	28	14	18	9	30	15	5	3	7	3.5
75	44	20	44	18	44	22	44	20	75	18	44	18	44	18	13	8	36	18	24	12	30	15	5	3	8	4

Note 1: The shortest straight pipe section required is the straight pipe section between various pipe fittings upstream or downstream of the orifice plates and the orifice plates. The straight pipe section shall be measured from the downstream end of the curved portion of the nearest (or only) elbow or tee, or from the downstream end of the curved or conical portion of the reducing or diverging pipe.

Note 2: The radius of curvature of most elbows on which the straight pipe in this table is based is equal to 1.5D.

a S is the spacing between two elbows measured from the downstream end in curved portion of the upstream elbow to the upstream end in curved portion of the downstream elbow.

b It is not a proper installation upstream and flow regulators shall be used if possible.

c The thermometer pocket or thermowell shall be installed without changing the shortest upstream straight pipe section required for other pipe fittings.

d As long as the values in columns A and B are increased to 20 and 10 respectively, the thermometer pocket or thermowell with a diameter of 3D 13D can be installed. However, this installation is not recommended.

e Column A for each type of pipe fitting gives a pipe section with a diameter corresponding to "zero additional uncertainty".

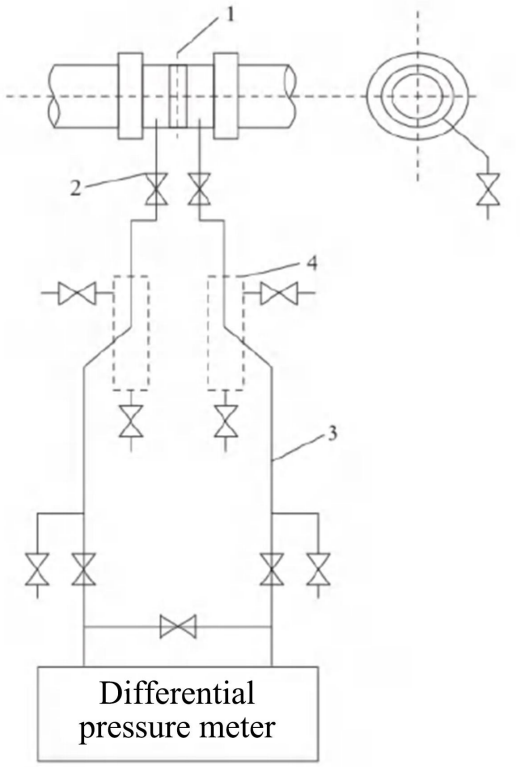
f Column B for each type of pipe fitting gives a pipe section with a diameter corresponding to "5% additional uncertainty".

g Zero additional uncertainty is given for the straight pipe section in column A. The data for shorter straight pipe sections are not currently available to give the required straight pipe sections in column B.

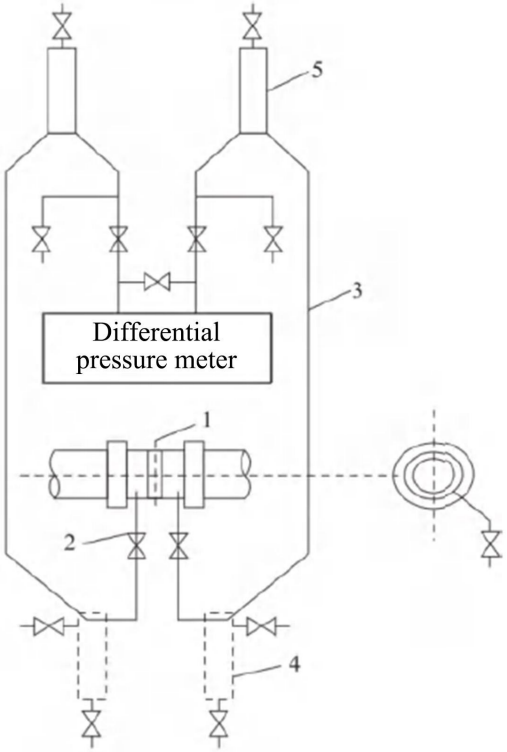
h In case of S<2D, 95D is required for ReD>2×108.

2.2 Installation of Differential Pressure Signal Pipeline

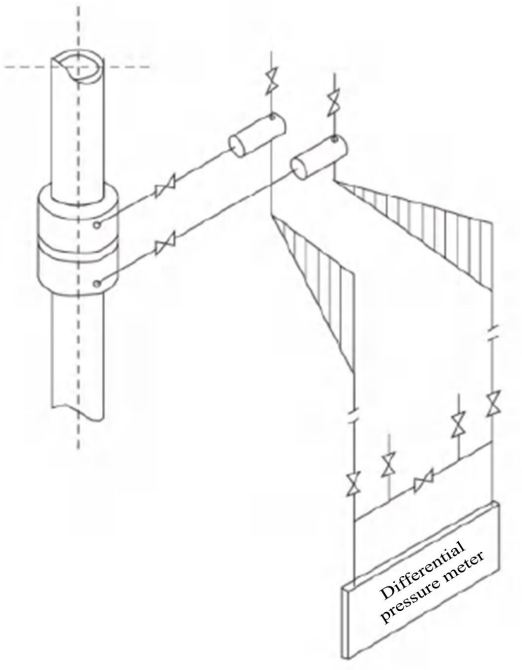
2.2.1 Schematic Diagram for Installation of Signal Pipeline When the Measured Fluid is Clean Liquid



a. The instrument is below the pipe

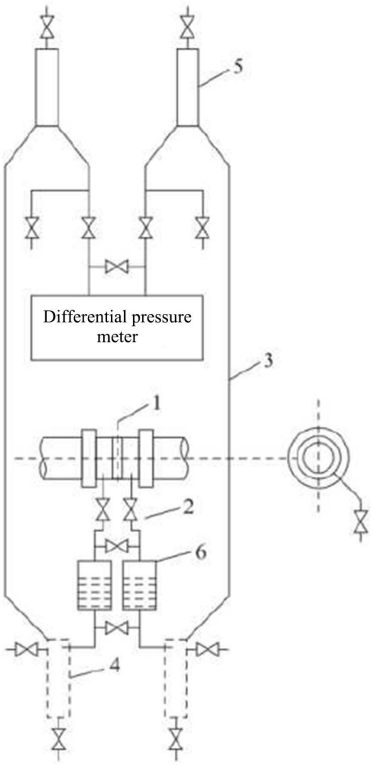


b. The instrument is above the pipe

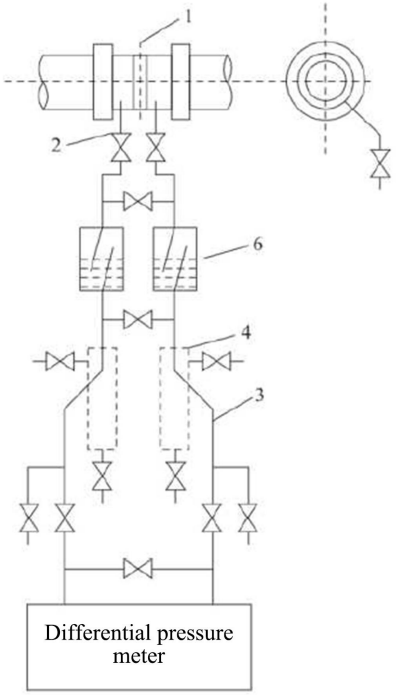


c. The measured fluid in the vertical pipe is high-temperature liquid

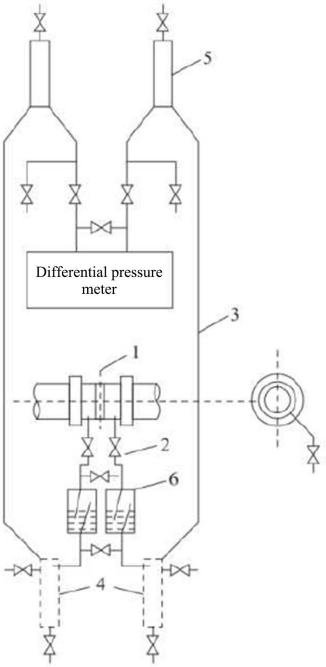
2.2.2 Schematic Diagram for Installation of Signal Pipeline When the Measured Fluid is Corrosive Liquid



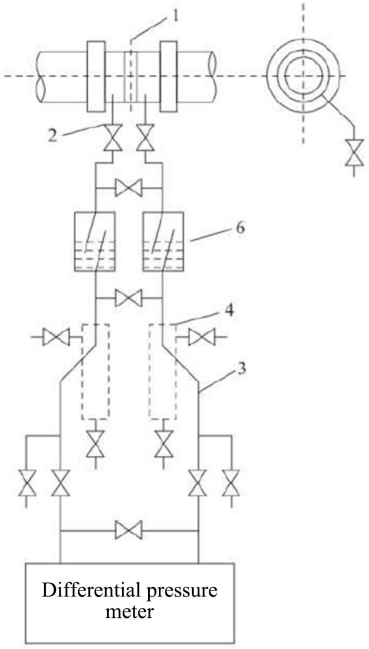
a. The instrument is above the pipe (the density of the spacer fluid is greater than that of the measured liquid)



b. The instrument is below the pipe (the density of the spacer fluid is greater than the measured density)

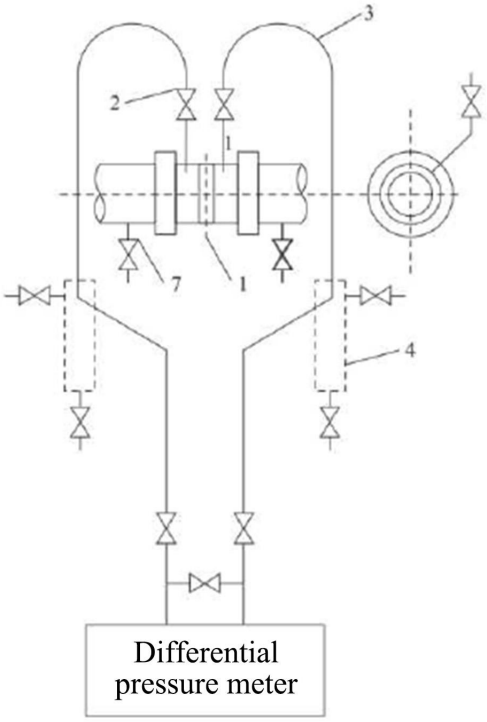


c. The instrument is above the pipe (the density of the spacer fluid is less than that of the measured liquid)

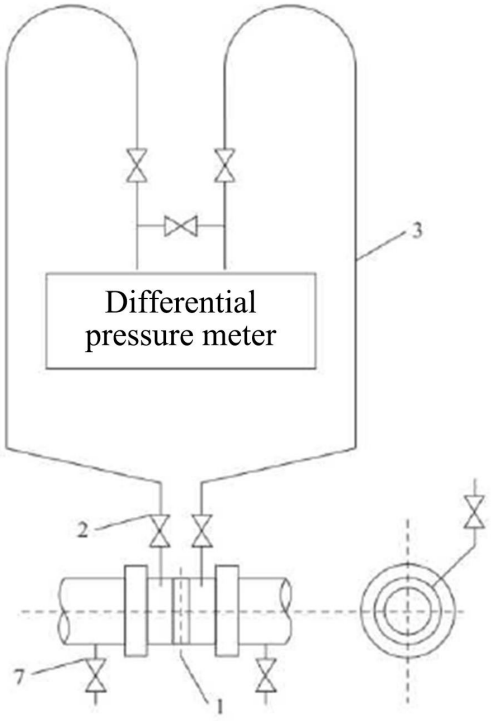


d. The instrument is below the pipe (the density of the spacer fluid is less than that of the measured liquid)

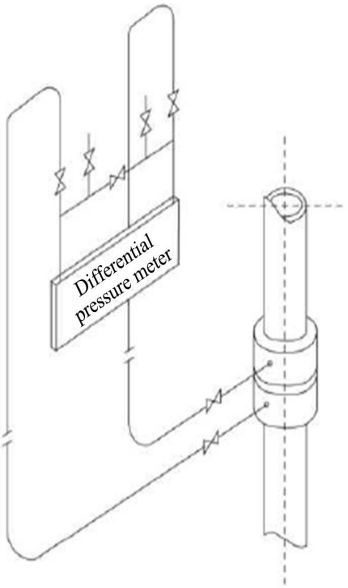
2.2.3 Schematic Diagram for Installation of Signal Pipeline When the Measured Fluid is Clean Dry Gas



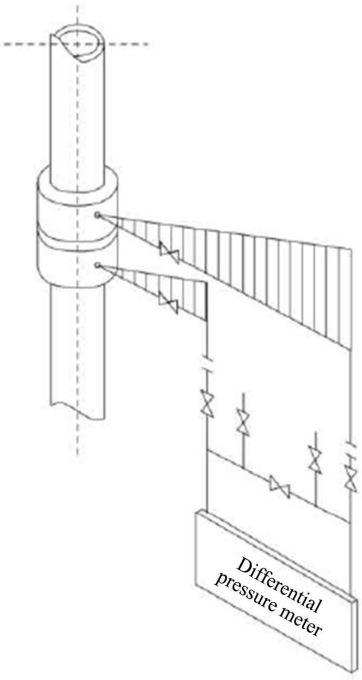
a. The instrument is below the pipe



b. The instrument is above the pipe

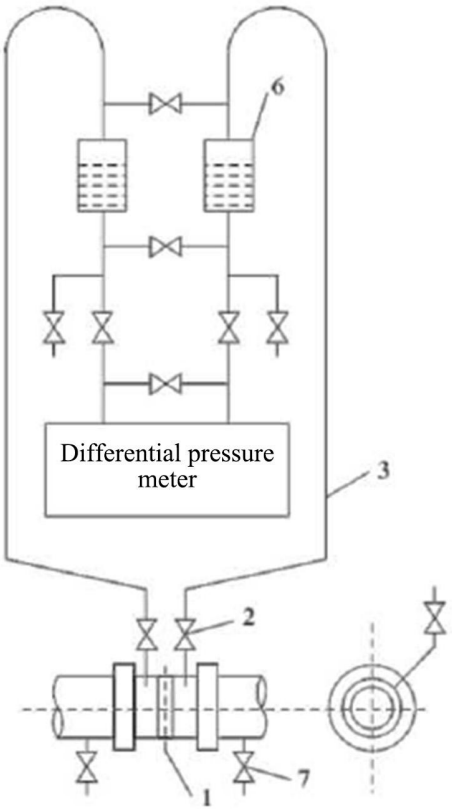


C. For vertical pipe, the meter is above the pressure tap

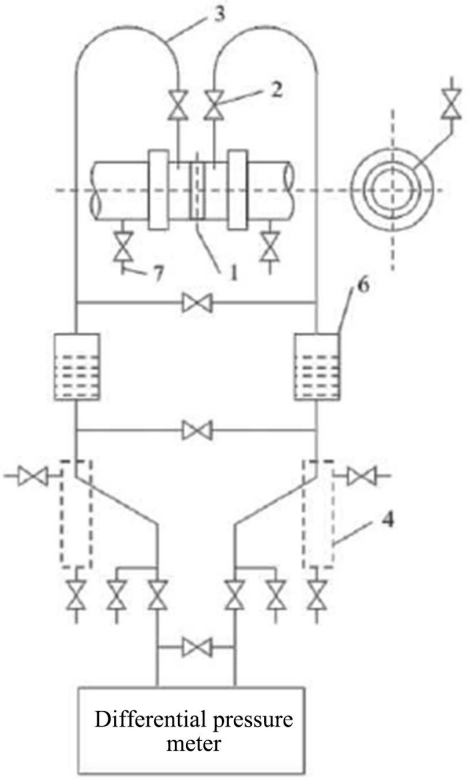


d. For vertical pipe, the meter is below the pressure tap

2.2.4 Schematic Diagram for Installation of Signal Pipeline When the Measured Fluid is Corrosive Dry Gas

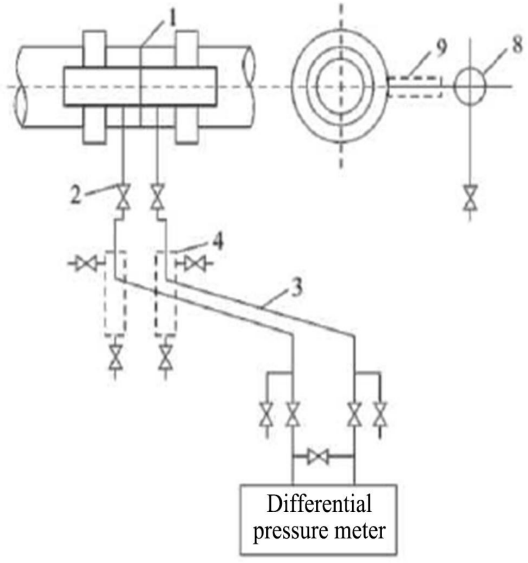


A. The meter is above the pressure tap

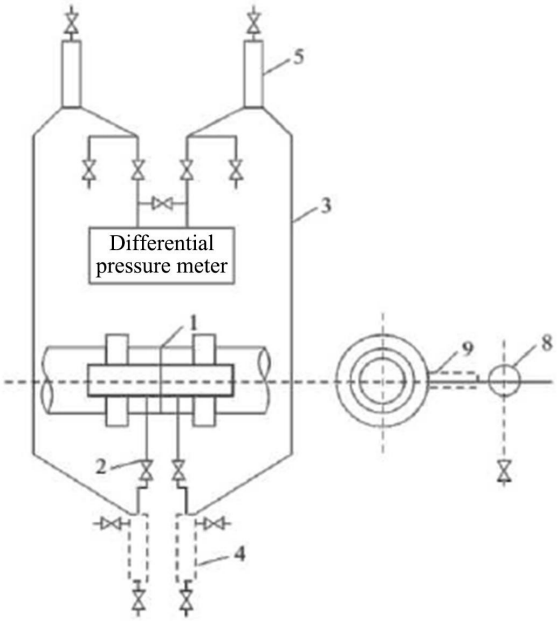


D. The meter is below the pressure tap

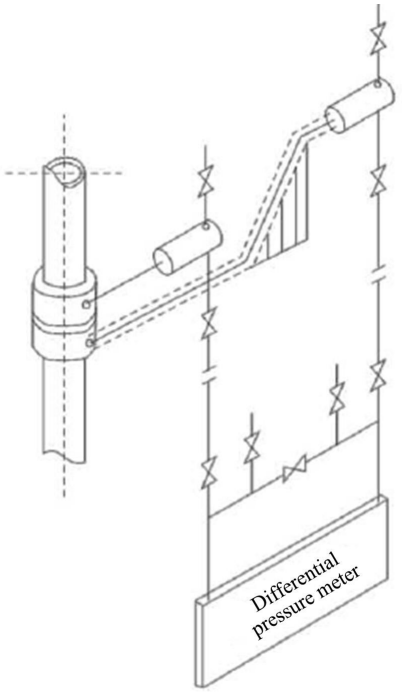
2.2.5 Schematic Diagram for Installation of Signal Pipeline When the Measured Fluid is Water Steam



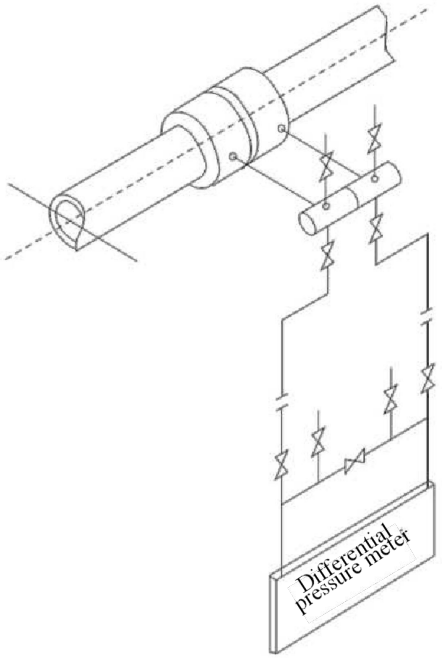
A. The meter is below the pipe



B. The meter is above the pipe

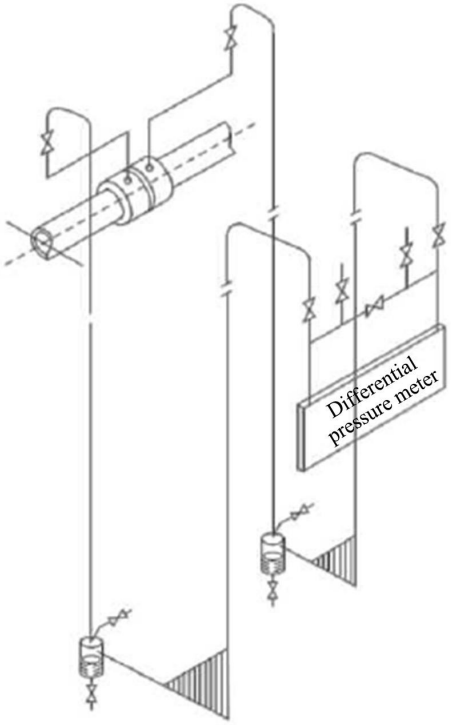


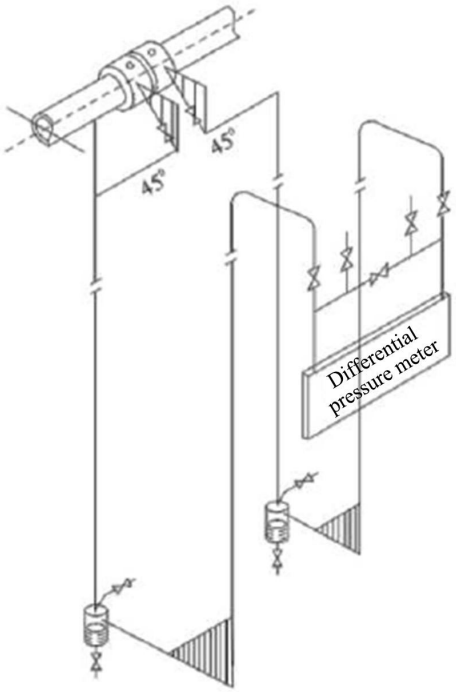
C. For vertical pipe, the meter is below the pressure tap

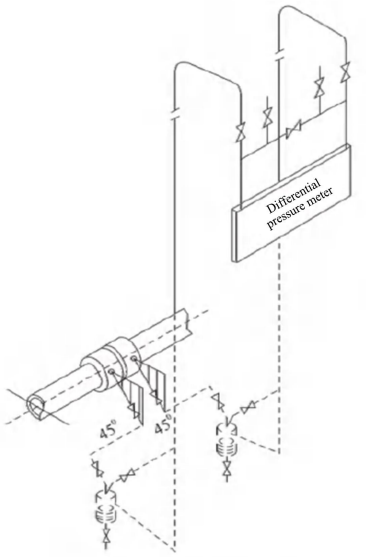


D. The meter is below the pipe, as shown in Fig. a, but the condenser is installed in a different way.

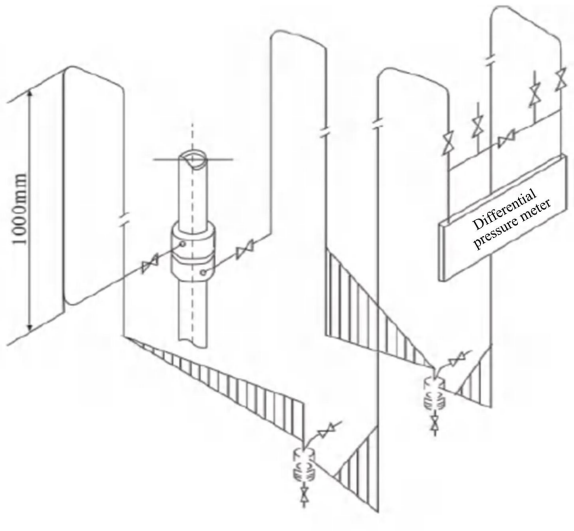
2.2.6 Schematic Diagram for Installation of Signal Pipeline When the Measured Fluid is Clean Gas



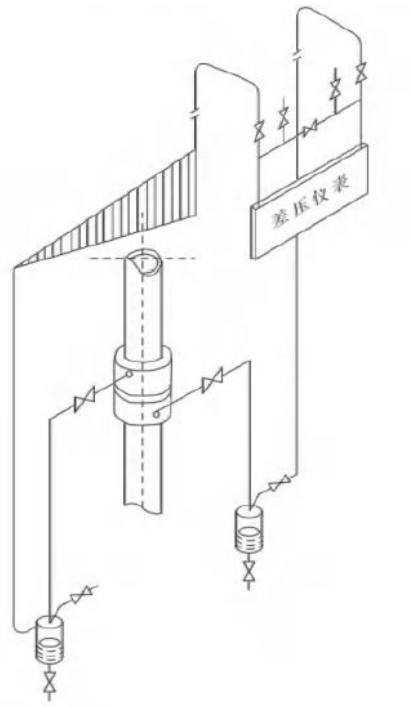




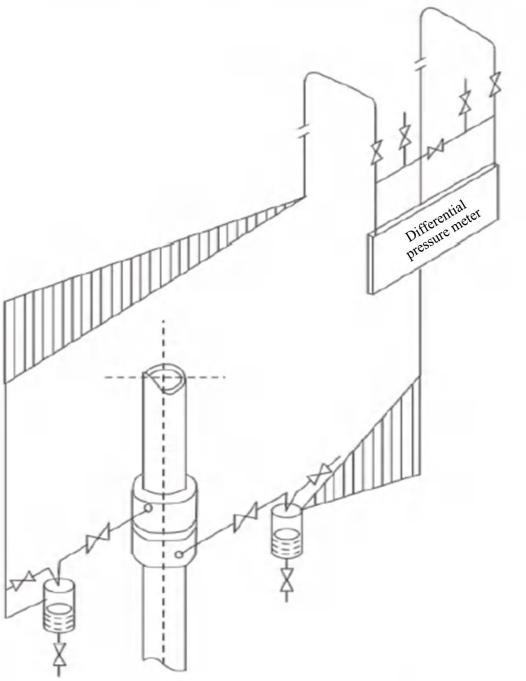
C. The meter is above the pipe



d. For vertical pipe, the meter is below the pressure tap



e. For vertical pipe, the meter is above the pressure tap

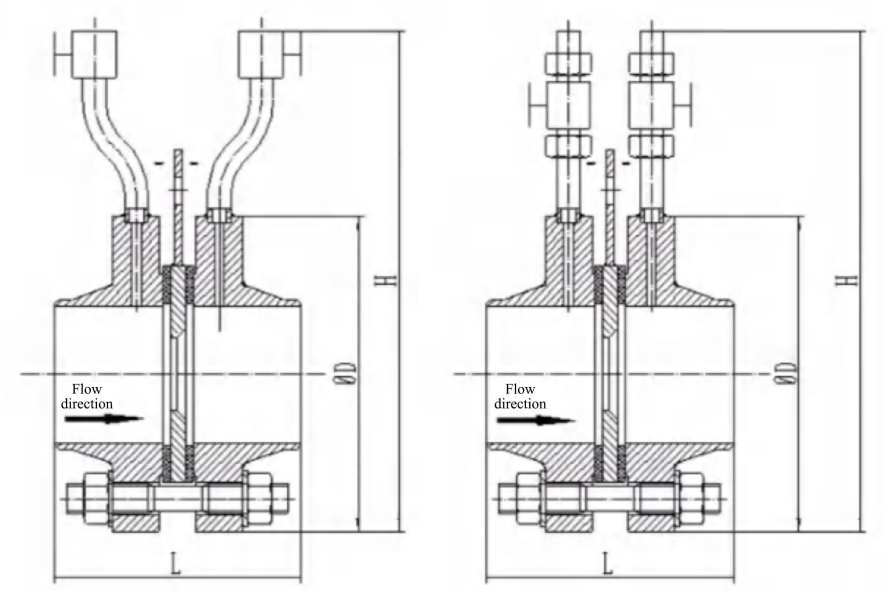


f. For vertical pipe, the meter is above the pressure tap (e and f can be optional)

Meaning of numerical sequence numbers in the above installation drawings for differential pressure signal: 1-Throttling element 2-Valve 3-Impulse pipe 4-Settler (optional in dotted line) 5-Gas collector 6-Isolator 7-Blow-off valve 8-Cooler 9-Insulating layer b. The meter is below the pipe (a and b can be optional)

2.3 Installation Dimension Drawing of Flange Pressure Tapping Orifice Plate of Common Specification

Installation Dimension Drawing of **RF** Flange Pressure Tapping Orifice Plate



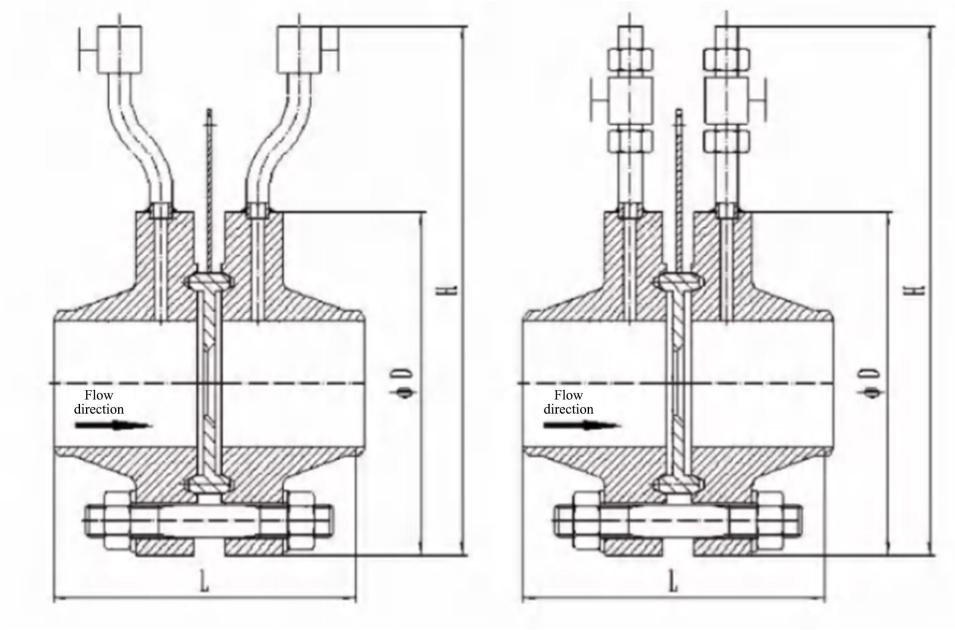
Pressure grade	1.0MPa				1.6MPa				2.5MPa			
Nominal diameter /DN	L/Length/mm	D/Width /mm	H/Height/mm	Reference weight/kg	L/Length/mm	D/Width /mm	H/Height/mm	Reference weight/kg	L/Length/mm	D/Width /mm	H/Height/mm	Reference weight/kg
25	130	115	295	7.4	130	115	295	8.0	130	115	295	8.0
32	134	140	320	13	134	140	320	15	134	140	320	15
40	140	150	330	11.7	140	150	330	11.7	140	150	330	11.6
50	140	165	345	13.6	140	165	345	13.6	142	165	345	13.5
65	140	185	365	16.9	140	185	365	16.8	146	185	365	16.9
80	146	200	380	18.8	146	200	380	18.9	154	200	380	19.0
100	150	235	415	21.0	150	220	400	21.3	168	235	415	25.6
125	152	270	450	25.2	152	250	430	25.6	170	270	450	33.0
150	152	300	480	31.4	152	285	465	32.1	180	300	480	38.2
200	164	340	520	42.2	164	340	520	43.5	188	360	540	54.4
250	176	395	575	53.2	176	405	585	59.4	200	425	605	72.0
300	195	445	625	64.1	190	460	640	73.1	206	485	665	93.6
350	203	505	685	94.0	194	520	700	98.0	214	555	735	133.9
400	209	565	745	115.6	196	580	760	123.7	234	620	800	169.4
450	209	615	795	132	190	640	820	146.0	236	670	850	207.3
500	215	670	850	147.9	196	715	895	194.5	266	730	910	252.0
600	227	780	960	200	206	840	1020	308.0	266	845	1025	361.5

Pressure grade	4.0MPa				6.3MPa				10MPa			
Nominal diameter /DN	L/Length/mm	D/Width /mm	H/Height/mm	Reference weight/kg	L/Length/mm	D/Width /mm	H/Height/mm	Reference weight/kg	L/Length/mm	D/Width /mm	H/Height/mm	Reference weight/kg
25	130	115	295	8.0	153	140	320	12,5	153	140	320	12.5
32	134	140	320	15	157	155	335	14.3	157	155	335	14.4
40	140	150	330	11.7	158	170	350	15.4	158	170	350	15.4
50	142	165	345	13.6	158	180	360	16.8	166	195	375	25
65	146	185	365	16.9	170	205	385	22.1	178	220	400	27.0
80	154	200	380	19.0	174	215	395	23.5	178	230	410	28.4
100	168	235	415	26.1	182	250	430	31.5	194	265	445	37.8
125	170	270	450	33.6	194	295	475	43.2	220	315	495	54.8
150	180	300	480	39.3	204	345	525	58.6	240	355	535	74.1
200	196	375	555	61.4	232	415	595	92.0	272	430	610	121.8
250	222	450	630	87.4	262	470	650	121.8	326	505	685	190
300	244	515	695	123.3	294	530	710	171.8	354	585	765	293.1
350	264	580	760	181.3	314	600	780	251.7	392	655	835	442.0
400	284	660	840	249.7	334	670	850	329.2				
450	286	685	865	275.5								
500	296	755	935	341.1								
600	316	890	1070	527.7								

Pressure grade	ANSI150				ANSI300				ANSI600			
Nominal diameter /DN	L/Length/mm	D/Width /mm	H/Height/mm	Reference weight/kg	L/Length/mm	D/Width /mm	H/Height/mm	Reference weight/kg	L/Length/mm	D/Width /mm	H/Height/mm	Reference weight/kg
25	170	110	290	7.1	176	125	305	8.5	176	125	305	8.5
32	170	115	295	7.7	180	135	315	9.5	180	135	315	9.5
40	176	125	305	8.6	184	155	335	13.6	194	155	335	14.8
50	176	150	330	12.0	184	165	345	15.0	194	165	345	16.3
65	182	180	360	16.3	190	190	370	20	200	190	370	21.7
80	182	190	370	17.9	190	210	390	23.7	200	210	390	25.9
100	192	230	410	25.7	194	255	435	33.2	228	275	455	46.1
125	216	255	435	31.7	214	280	460	39.6	252	330	510	73.3
150	214	280	460	35.9	212	320	500	52	258	355	535	88.4
200	236	345	525	52.7	236	380	560	74.4	292	420	600	132.7
250	236	405	585	77	248	445	625	109.5	330	510	690	217.3
300	256	485	665	105.2	276	520	700	158.7	340	560	740	265.6
350	274	535	715	131.1	300	585	765	219.0	358	605	785	377.7
400	274	595	775	165	306	650	830	277.4	384	685	865	518.6
450	296	635	815	186.2	334	710	890	342.3	398	745	925	622.8
500	306	700	880	224.1	340	775	955	399.1	410	815	995	1314.3
600	322	815	995	3103	354	915	1095	593.0	436	940	1120	1608.3

Note: The above dimensions are for reference only.

Installation Dimension Drawing of **RJ** Flange Pressure Tapping Orifice Plate



Pressure grade	6.3MPa				10MPa				16.0MPa			
Nominal diameter /DN	L/Length/mm	D/Width /mm	H/Height/mm	Reference weight/kg	L/Length/mm	D/Width /mm	H/Height/mm	Reference weight/kg	L/Length/mm	D/Width /mm	H/Height/mm	Reference weight/kg
25	153	140	320	12.5	153	140	320	12.5	153.0	140	320	12.5
32	157	155	335	14.3	157	155	335	14.4	157.0	155.0	335	14.4
40	171	170	350	15.5	171	170	350	15.4	171.0	170	350	15.4
50	174	180	360	17.1	182	195	375	28	182.0	195.0	375	28
65	186	205	385	22.5	194	220	400	27.4	194.0	220	400	27.4
80	190	215	395	23.9	194	230	410	28.8	194.0	230	410	28.8
100	198	250	430	32.0	210	265	445	38.2	210	265.0	445	38.2
125	210	295	475	43.7	236	315	495	55.3	236.0	315.0	495	55.3
150	220	345	525	59.2	256	355	535	75.8	256.0	355.0	535	75.8
200	248	415	595	94.0	288	430	610	123.5	288.0	430	610	123.5
250	278	470	650	123.9	342	505	685	191.1	342.0	505.0	685	191.1
300	310	530	710	174.1	370	585	765	292.0	370	585.0	765	292.0
350	330	600	780	257.3	414	655	835	448.4	414.0	655.0	835	448.4
400	350	670	850	336.4	446	715	895	113.9	446.0	715.0	895	113.9

Pressure grade	ANSI150				ANSI300				ANSI600			
Nominal diameter /DN	L/Length/mm	D/Width /mm	H/Height/mm	Reference weight/kg	L/Length/mm	D/Width /mm	H/Height/mm	Reference weight/kg	L/Length/mm	D/Width /mm	H/Height/mm	Reference weight/kg
25	168	110	290	7.1	174	125	305	8.5	174	125	305	11.3
32	168	115	295	7.8	178	135	315	9.6	174	135	315	12.6
40	176	125	305	8.8	184	155	335	12.6	184	155	335	14.9
50	176	150	330	12.2	184	165	345	15.3	184	165	345	16.6
65	182	180	360	16.5	190	190	370	24	190	190	370	22.1
80	182	190	370	18.1	190	210	390	24.3	190	210	390	26.4
100	192	230	410	26.0	194	255	435	33.8	228	275	455	46.6
125	216	255	435	32.1	216	280	460	43	252	330	510	73.7
150	214	280	460	36.3	224	320	500	51.0	258	355	535	89.0
200	236	345	525	53.1	248	380	560	75.3	292	420	600	133.3
250	236	405	585	713	260	445	625	117	330	510	690	217.4
300	256	485	665	106.2	288	520	700	168	340	560	740	265.3
350	274	535	715	131.1	312	585	765	219.3	358	605	785	379.6
400	274	595	775	162	318	650	830	278.7	384	685	865	533.8
450	296	635	815	187.6	346	710	890	344.3	398	745	925	642.4
500	306	700	880	224.9	358	775	955	402.2	410	815	995	771.0
600	322	815	995	311.9	358.0	775.0	955	596.3	436	940	1120	1111.2

Pressure grade	ANSI900				ANSI1500				ANSI2500			
Nominal diameter /DN	L/Length/mm	D/Width/mm	H/Height/mm	Reference weight/kg	L/Length/mm	D/Width/mm	H/Height/mm	Reference weight/kg	L/Length/mm	D/Width/mm	H/Height/mm	Reference weight/kg
25	187	150	330	15.2	187	150	330	15.2	205	160	340	17.3
32	187	160	340	16.9	187	160	340	16.9	213	185	365	23.6
40	199	180	360	21.2	199	180	360	21.2	245	205	385	32.3
50	228	215	395	32.5	228	215	395	32.5	277	235	415	49.7
65	233	245	425	43.7	233	245	425	43.7	312	265	445	65.4
80	228	240	420	38.2	257	265	445	56.7	362	305	485	105.8
100	252	290	470	62.0	271	310	490	82.5	410	355	535	168.5
125	278	350	530	96.7	335	375	555	155.0	492	420	600	275.4
150	304	380	560	121.8	368	395	575	194.6	580	485	665	422.7
200	350	470	650	212.4	458	485	665	316.7	676	550	730	657.0
250	394	545	725	304.4	540	585	765	543.6	885	675	855	1205.7
300	428	610	790	421.8	608	675	855	848.4	979	760	940	1767.7
350	460	640	820	608.8	642	750	930	1125.5				
400	466	705	885	741.6	673	825	1005	1426.1				
450	496	785	965	1011.9	705	915	1095	1849.4				
500	534	855	1035	1269.6	765	985	1165	2325.0				
600	632	1040	1220	2297.4	874	1170	1350	3711.8				

Note: The above dimensions are for reference only.

Multi-hole Flow Measurement Throttling Device

I. Overview

DF series multi-hole orifice plate (also known as balanced flowmeter) is a new type of flow measurement sensor based on the combination of standard orifice plate and multi-hole rectifier according to national standard GB/T 2624-2006. It adjusts the balance of various disturbance flows to an ideal state to the maximum extent. Therefore, excellent performance can be achieved by laying the shortest straight pipe section. It is suitable for almost all fluid measurement, and its processing, manufacturing and installation are realized just like the standard orifice plate.

II. Measurement Principles

The traditional throttling device has been greatly improved by the multi-hole meter, and the throttling principle has been changed from edge throttling to multi-hole balanced throttling. The sensor is a multi-hole disc throttle rectifier, which is installed on the cross section of the pipe. The size and distribution of each hole are customized based on the unique formula and test data, which is called function hole. When the fluid passes through the disc function hole, the fluid will be balanced and adjusted, and the vortex will be minimized to form an approximate ideal fluid. The stable differential pressure signal will be obtained by taking the device, and the volume flow and mass flow will be calculated according to Bernoulli equation.

$$Q_m = \frac{C\varepsilon}{\sqrt{1-\beta^4}} * \frac{\pi}{4} * d^2 * \sqrt{2\rho\Delta P}$$

$$Q_v = \frac{C\varepsilon}{\sqrt{1-\beta^4}} * \frac{\pi}{4} * d^2 * \sqrt{\frac{2\Delta P}{\rho}}$$

Where: Qm and Qv - mass flow (kg/s) and volume flow (m^3/s) respectively;

C- efflux coefficient;

ε- expandability coefficient;

D- opening diameter of throttle element, (m);

β- diameter ratio, β = d/D;

ρ1ρ- density of measured fluid, kg/m^3;

△P- differential pressure, Pa.

III. Features

1. Multi-hole flowmeter is characterized by symmetrical multi-hole structure, which can balance the flow field, reduce eddy current, vibration and signal noise, and greatly improve the stability of flow field.

2. Low requirement for straight pipe section: Because of the balanced flow field, stable adjustment and quick pressure recovery, the requirement for straight pipe section is greatly reduced. In most cases, the diameter of straight pipe section can be less than 5D, which is more advantageous especially for pipes made of special expensive materials.

3. Low permanent pressure loss: The balanced design of multi-hole symmetry reduces the formation of vortex and turbulent friction, and reduces the kinetic energy loss.

4. Resistance to dirt and low risk of blockage: The balanced design of multi-hole symmetry reduces the formation of turbulent shear force and vortex and stagnant dead zone, and ensures the smooth passage of dirty media through multiple holes, thus reducing the chance of fluid holes being blocked.

5. Suitable for most gas, liquid and steam media, as well as high temperature and high pressure applications.

IV. Main technical parameters

1. Pipe specification: DN15~DN3000 round pipe and rectangular pipe
2. Nominal pressure: PN25~42MPa
3. Operating temperature: -200℃~600℃
4. Range ratio: 1:10~15
5. Accuracy class: 5, 1 and 2
6. Connection mode: clamping type, flange welding type, pipe type connection, etc.

V. Structure type:

Multi-hole flowmeter can be classified into ordinary type and handle type.

1. Ordinary type (see Fig. 1) 2. Handle type (see Fig. 2)

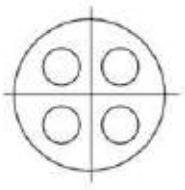


Fig. 1

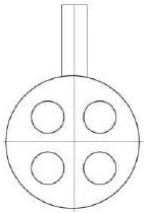


Fig. 2

III. Accessories

3.1 Condenser

In order to avoid the influence of high-temperature medium on the differential pressure meter, a condenser shall be installed in the impulse pipeline for measuring the steam and medium with a temperature higher than 70°C. The condenser is used to condense the medium in the impulse pipe, protect the differential pressure meter, and make the condensate level in the positive- and negative-pressure impulse pipes equal and constant.

3.2 Isolator

The isolator shall be used for measuring liquids or corrosive gases with high viscosity, corrosivity and easy precipitation of solids. The isolator is installed between the differential pressure meter and the throttling device. The protective liquid is injected into the isolator and the impulse pipe behind it to prevent the measured fluid from direct contact with the differential pressure meter, so as to avoid damage to the differential pressure meter.

If the specific gravity of the measured medium is less than that of the spacer fluid, FG-64A type shall be adopted;

If the specific gravity of the measured medium is greater than that of the spacer fluid, FG-64B type shall be adopted.

Positive- and negative-pressure isolators shall be installed on impulse pipes vertically installed and at the same height. Common spacer fluids include methyl silicone oil, glyceryl tartarate, dibutyl phthalate, ethanol, ethylene glycol, etc.

3.3 Gas Collector and Settler

When the measured fluid is liquid, a gas collector shall be installed at the highest point of the impulse pipe to collect and regularly exhaust the gas in the impulse pipe. When the differential pressure meter is installed higher than the main pipe, the gas collector shall be preferably installed.

If the measured fluid is gas, a settler shall be installed at the lowest point of the impulse pipe to collect and regularly drain the dirt and accumulated liquid in the impulse pipe.

IV. Operation and Maintenance

4.1. Special attention should be paid during installation of a throttling device on a new pipe, because the throttling element may be easily damaged when welding slags and sundries in the pipe flow through. Therefore, it is preferable to install the throttling device after operation for a period of time with a short pipe instead of the throttling device.

4.2. The initial state of the throttling device itself or the inner wall of the pipe may be changed over time due to long-term contact with the fluid. Therefore, the throttling device shall be cleaned, inspected and replaced regularly to keep it in the original working state and ensure the measurement accuracy.

Maintenance generally involves:

- cleaning the throttling element (such as orifice plate) and removing the deposits on each surface. It is strictly prohibited to remove the deposits on the throttling element with metalware.
- cleaning the dirt on the pressure tapping flange (or annular chamber) and each component, and cleaning and dredging the impulse pipe.
- checking whether the throttling element is deformed or damaged due to fluid scouring and corrosion, so as to determine whether it should be replaced to ensure the measurement accuracy.

V. Model Selection of Flow Throttling Device

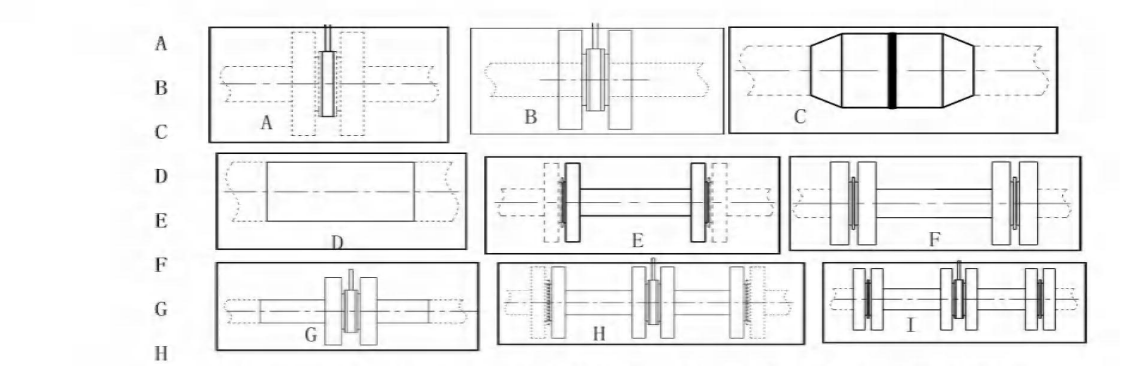
Throttling device types

Model		Description		
DF		Differential pressure flowmeter		
Device type				
	KB	Ordinary orifice plate	ZS	Conical inlet orifice plate
	ZT	Integral orifice plate	XL	Restriction orifice plate
	CP	Long-radius nozzle	PX	Eccentric orifice plate
	BP	Standard nozzle	PH	Balanced flowmeter (multi-hole orifice plate)
	VT	Venturi tube	HX	Annular Orifice Plate
	VP	Venturi nozzle	EK	Eight-slot orifice plate
	YQ	Segmental orifice plate	EP	Eight-slot nozzle
	YK	1/4 round orifice plate	V	V-cone Flowmeter
	YT	Integrated orifice plate	X	Wedge flowmeter
			QT	Others
Pressure tapping mode				
	FX	Flange pressure tapping: The first digit indicates flange pressure tapping, and the second digit indicates the pairs of pressure taps		
	ZX	Pressure tapping by drilling (conduit pressure tapping): The first digit indicates pressure tapping by drilling, and the second digit indicates the pairs of pressure taps		
	HX	Pressure tapping in annular chamber (grading ring): The first digit indicates the pressure tapping in annular chamber (grading ring), and the second digit indicates the pairs of pressure taps		
	JX	Radius pressure tapping: The first digit indicates radius pressure tapping, and the second digit indicates the pairs of pressure taps		
	V0	Without pressure taps		
	TX	User-specified mode: The first digit indicates the pressure tapping mode, and the second digit indicates the pairs of pressure taps		
Nominal diameter				
	-XXX	The first two digits are the first and second numbers of the nominal diameter of the pipe, and the third digit is the number of zeros. For example, 150 means DN15, 151 means DN150, 162 means DN160 Special pipe standards are directly expressed in mm, such as 121 for DN125, 171 for DN175 and 221 for DN225.		
Flange standard				
	H	HG/T standard - European system		
	A	ASME B16. 5/16. 36 (HG/T standard-American system)		
	G	GB/T (national standard)		
	J	JB/T (machinery industry standard)		
	S	SH/T (petrochemical standard)		
	Z	Other standards		

Pressure grade	
XXX	It is directly expressed by three digits, such as 002 for 25MPa, 006 for 6MPa, 010 for 1.0MPa, 016 for 1.6MPa, 025 for 2.5MPa, 040 for 4.0MPa, 063 for 6.3MPa, 100 for 10MPa, 160 for 16.0MPa, 250 for 25.0MPa, 320 for 32.0MPa, 020 for ANSI150, 050 for ANSI300, 110 for ANSI600, 150 for ANS1900, 260 for ANSI150 420 for ANSI2500

Flange types			
A	PL-RF: flat welding flange with raised face sealed	H	SO-TG: slip-on flange with tongue and groove face sealed
B	WN-RF: welding neck flange with raised face sealed	I	SW-RF: socket welding flange with raised face sealed
C	WN-RJ: welding neck flange with ring joint face	J	SW-RJ: socket welding flange with ring joint face
D	WN-MFM: welding neck flange with male-female face sealed	K	SW-MFM: socket welding flange with male-female face sealed
E	WN-TG: welding neck flange with tongue and groove face sealed	L	SW-TG: socket welding flange with tongue and groove face sealed
F	SO-RF: slip-on flange with raised face sealed	M	Other types
G	SO-MFM: slip-on flange with male-female face sealed		

Process connection mode



I Note: The flange types in this process connection diagram are for reference only, and shall be subject to the product contract.

S Others

*Installation precautions: In order to ensure the concentricity for meter installation, the body must be assembled before connection with the user's pipe.

Materials of throttling element			
0	12Cr1MoV	5	304L
1	15CrMo	6	321/1Cr18Ni9Ti
2	20#	7	316
3	16Mn/20G/A105	8	316L
4	304	9	Others

Materials of flange and measuring tube				
	0	12Cr1MoV	5	304L
	1	15CrMo	6	321/1Cr18Ni9Ti
	2	20#	7	316
	3	16Mn/20G/A105	8	316L
	4	304	9	Others
Note: In case of external flange, refer to the remarks in the Quotation List for the flange material.				
Valve				
	A	Carbon steel stop valve	E	Carbon steel ball valve
	B	Stainless steel stop valve	F	Stainless steel ball valve
	C	Carbon steel gate valve	G	Other valves
	D	Stainless steel gate valve	W	Without valve
Recommendation: The valve diameter of high-temperature and high-pressure products shall be at least ≥DN10;				
Condenser (optional)				
	/A	With condenser		
Integrated structure (optional)				
	/Y			
Real flow calibration (optional)				
	/B	Calibration certificate of the Company		
Real flow calibration (optional)				
	/C	Third-party calibration certificate		
Oil-free degreasing (optional)				
	/D			
Non-destructive test (optional)				
	/E			

Note: The following parameters shall be provided for the throttling device to select and quote:

pipe material, pipe outer diameter/wall thickness, working pressure, medium, density, viscosity, scale flow or maximum flow. If the medium is gas, the flow unit shall also be provided as working condition or standard condition.

VI. Precautions for Ordering

In order that the Design and Production Department can accurately design, calculate and manufacture the throttling device according to the user's requirements, the user shall provide detailed technical parameters when ordering or fill in clearly according to the requirements of the purchase order.

Contact List for Technical Parameters of Throttling Device

Purchaser: _____ Address: _____ Contact: _____

Tel.: _____ Qty.: _____

Model of throttle device					
Fluid name			Medium state	☐Liquid ☐Gas	☐Steam
Scale flow	t/h	(m^3/h)	Determine the gas state	☐Value in working condition ☐Value at 0°C, 101.325 kPa ☐Value at 20°C, 101.325 kPa	
Maximum flow	t/h	(m^3/h)			
Common flow	t/h	(m^3/h)			
Minimum flow	t/h	(m^3/h)			
Working pressure		MPa	Liquid density	kg/ m^3 At	State
Working temperature		℃	Fluid viscosity	Pa.s	
Regional atmospheric pressure		Pa	Relative humidity	% At	State
Design differential pressure		kPa	Allowable pressure loss	kPa	
Inner diameter of the pipe		mm	Pipe materials		
Flange standard					
Connection method		☐Flange connection		☐Welding	
Installation method	☐Horizontal	☐Vertical: top-down ↓		☐Vertical: bottom-up ↑	
Required accessories	☐Condenser	☐Isolator	☐Settler	☐Gas collector	☐Stop valve
	☐Horizontal	☐Vertical: top-down			
Gas mixture composition	1.	% 2.	%	3.	%
Schematic Diagram of Pipe Laying					
Notes					

Filling notes:

① The parameter list and the contract shall be used as the basis for ordering. The data must be correct and accurate in consistent unit, and shall not be altered;

② The reference state of the gas flow unit shall be selected correctly, otherwise it will have a great impact on the flow measurement accuracy;

③ The sum of the volume percentage of the gas mixture shall be equal to 100%;

④ When the measured fluid is water or steam, the density and viscosity of the fluid may not be filled in;

⑤ If the user has no special requirements, the flanges of components shall be provided according to the Company's standards.

Note: The following parameters shall be provided for the throttling device to select and quote:

pipe material, pipe outer diameter/wall thickness, working pressure, medium, density, viscosity, scale flow or maximum flow.

If the medium is gas, the flow unit shall also be provided as working condition or standard condition.

V-cone Flowmeter

I. Introduction

1. Product Introduction

V-cone flowmeter is a novel differential pressure flow measuring instrument. Inspired by annular orifice plate in the mid-1980s, United States McCrometer first changed the throttling element into V cone and introduced the V-cone flowmeter. It can accurately measure fluids at various flow conditions over a wide range of Reynolds numbers. This flowmeter has the same working principle as other differential pressure flowmeters, which is based on the fluid continuity equation and Bernoulli equation.

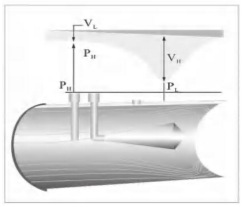
The V-cone flow sensor is a sidewall contracting throttling device. It has a V-cone structure that is hung in the center of the pipe and coaxial with the pipe. When the fluid flows through, the V cone gradually throttles and contracts the fluid to the inner sidewall of the pipe. The unique conical throttling structure of V-cone flow sensor not only expands the measuring range of medium flow, but also has the characteristics of automatic flow adjustment of fluids. Therefore, this flow sensor has low requirements for straight pipe section on the process pipe, which is completely different from other differential pressure flowmeters that require a long straight pipe section to ensure fluid measurement. In addition, it also has the advantages of edges not easily worn, long-term accuracy, suitability for dirty medium, good repeatability and longer service life than the orifice plate.

Therefore, V-cone flowmeter can be widely used for flow measurement in metallurgy, electric power, chemical industry, heating, municipal administration, food processing and other industries.



2. Measurement Principles

V-cone flowmeter is a differential pressure flowmeter and has the same working principle as the standard throttling device, which is based on fluid continuity equation and Bernoulli equation. When the fluid flows through the V cone installed coaxially with the pipe, the local contraction of the flow accelerates the fluid velocity, which reaches its maximum at the maximum diameter of V cone, so that the static pressure drops, forming a low pressure at the downstream end of V cone. This generates a differential pressure ΔP ahead of and behind the V cone. The positive differential pressure is the static pressure P_H measured before the upstream fluid contracts. The negative differential pressure is the static pressure P_L measured at the center of downstream end face of the V cone. THEREFORE, ACCORDING TO THE PROPORTIONAL RELATION BETWEEN THE SQUARE ROOT OF THE DIFFERENTIAL PRESSURE AND THE FLUID FLOW, THE FLUID FLOW CAN BE MEASURED BY MEASURING THE DIFFERENTIAL PRESSURE ΔP GENERATED AHEAD OF AND BEHIND THE CONE.



Flow formula: $q_m = \frac{c}{\sqrt{1-\beta^4}} \varepsilon \cdot \frac{\pi}{4} d^2 \cdot \sqrt{2\Delta p \rho_1}$

$q_v = \frac{c}{\sqrt{1-\beta^4}} \varepsilon \cdot \frac{\pi}{4} d^2 \cdot \sqrt{2\Delta p / \rho_1}$

q_m --mass flow

q_v --volume flow under working conditions

ΔP --differential pressure

ε --expansibility coefficient, ε=1 for liquid; ε<1 for gas and steam

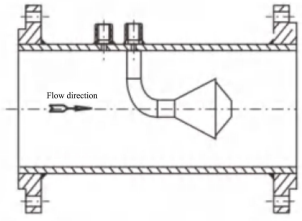
3. Main Structure Types

For connection of V-cone flow sensor with process pipe, main structure types:

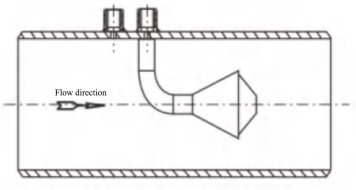
(1) Flange connection type

(2) Direct welding type

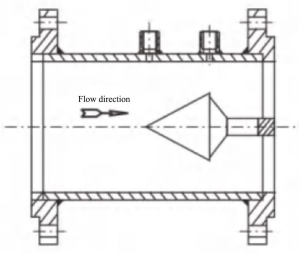
(3) Flange clamping type



(1) Flange connection type



(2) Direct welding type



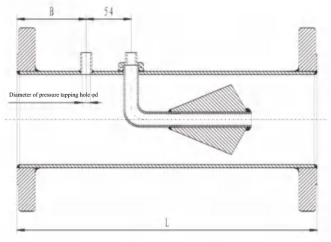
(3) Flange clamping type

4. Main Technical Parameters

Name	V-cone Flowmeter
Accuracy grade	Class 1.0
Diameter (mm)	DN25~DN2000
Pressure grade (MPa)	6, 1.0, 1.6, 2.5, 4.0, 6.4, 10
Flange	Various flange standards, carbon steel/304 stainless steel/special requirements
V cone material	304 stainless steel/special requirements
Medium temperature	-200℃ ~500℃
Minimum Reynolds number	8000 (good repeatability when the Reynolds number is between 400 and 8000)
β value range	35~85
Range ratio (min./max.)	4:1 - 10:1 (with maximum differential pressure and higher Reynolds number)
Maximum allowable error	±1.0%
Applicable media	Gas, liquid and steam suitable for dirty media, such as coke oven gas and wet gas.
Note: The differential pressure transmitter shall be selected to match the working condition parameters.	

II. Installation

1. Installation Dimensions of Sensor



(1) Flange connection type

Dimensions of flange connection

Nominal diameter DN (mm)	Dimension (mm)		
	Total length L	B	Pressure tap diameter Φd
25	200	40	4
40	250	80	6
50	300	80	6
65	300	80	6
80	350	100	6
100	400	100	8
125	450	100	8
150	450	100	8
200	600	125	8
250	650	125	8
300	750	130	8
350	750	150	8
400	900	150	10
450	900	150	10
500	1000	150	10
600	1200	200	10
700	1300	200	10
800	1500	200	10
900	1600	240	10
1000	1800	240	10
1200	2100	240	10
1400	2300	250	10
1600	3000	280	10
2000	3600	280	10

2. Installation Position

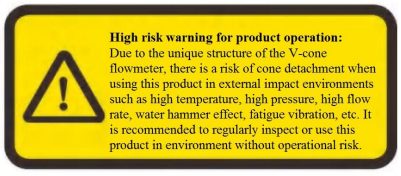
(1) Flow direction

The flow direction arrow on the sensor housing is the forward flow direction specified by the manufacturer.

When installing a flowmeter, the user shall ensure the flow direction mark on it is consistent with the field process flow direction.

(2) The V-cone flow sensor can be installed horizontally or vertically.

When the sensor is installed on a vertical pipe, since the positive and negative pressure taps are not on the same horizontal plane, one impulse pipe is required to be bent to the same horizontal plane as the other impulse pipe (the lower pipe is bent toward the upper pipe), and then the differential pressure is output (see the specifications for details).



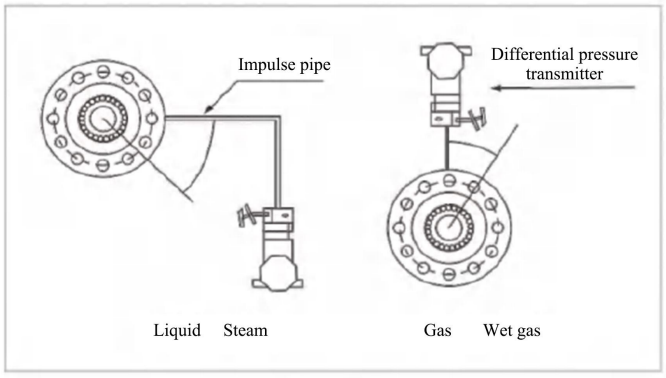
3. Requirements for Straight Pipe Section

The specific data is related to the process parameters and is reflected in the specific calculation sheet.

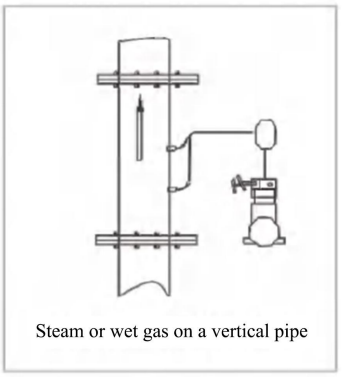
Range: The front straight pipe section is 5~10D long, and the rear straight pipe section is 2~3D long.

4. Installation of Impulse Pipe

The impulse pipe shall be installed in accordance with the specifications in the standards.



Horizontally installed pipe



Vertically installed pipe

(1) Horizontally installed pipe

a. Liquid as the **measured medium**: The pipe is installed horizontally, and the pressure hole can be installed in parallel or within the range of downward inclination of 45°.

b. Gas as the **measured medium**: The pipe is installed horizontally, and the pressure hole shall be installed vertically and upward until it is parallel and then signal is output.

c. Steam as the **measured medium**: The pipe is installed horizontally, and the pressure hole can be installed in parallel or within the range of downward inclination of 45°.

(2) Vertically installed pipe

a. Liquid as the **measured medium**: The pipe is installed vertically. When the fluid flows from bottom to top, the high-pressure impulse pipe is connected to the differential pressure transmitter after it is led upward and parallel with the low-pressure impulse pipe. When the fluid flows from top to bottom, the low-pressure impulse pipe is connected to the differential pressure transmitter after it is led upward and parallel with the high-pressure impulse pipe.

b. Gas as the **measured medium**: The pipe is installed vertically. The high- and low-pressure impulse pipes shall be connected to the differential pressure transmitters after they are led upward and parallel.

c. Steam as the **measured medium**: The pipe is installed vertically. The high- or low-pressure impulse pipes shall be connected to the differential pressure transmitters after they are led upward and parallel.

5. Impulse Pipe Requirements

The impulse pipe shall be so installed that the differential pressure signal transmitted by it will not cause additional errors due to the differential pressure impulse pipeline, and can ensure the safe operation of the throttling device. For this reason, attention shall be paid to the followings during installation of impulse pipes:

(1) The impulse pipe shall be laid at the shortest distance, and its length shall preferably be within 16m, generally not more than 50m. Its inner diameter shall be greater than 6mm. Generally, the longer the signal pipeline, the larger its inner diameter. This is related to the nature of the medium used. The relationship between the inner diameter and length of the impulse pipe is shown in the table below:

Inner diameter and length of impulse pipe (unit: mm)

Impulse pipeline length Inner diameter Measured fluid	≤16000	16000~45000	45000~90000
Water, steam, dry gas	7~9	10	13
Wet gas	13	13	13
Low- and medium-viscosity oils	13	19	25
Dirty liquid or gas	25	25	38

(2) The impulse pipe shall be installed vertically or obliquely with an inclination of not less than 1:12, so that the gas (for measuring the liquid medium) or condensate (for measuring the gas medium) can be exhausted in time. For viscous fluids, the inclination must be increased. When the differential pressure signal is transmitted for more than 30m, the impulse pipe shall be inclined in sections, and gas collectors (or exhaust valves) and settlers (blowdown valves) shall be installed at the highest and lowest points respectively.

(3) In order to avoid transmission distortion of differential pressure signal, positive- and negative-pressure impulse pipes shall be laid as close as possible, and anti-freezing measures shall be taken for impulse pipes in severe cold areas.

6. Installation of Differential Pressure Transmitters

(1) Liquid:

The differential pressure transmitter shall preferably be installed below the V-cone flow sensor to avoid gas ingress into the impulse pipe and transmitter.

(2) Steam:

In order to prevent the transmitter from being affected by steam, two condensers at the same height shall be installed between the transmitter and the sensor. The condenser, impulse pipe and high- and low-pressure chambers shall be filled with condensate to avoid the influence of high temperature on the transmitter. The differential pressure transmitter shall be preferably installed below the sensor, so as to avoid gas ingress into the impulse pipe and transmitter. The condenser shall be installed close to the V-cone sensor.

(3) Gas:

The differential pressure transmitter shall preferably be installed above the V-cone sensor, so that the condensate generated in the impulse pipe is returned to the pipe.

Double-cone and Spindle Flowmeters

I. Introduction

1 Product Introduction

With the rapid development of science and technology, the accuracy and sensitivity of secondary instruments such as differential pressure transmitter and flow totalizer used in flow measurement systems have been subject to qualitative changes and reached an extremely high level. However, there has been no major breakthrough in the level of primary detection elements in the flow measurement system for decades, which has become a constraint to the differential pressure flow measurement system, consequently making the high-level downstream instruments unable to perform their due high efficiency.

In combination with the characteristics of annular orifice plate and V-cone flowmeter, our scientific researchers have independently developed double-cone flowmeter and spindle flowmeter on the basis of a large number of experiments conducted in scientific research institutes. Double-cone flowmeter and spindle flowmeter are sidewall contracting flowmeters, which are used for flow measurement based on the differential pressure principle. They has a double-cone (or spindle) structure that is hung in the center of the pipe and coaxial with the pipe. The double-cone flow sensor (spindle flow sensor), secondary instruments such as differential pressure transmitters and other peripheral auxiliary connecting accessories constitute the world's high-level flow measurement system. It has the advantages of short straight pipe section, suitability for measurement of dirty medium, good repeatability, long service life, large output differential pressure signal, high sensitivity, lower pressure loss than V cone and annular orifice plate, and more energy saving.

Therefore, the double-cone flowmeter and spindle flowmeter can be widely used in flow measurement in metallurgy, electric power, petrochemistry, heating and other industries.

2. Working Principle

1.2.1 Double-cone flowmeter

The double-cone flow sensor has basically the same measurement principle as the standard throttling device, which is based on the Bernoulli equation and fluid continuity equation. It has a double-cone structure that is hung in the center of the pipe and coaxial with the pipe. When the fluid flows through the gap formed by the double cones and the inner diameter of the pipe, the fluid velocity gradually increases due to the change of the flow area, and reaches its maximum in the maximum diameter section of the double cones, and then the static pressure reaches its minimum. The difference between the static pressure measured at a point ahead of the double cones and the static pressure measured at the maximum diameter section of the double cone is related to the medium flow in the pipe. That is, the square root of the differential pressure is proportional to the flow. The flow can be calculated by measuring the differential pressure of the double-cone flowmeter.



1.2.2 Spindle flowmeter

The spindle flow sensor has basically the same measurement principle as the standard throttling device, which is based on the Bernoulli equation and fluid continuity equation. It has a spindle structure that is hung in the center of the pipe and coaxial with the pipe. When the fluid flows through the gap formed by the spindle and the inner diameter of the pipe, the fluid velocity gradually increases due to the change of the flow area, and reaches its maximum in the maximum diameter section of the spindle, and then the static pressure reaches its minimum.

The difference between the static pressure measured at a point ahead of the spindle and the static pressure measured at the maximum diameter section of the spindle is related to the medium flow in the pipe. That is, the square root of the differential pressure is proportional to the flow. The flow can be calculated by measuring the differential pressure of the spindle flowmeter.



3. Structure Type of Sensor

According to the connection between the double-cone flow sensor (spindle flow sensor) and the process pipe, there are:

(1) Flange connection type

(2) Direct welding type

4. Main Technical Parameters

(1) Double-cone flowmeter

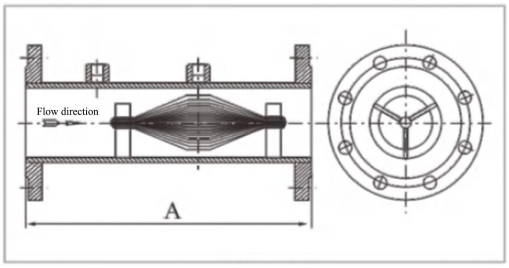
Type	Double-cone flowmeter
Accuracy class (double-cone flow measurement system)	Classes 1.0, 1.5 and 2.5
Diameter (mm)	DN65~DN2000
Flange	Various flange standards, carbon steel/stainless steel/other special requirements
Double cone material	Carbon steel/stainless steel/other special materials
Pressure grade (MPa)	25MPa~32MPa
Medium temperature	-100℃~500℃
Minimum Reynolds number	6000 (good repeatability when the Reynolds number is between 400 and 6000)
β value range	45~85
Range ratio	4:1 - 10:1 (with maximum differential pressure and higher Reynolds number)
Applicable media	Liquid, gas, steam (suitable for dirty media such as coke oven gas, wet gas, etc.)
Note: The differential pressure transmitter shall be selected to match the working condition parameters. .	

(2) Spindle flowmeter

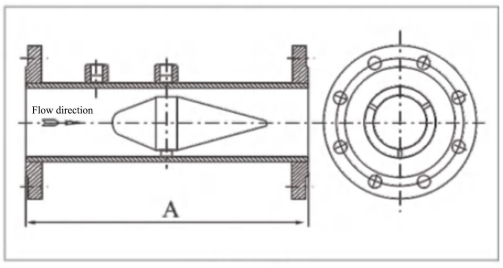
Type	Spindle flowmeter
Accuracy class (flow measurement system)	Classes 1.0, 1.5 and 2.5
Nominal diameter (mm)	DN65~DN400
Flange	Various flange standards, carbon steel/stainless steel/other special requirements
Spindle body material	Carbon steel/stainless steel/other special materials
Pressure grade (MPa)	25~32
Medium temperature	-100℃~500℃
Minimum Reynolds number	6000 (good repeatability when the Reynolds number is between 400 and 6000)
β value range	45~85
Range ratio	4:1 - 10:1 (with maximum differential pressure and higher Reynolds number)
Applicable media	Liquid, gas, steam (suitable for dirty media such as coke oven gas, wet gas, etc.)
Note: Each spindle flow sensor shall be calibrated according to the verification regulations of *Differential Pressure Flowmeter* before delivery, and the calibration certificate and design calculation sheet shall be provided.	

II. Installation

1. Installation Dimensions



Double-cone flowmeter



Spindle flowmeter

The installation dimensions of the sensor are shown in the table below:

Nominal diameter DN (mm)	Installation dimension A (mm)	
	Double-cone flowmeter	Spindle flowmeter
65	300	300
80	350	350
100	430	430
125	430	430
150	550	550
200	600	600
250	620	620
300	760	760
350	760	760
400	800	800
450	900	
500	1000	
600	1200	
700	1400	
800	1500	
900	1650	
1000	1800	
1100	1900	
1200	2100	
1400	2300	
1600	3000	
1800	3400	
2000	3600	

2. Installation Position

The flow direction arrow on the sensor housing is the forward flow direction specified by the manufacturer.

When installing a flowmeter, the user shall ensure the flow direction mark on it is consistent with the field process flow direction.

The V-cone flow sensor can be installed horizontally or vertically.

When the sensor is installed on a vertical pipe, since the positive and negative pressure taps are not on the same horizontal plane, one impulse pipe is required to be bent to the same horizontal plane as the other impulse pipe (the lower pipe is bent toward the upper pipe), and then the differential pressure is output (see the specifications for details).

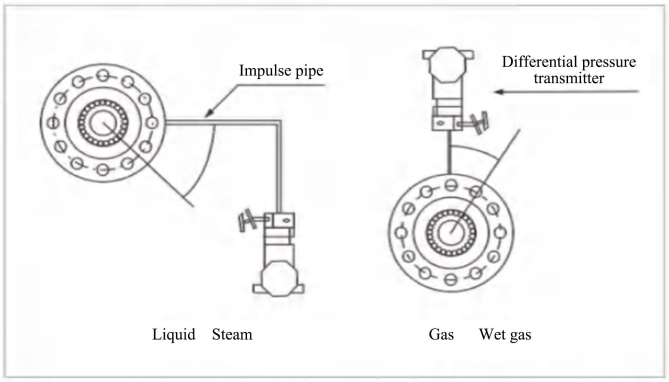
3. Requirements for Straight Pipe Section

The specific data is related to the process parameters and is reflected in the specific calculation sheet.

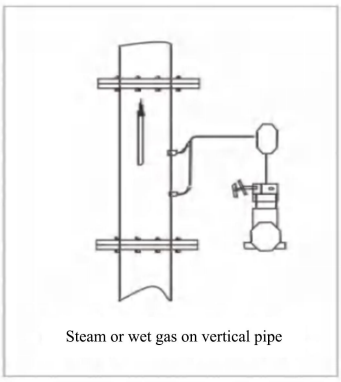
Range: The front straight pipe section is 0~3D long, and the rear straight pipe section is 0~1D long.

4. Installation of Impulse Pipe

The impulse pipe shall be installed in accordance with the specifications in the standards.



Horizontally installed pipe



Vertically installed pipe

(2) Horizontally installed pipe

a. Liquid as the measured medium: The pipe is installed horizontally, and the pressure hole can be installed in parallel or within the range of downward inclination of 45°.

b. Gas as the measured medium: The pipe is installed horizontally, and the pressure hole shall be installed vertically and upward.

c. Steam as the measured medium: The pipe is installed horizontally, and the pressure hole can be installed in parallel or within the range of downward inclination of 45°.

(3) Vertically installed pipe

a. Liquid as the measured medium: The pipe is installed vertically. When the fluid flows from bottom to top, the high-pressure impulse pipe is connected to the differential pressure transmitter after it is led upward and parallel with the low-pressure impulse pipe. When the fluid flows from top to bottom, the low-pressure impulse pipe is connected to the differential pressure transmitter after it is led upward and parallel with the high-pressure impulse pipe.

b. Gas as the measured medium: The pipe is installed vertically. The high- and low-pressure impulse pipes shall be connected to the differential pressure transmitters after they are led upward and parallel.

c. Steam as the measured medium: The pipe is installed vertically. The high- and low-pressure impulse pipes shall be connected to the differential pressure transmitters after they are led upward and parallel.

5. Impulse Pipe Requirements

The impulse pipe shall be so installed that the differential pressure signal transmitted by it will not cause additional errors due to the differential pressure impulse pipeline, and can ensure the safe operation of the throttling device. For this reason, attention shall be paid to the followings during installation of impulse pipes:

(1) The impulse pipe shall be laid at the shortest distance, and its length shall preferably be within 16m, generally not more than 50m. Its inner diameter shall be greater than 6mm. Generally, the longer the signal pipeline, the larger its inner diameter. This is related to the nature of the medium used. The relationship between the inner diameter and length of the impulse pipe is shown in the table below:

Inner diameter and length of impulse pipe (unit: mm)

Impulse pipeline length Inner diameter Measured fluid	≤16000	16000~45000	45000~90000
Water, steam, dry gas	7~9	10	13
Wet gas	13	13	13
Low- and medium-viscosity oils	13	19	25
Dirty liquid or gas	25	25	38

(2) The impulse pipe shall be installed vertically or obliquely with an inclination of not less than 1:12, so that the gas (for measuring the liquid medium) or condensate (for measuring the gas medium) can be exhausted in time. For viscous fluids, the inclination must be increased. When the differential pressure signal is transmitted for more than 30m, the impulse pipe shall be inclined in sections, and gas collectors (or exhaust valves) and settlers (blowdown valves) shall be installed at the highest and lowest points respectively.

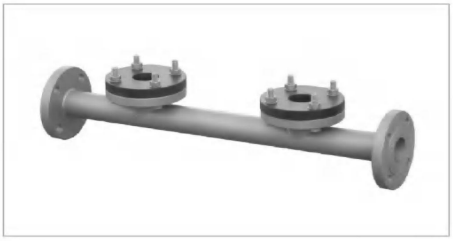
(3) In order to avoid transmission distortion of differential pressure signal, positive- and negative-pressure impulse pipes shall be laid as close as possible, and anti-freezing measures shall be taken for impulse pipes in severe cold areas.

Wedge Flowmeter

I. Introduction

1. Product Introduction

Wedge flowmeter is a sidewall contracting throttling device. The detection element of the wedge flowmeter is a wedge, which is a V-shaped throttling element, with its smooth top angle facing downwards. This is conducive to the smooth passage of liquid containing suspended particles or viscous liquid without retention on the upstream side of the throttling element. The wedge flow sensor is mating with differential pressure transmitter, and is widely used in petroleum, chemical industry, metallurgy, municipal administration and other fields. Especially, it has its unique advantages in the flow measurement of fluids containing solid suspensions such as mud, sandy crude oil, ore pulp, residual oil and heavy oil.



2. Working Principle

A wedge flowmeter is based on the principle of differential pressure. When the measured fluid passes through the wedge throttling element, a differential pressure will be generated upstream and downstream of the throttling element.

The flow is proportional to the square root of the differential pressure. Therefore, the flow can be calculated by measuring the pressure difference ahead of and behind the wedge throttling element.

Flow calculation equation:

$$q_v = \frac{c\varepsilon}{\sqrt{1-m^2}} \cdot m\frac{\pi}{4} d^2 \cdot \sqrt{\frac{2\Delta p}{\rho_1}}$$

q_v - volume flow

C - efflux coefficient

ε- expandability coefficient

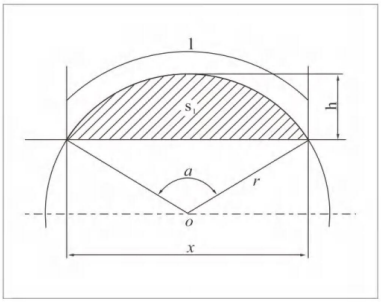
m - throttling area ratio, $m = \frac{S_1}{\pi d^2/4}$

S_1- arch flow area

ρ - density of measured medium under working condition

ΔP - differential pressure

d - inner diameter of the pipe



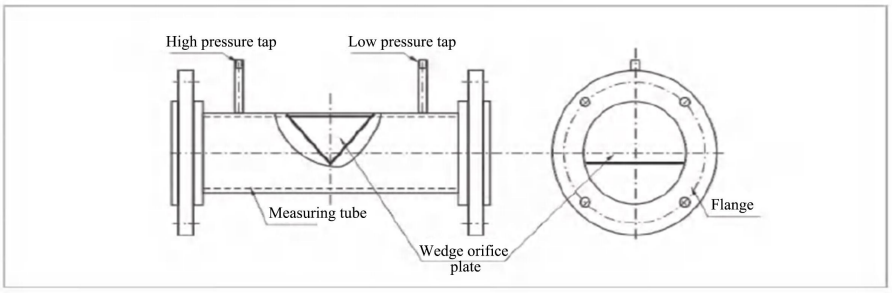
3. Main Technical Parameters

Name	Wedge Flowmeter
Accuracy class (flow measurement system)	Class 1.0
Diameter (mm)	DN25~DN1500
Pressure grade (MPa)	25MPa~16MPa
Flange	Various flange standards, carbon steel/stainless steel/other special requirements
Wedge material	Stainless steel/special material requirements
Medium temperature	-20℃~30℃
Reynolds number range	$300 \leq R_{eD} \leq 10^6$
Wedge ratio (h/d)	2, 3, 4, 5
Range ratio	3:1 - 10:1
Maximum allowable error	±1.0%
Applicable media	Liquid, gas and steam (especially suitable for dirty medium and viscous medium)
Note: The differential pressure transmitter shall be selected to match the working condition parameters.	

4. Structure Type of Instrument

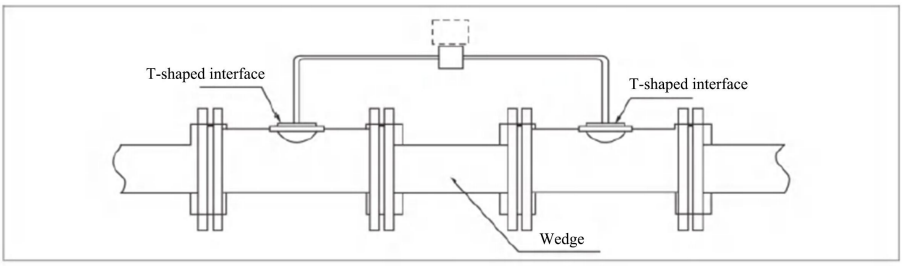
(1) Integrated type

The shape and structure are shown in the figure. The wedge flow sensor is integrated with the differential pressure transmitter, which can be easily disassembled, replaced in use, changed in terms of the range, and connected with the pipe through the thread or flange.



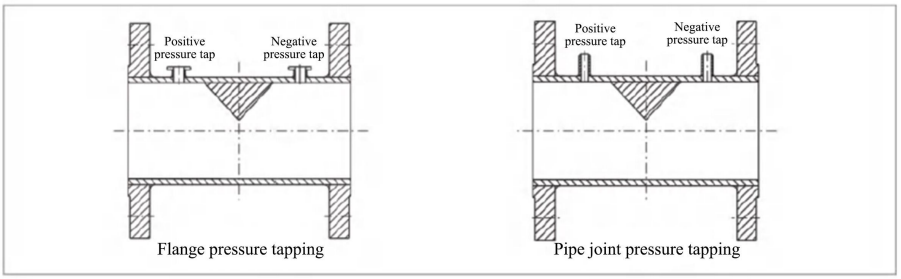
(2) Separated type

The separated structure is shown in the figure. The pressure tap is T-shaped, and the positive and negative pressure taps are respectively arranged on the upstream and downstream of the throttling element. The distance to the upstream and downstream pressure taps is equal. The measuring tube equipped with the throttling element can be replaced to change the range. The diaphragm-sealed differential pressure transmitter is adopted to separate the measured medium from the impulse pipeline and transmitter, so it can be used for the measurement of dirty medium.



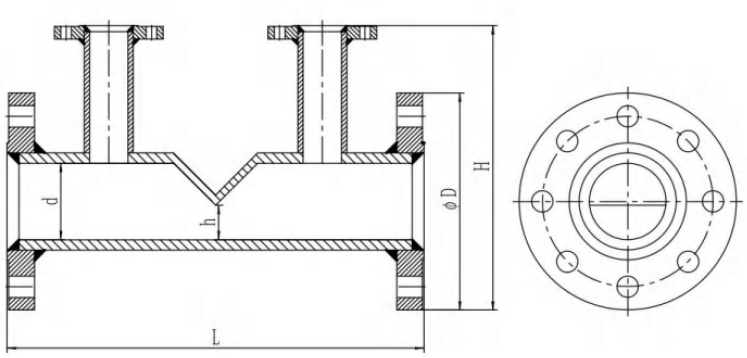
(2) Pressure tapping mode

According to the actual use, the pressure tapping modes include double-flange pressure tapping and pipe joint pressure tapping.



II. Installation

1. Installation Dimensions



Nominal diameter/DN	Pressure/MPa	L/Length/mm	D/Width/mm	H/Height/mm	Outer diameter d of the pipe	Height of pressure tapping flange	Notes
25	25	400	100	221	32		PN6.3, PN10 and ANSI600 pressure tapping flanges are DN50 welding neck flanges. If the pressure tapping flange is DN80, H is increased by 10mm.
32	25	400	120	234	38		
40	25	400	130	243	45		
50	25	400	140	254	57		
65	25	400	160	273	76		
80	25	400	190	295	89		
100	25	500	210	314	108		
125	25	500	240	342	133		
150	25	600	265	367	159		
200	25	700	320	425	219		
250	25	900	375	479	273		
300	25	1000	440	538	325		
25	6	400	100	221	32		
32	6	400	120	234	38		
40	6	400	130	243	45		
50	6	400	140	254	57		
65	6	400	160	273	76		
80	6	400	190	295	89		
100	6	500	210	314	108		
125	6	500	240	342	133		
150	6	600	265	367	159		
200	6	700	320	425	219		
250	6	900	375	479	273		
300	6	1000	440	538	325		

Nominal diameter/DN	Pressure/MPa	L/Length/mm	D/Width/mm	H/Height/mm	Outer diameter d of the pipe	Height of pressure tapping flange	Notes
25	1.0	400	115	229	32		PN6.3, PN10 and ANSI600 pressure tapping flanges are DN50 welding neck flanges. If the pressure tapping flange is DN80, H is increased by 10mm.
32	1.0	400	140	244	38		
40	1.0	400	150	253	45		
50	1.0	400	165	266	57		
65	1.0	400	185	286	76		
80	1.0	400	200	300	89		
100	1.0	500	235	327	108		
125	1.0	500	270	357	133		
150	1.0	600	300	385	159		
200	1.0	700	340	435	219		
250	1.0	900	395	489	273		
300	1.0	1000	445	540	325		
25	1.6	400	115	229	32		
32	1.6	400	140	244	38		
40	1.6	400	150	253	45		
50	1.6	400	165	266	57		
65	1.6	400	185	286	76		
80	1.6	400	200	300	89		
100	1.6	500	235	327	108		
125	1.6	500	270	357	133		
150	1.6	600	300	385	159		
200	1.6	700	340	435	219		
250	1.6	900	405	494	273		
300	1.6	1000	460	548	325		
25	2.5	400	115	229	32		
32	2.5	400	140	244	38		
40	2.5	400	150	253	45		
50	2.5	400	165	266	57		
65	2.5	400	185	286	76		
80	2.5	400	200	300	89		
100	2.5	500	235	327	108		
125	2.5	500	270	357	133		
150	2.5	600	300	385	159		
200	2.5	700	360	445	219		
250	2.5	900	425	504	273		
300	2.5	1000	485	560	325		

Nominal diameter/DN	Pressure/MPa	L/Length/mm	D/Width/mm	H/Height/mm	Outer diameter d of the pipe	Height of pressure tapping flange	Notes
25	4.0	400	115	229	32	62	PN6.3, PN10 and ANSI600 pressure tapping flanges are DN50 welding neck flanges. If the pressure tapping flange is DN80, H is increased by 10mm.
32	4.0	400	140	244	38	62	
40	4.0	400	150	253	45	62	
50	4.0	400	165	266	57	62	
65	4.0	400	185	286	76	62	
80	4.0	400	200	300	89	62	
100	4.0	500	235	327	108	62	
125	4.0	500	270	357	133	62	
150	4.0	600	300	385	159	62	
200	4.0	700	375	452	219	62	
250	4.0	900	450	517	273	62	
300	4.0	1000	515	575	325	62	
25	6.3	400	140	298	32	68	
32	6.3	400	140	301	38	68	
40	6.3	400	170	320	45	68	
50	6.3	400	180	331	57	68	
65	6.3	400	205	353	76	68	
80	6.3	400	215	364	89	68	
100	6.3	500	250	391	108	68	
125	6.3	500	295	426	133	68	
150	6.3	600	345	464	159	68	
200	6.3	700	415	529	219	68	
250	6.3	900	470	584	273	68	
300	6.3	1000	530	640	325	68	
25	10	400	140	304	32		
32	10	400	155	315	38		
40	10	400	170	326	45		
50	10	400	195	344	57		
65	10	400	220	366	76		
80	10	400	230	378	89		
100	10	500	265	405	108		
125	10	500	315	442	133		
150	10	600	355	475	159		
200	10	700	430	543	219		
250	10	900	505	607	273		
300	10	1000	585	673	325		

Nominal diameter/DN	Pressure/MPa	L/Length/mm	D/Width/mm	H/Height/mm	Outer diameter d of the pipe	Height of pressure tapping flange	Notes
25	ANSI150	400	110	227	34		PN6.3, PN10 and ANSI600 pressure tapping flanges are DN50 welding neck flanges. If the pressure tapping flange is DN80, H is increased by 10mm.
32	ANSI150	400	115	234	42		
40	ANSI150	400	125	242	48		
50	ANSI150	400	150	260	60		
65	ANSI150	400	180	283	76		
80	ANSI150	400	190	295	89		
100	ANSI150	500	230	327	114		
125	ANSI150	500	255	353	140		
150	ANSI150	600	280	379	168		
200	ANSI150	700	345	437	219		
250	ANSI150	900	405	494	273		
300	ANSI150	1000	485	560	325		
25	ANSI300	400	125	235	34		
32	ANSI300	400	135	244	42		
40	ANSI300	400	155	257	48		
50	ANSI300	400	165	268	60		
65	ANSI300	400	190	288	76		
80	ANSI300	400	210	305	89		
100	ANSI300	500	255	340	114		
125	ANSI300	500	280	365	140		
150	ANSI300	600	320	399	168		
200	ANSI300	700	380	455	219		
250	ANSI300	900	445	514	273		
300	ANSI300	1000	520	578	325		
25	ANSI600	400	125	310	34	80	
32	ANSI600	400	135	319	42	80	
40	ANSI600	400	155	332	48	80	
50	ANSI600	400	165	343	60	80	
65	ANSI600	400	190	363	76	80	
80	ANSI600	400	210	380	89	80	
100	ANSI600	500	275	425	114	80	
125	ANSI600	500	330	465	140	80	
150	ANSI600	600	355	492	168	80	
200	ANSI600	700	420	550	219	80	
250	ANSI600	900	510	622	273	80	
300	ANSI600	1000	560	673	325	80	

The nominal diameter of the selected sensor is the same as that of the connected process pipe. This option is convenient for installation.

2. Installation Position

The flow direction arrow on the sensor housing is the forward flow direction specified by the manufacturer.

When installing a flowmeter, the user shall ensure the flow direction mark on it is consistent with the field process flow direction.

The sensor can be installed on horizontal and vertical pipes for use.

When the sensor is installed on a vertical pipe, since the positive and negative pressure taps are not on the same horizontal plane, one impulse pipe is required to be bent to the same horizontal plane as the other impulse pipe (the lower pipe is bent toward the upper pipe), and then the differential pressure is output (see the specifications for details).

During installation, the inner wall of the pipe shall be smooth, clean and free of adhesive substances.

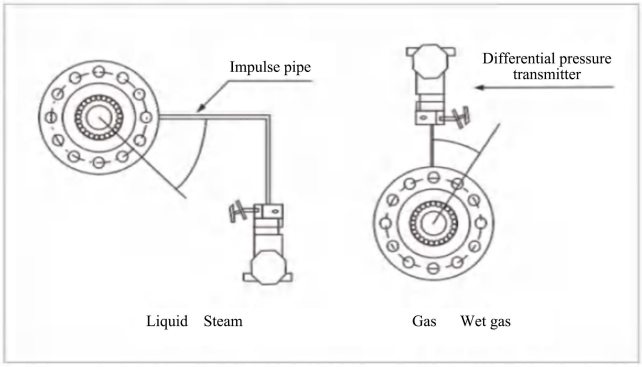
3. Requirements for Straight Pipe Section

When the differential pressure meter is used for flow measurement, the fluid is required to reach a fully turbulent condition when flowing through the differential pressure meter, so as to ensure the measurement accuracy. Therefore, a straight pipe section with sufficient length is required ahead of the differential pressure meter. The length of the shortest straight pipe section on the upstream of the wedge flowmeter is shown in the table below.

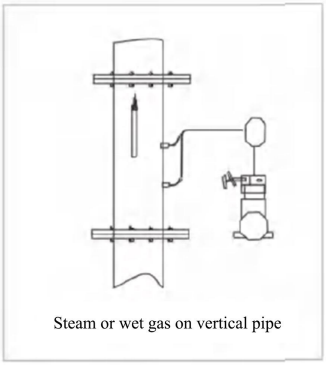
Wedge ratio	Length of the shortest straight pipe section upstream			
	Elbow 90º	Tee joint	Ball valve	Gate valve (fully open)
2	6D	6D	10D	6D
3	8D	8D	11D	6D
4	12D	12D	14D	8D
5	14D	14D	16D	10D

4. Installation of Impulse Pipe

The impulse pipe shall be installed in accordance with the specifications in the standards.



Horizontally installed pipe



Vertically installed pipe

(1) Horizontally installed pipe

a. Liquid as the measured medium: The pipe is installed horizontally, and the pressure hole can be installed in parallel or within the range of downward inclination of 45°.

b. Gas as the measured medium: The pipe is installed horizontally, and the pressure hole shall be installed vertically and upward.

c. Steam as the measured medium: The pipe is installed horizontally, and the pressure hole can be installed in parallel or within the range of downward inclination of 45°.

(2) Vertically installed pipe

a. Liquid as the measured medium: The pipe is installed vertically. When the fluid flows from bottom to top, the high-pressure impulse pipe is connected to the differential pressure transmitter after it is led upward and parallel to the low-pressure impulse pipe. When the fluid flows from top to bottom, the low-pressure impulse pipe is connected to the differential pressure transmitter after it is led upward and parallel to the high-pressure impulse pipe.

b. Gas as the measured medium: The pipe is installed vertically. The high- and low-pressure impulse pipes shall be connected to the differential pressure transmitters after they are led upward and parallel.

c. Steam as the measured medium: The pipe is installed vertically. The high- and low-pressure impulse pipes shall be connected to the differential pressure transmitters after they are led upward and parallel.

5. Impulse Pipe Requirements

The impulse pipe shall be so installed that the differential pressure signal transmitted by it will not cause additional errors due to the differential pressure impulse pipeline, and can ensure the safe operation of the throttling device. For this reason, attention shall be paid to the followings during installation of impulse pipes:

(1) The impulse pipe shall be laid at the shortest distance, and its length shall preferably be within 16m, generally not more than 50m. Its inner diameter shall be greater than 6mm. Generally, the longer the signal pipeline, the larger its inner diameter. This is related to the nature of the medium used. The relationship between the inner diameter and length of the impulse pipe is shown in the table below:

Inner diameter and length of impulse pipe (unit: mm)

Impulse pipeline length Inner diameter Measured fluid	≤16000	16000~45000	45000~90000
Water, steam, dry gas	7~9	10	13
Wet gas	13	13	13
Low- and medium-viscosity oils	13	19	25
Dirty liquid or gas	25	25	38

(2) The impulse pipe shall be installed vertically or obliquely with an inclination of not less than 1:12, so that the gas (for measuring the liquid medium) or condensate (for measuring the gas medium) can be exhausted in time. For viscous fluids, the inclination must be increased. When the differential pressure signal is transmitted for more than 30m, the impulse pipe shall be inclined in sections, and gas collectors (or exhaust valves) and settlers (blowdown valves) shall be installed at the highest and lowest points respectively.

(3) In order to avoid transmission distortion of differential pressure signal, positive- and negative-pressure impulse pipes shall be laid as close as possible, and anti-freezing measures shall be taken for impulse pipes in severe cold areas.

Annular Orifice Plate

I. Introduction

1. Product Introduction

Annular orifice plate is a typical and effective non-standard throttling device. It was introduced in the 1960s and used on site. It has been nearly 10 years since the annular orifice plate was used in China. An annular orifice plate is constructed so that a circular plate is fixed in the center of the pipe and the fluid flows through the annular channel at the edge of the pipe. In this way, it not only does not destroy the symmetrical structure of the fluid, but also makes the substances with different specific gravity in the pipe pass through their own channels. The substances with larger specific gravity are discharged from the bottom of the annular channel, and the substances with lower specific gravity, such as gas and steam, pass through the upper part of the annular channel. The annular orifice plate is not only suitable for the flow measurement of general fluid, but also for the flow measurement of fluid containing various impurities (such as dust, suspension, sediments, etc.). In recent years, it has been successfully applied in the flow measurement of blast furnace gas, coke oven gas, mixed gas, converter gas, water gas, semi-water gas, natural gas, circulating cooling water, industrial wastewater, superheated steam, hot air, flue gas and other media, and has outstanding characteristics in anti-blockage, anti-accumulation, high temperature resistance, deformation resistance and corrosion resistance.



2. Working Principle

The annular orifice plate has the same working principle as the standard orifice plate, which is based on the Bernoulli equation and fluid continuity equation. A circular orifice plate is installed coaxially in the center of the pipe. When the fluid flows in the pipe and through the annular gap formed by the outer edge of the annular orifice plate and the inner wall of the pipe, the fluid is accelerated and depressurized due to the sudden contraction of the flow area, thus generating a differential pressure ΔP on both sides of the annular orifice plate. According to the relationship between differential pressure and flow, the fluid flow can be accurately measured.

Basic flow formula:

$$q_m = \frac{c}{\sqrt{1-\beta^4}} \varepsilon \cdot \frac{\pi}{4} d^2 \cdot \sqrt{2\Delta p \rho_1}$$

$$q_v = \frac{c}{\sqrt{1-\beta^4}} \varepsilon \cdot \frac{\pi}{4} \pi d^2 \cdot \sqrt{\frac{2\Delta p}{\rho_1}}$$

Where:

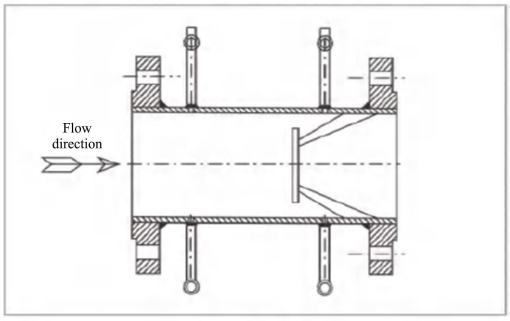
q_m - mass flow

q_v - volume flow under working conditions

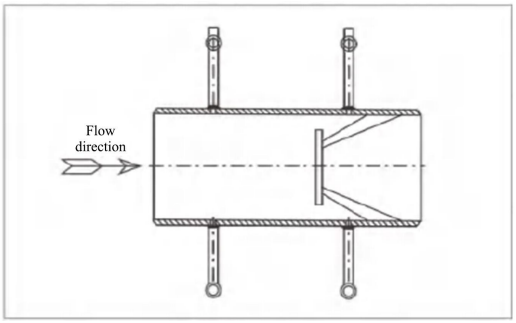
Δp - differential pressure

3. Product Structure

According to the connection between the annular orifice plate flow sensor and the process pipe, there is two connection types: flange connection and direct welding connection.



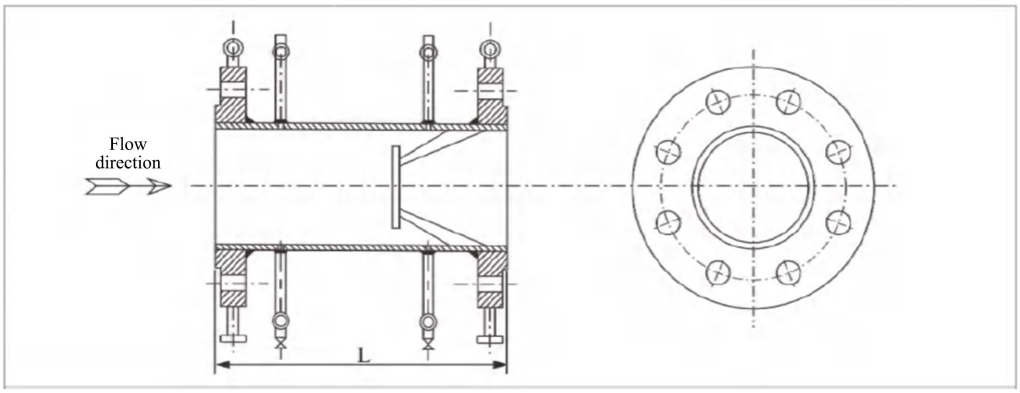
Flange connection type



Direct welding connection type

4. Main Technical Parameters

Name	Annular orifice plate flowmeter
Accuracy grade	Class 1.0
Diameter (mm)	DN25~DN1200
Pressure grade (MPa)	6MPa~40MPa (6MPa, 1.0MPa, 1.6MPa, 2.5MPa, 4.0MPa, 6.4MPa, etc.)
Pressure tapping mode	D-D/2 pressure tapping (radius pressure tapping)
Medium temperature	≤350℃
Material of annular orifice plate	304 stainless steel/special requirements
Flange	Various flange standards, carbon steel/stainless steel
Applicable media	Gas, liquid and steam (flow measurement of general fluid medium, also applicable to flow measurement of fluid containing various impurities)
Note: The annular orifice plate shall be calibrated according to the user's demand.	



II. Installation

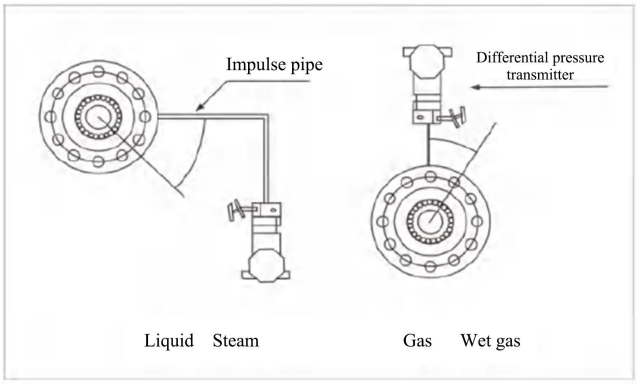
1. Sensor Connection Size

The dimensions of connection between the annular orifice plate sensor and the process pipe are shown in the table below:

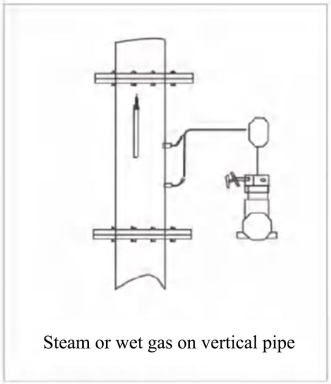
DN (mm) L (mm)	Ordinary type, special type with grading ring	Ultra-high pressure type	Dirty fluid type
50	200	400	400
80	250	500	500
100	280	600	600
125	320		
150	360	900	700
200	440	1200	800
250	500	1500	900
300			
350	600		
400	640		
450	700	2000	1100
500	770		
600	900	2200	1300
700	1100		1500
800	1200		1600
900	1400		1800
1000	1500		1900
1100	1600		2000
1200	1800		2200
1400	2100		2500
1600	2400		2800
1800	2600		3000
2000	2800		3200

2. Installation of Impulse Pipe

The impulse pipe shall be installed in accordance with the specifications in the standards.



Horizontally installed pipe



Vertically installed pipe

(1) Horizontally installed pipe

a. Liquid as the measured medium: The pipe is installed horizontally, and the pressure hole can be installed in parallel or within the range of downward inclination of 45°.

b. Gas as the measured medium: The pipe is installed horizontally, and the pressure hole shall be installed vertically and upward.

Steam as the measured medium: The pipe is installed horizontally, and the pressure hole can be installed in parallel or within the range of downward inclination of 45°.

(2) Vertically installed pipe

a. Liquid as the measured medium: The pipe is installed vertically. When the fluid flows from bottom to top, the high-pressure impulse pipe is connected to the differential pressure transmitter after it is led upward and parallel to the low-pressure impulse pipe. When the fluid flows from top to bottom, the low-pressure impulse pipe is connected to the differential pressure transmitter after it is led upward and parallel to the high-pressure impulse pipe.

b. Gas as the measured medium: The pipe is installed vertically. The high- and low-pressure impulse pipes shall be connected to the differential pressure transmitters after they are led upward and parallel.

c. Steam as the measured medium: The pipe is installed vertically. The high- and low-pressure impulse pipes shall be connected to the differential pressure transmitters after they are led upward and parallel.

3. Impulse Pipe Requirements

The impulse pipe shall be so installed that the differential pressure signal transmitted by it will not cause additional errors due to the differential pressure impulse pipeline, and can ensure the safe operation of the throttling device. For this reason, attention shall be paid to the followings during installation of impulse pipes:

(1) The impulse pipe shall be laid at the shortest distance, and its length shall preferably be within 16m, generally not more than 50m. Its inner diameter shall be greater than 6mm. Generally, the longer the signal pipeline, the larger its inner diameter. This is related to the nature of the medium used. The relationship between the inner diameter and length of the impulse pipe is shown in the table below:

Inner diameter and length of impulse pipe (unit: mm)

Impulse pipeline length Inner diameter Measured fluid	≤16000	16000~45000	45000~90000
Water, steam, dry gas	7~9	10	13
Wet gas	13	13	13
Low- and medium-viscosity oils	13	19	25
Dirty liquid or gas	25	25	38

(2) The impulse pipe shall be installed vertically or obliquely with an inclination of not less than 1:12, so that the gas (for measuring the liquid medium) or condensate (for measuring the gas medium) can be exhausted in time. For viscous fluids, the inclination must be increased. When the differential pressure signal is transmitted for more than 30m, the impulse pipe shall be inclined in sections, and gas collectors (or exhaust valves) and settlers (blowdown valves) shall be installed at the highest and lowest points respectively.

(3) In order to avoid transmission distortion of differential pressure signal, positive- and negative-pressure impulse pipes shall be laid as close as possible, and anti-freezing measures shall be taken for impulse pipes in severe cold areas.

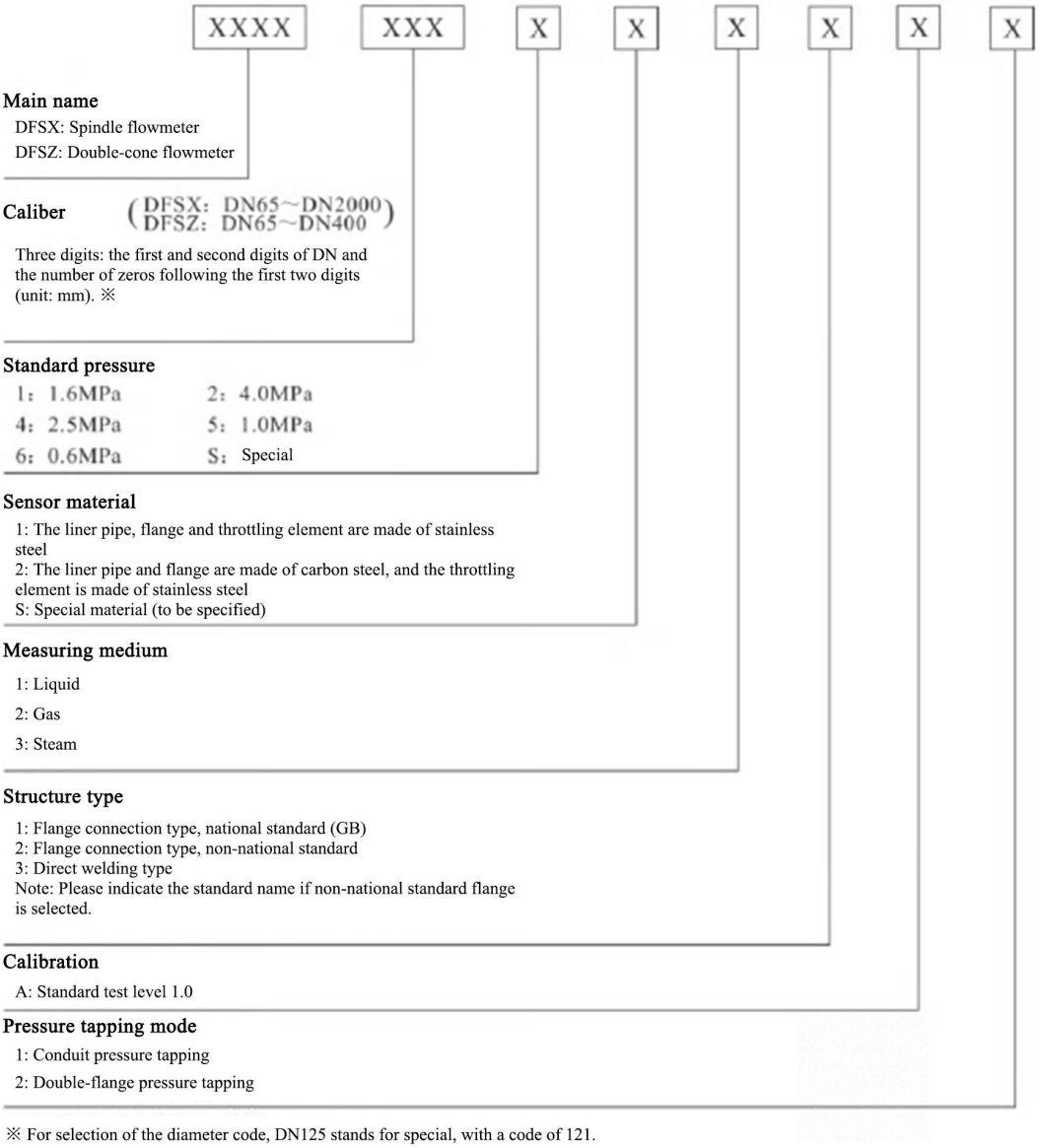
4. Precautions for Use

(1) For a new flowmeter or a throttling device that is reactivated after a period of time, check whether the impulse pipeline is blocked or leaked before use. For the liquid medium, fill the impulse pipeline with clean water or other impulse liquid. Pay attention to the exhaust of gas mixed in the pipeline. For the gas medium, pay attention to discharging the accumulated liquid in the pipeline.

(2) Install the settlers or isolators when measuring the flow of fluids containing suspended solids or dust. Pay attention to reasonably selecting the inlet, outlet and drain outlet of the impulse fluid for drainage. It is recommended to select "dirty fluid type" sensor and "differential pressure transmitter with remote diaphragm box" to measure dirty fluid.

Appendix

1. Model Selection of Double-cone and Spindle Flowmeters



※ For selection of the nominal diameter code, DN125 stands for special, with a code of 121.

SDB Averaging Pitot-tube Flowmeter

I. Introduction

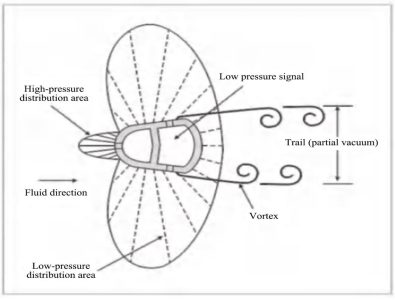
1. Scope of Application

The averaging pitot-tube is the measuring element of sic-de-ba (SDB) averaging pitot-tube flowmeter, which is a new differential pressure flow measuring element developed based on the early pitot-tube velocity measurement principle. SDB flow sensors combined with differential pressure transmitters are used to measure gas, liquid, and steam flows in circular and rectangular pipes. Compared with other flow instruments, this flowmeter has a series of outstanding advantages such as long-term stability, good repeatability, simple installation and maintenance, small permanent pressure loss, low operation costs, significant energy saving, simple and reliable structure, etc. It is especially widely used in energy, environmental protection and other metrological tests.

Therefore, SDB averaging pitot-tube flowmeter is widely used in electric power, metallurgy, petroleum, chemical industry, light industry, coal and urban public utilities.

2. Working Principle

The measurement principle of SDB averaging pitot-tube flowmeter is as follows: The sensor is inserted into the pipe, a high-pressure distribution area is generated ahead of the probe according to the fluid continuity equation and Bernoulli principle when the fluid flows through the probe, with a pressure slightly higher than the static pressure of the pipe. When the fluid flows through the probe, it is split into two streams to flow through the averaging pitot-tube. In this case, the fluid speeds up, and a low-pressure distribution area is generated at the rear of the probe, with a pressure slightly lower than the static pressure of the pipe. The fluid flow is accurately measured by measuring the differential pressure ΔP between the average positive pressure PH in the high-pressure area and the average negative pressure PL in the low-pressure area.



Simplified formula for flow:

$$Q_v = C \bullet \sqrt{\frac{\Delta P \bullet P}{T \bullet Z}}$$

Where:

Q_v: fluid volume flow

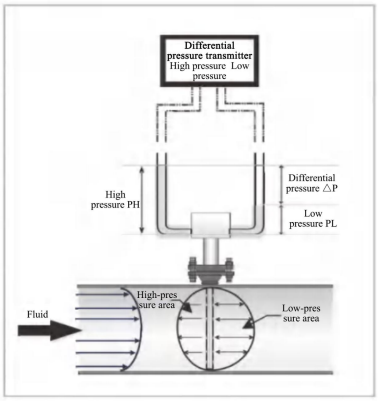
T: absolute temperature of fluid

C: fluid constant

Z: compressibility coefficient of fluid

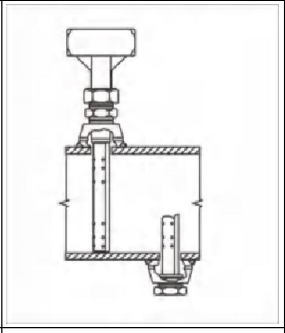
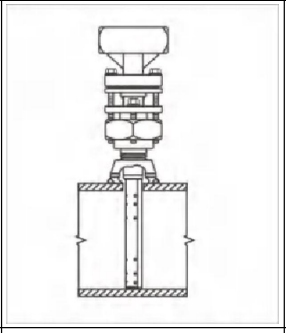
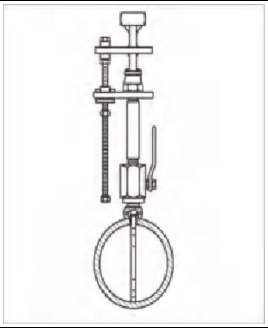
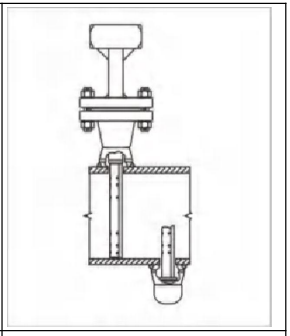
ΔP: differential pressure

P: absolute pressure of fluid



3. Product Type

According to the connection mode, SDB averaging pitot-tube flowmeters are divided into the following types:

SDB averaging pitot-tube flowmeters				
				
Product	Ferrule type SDB-R/SDB-RS	Threaded connection and spring-locked type SDB-SS	Threaded connection and online type SDB-HS	Flange connection type SDB-F/SDB-FS
Sealing	Double metal ring bulging sealing	Metal wire bulging sealing	Metal wire bulging sealing	Flange sealing
Connection method	Threaded connection	Threaded connection	Threaded connection	Flange connection

4. Main Technical Parameters



Ferrule type



Spring-locked type



Online type



Flange type

Instrument type	SDB averaging pitot-tube flowmeters
Accuracy grade	Class 1.0
Maximum allowable error	±1.0%
Working pressure	6MPa~40MPa (6MPa, 1.0MPa, 1.6MPa, 2.5MPa, 4.0MPa and above)
Medium temperature	-180℃～550℃
Upper limit of measurement	Depending on probe strength
Lower limit of measurement	Depending on minimum differential pressure requirement for measurement
Sensor material	316L stainless steel, alloy steel or special materials (please indicate special materials when ordering)
Range ratio	Larger than 10:1
Applicable pipe diameter	40mm~9000mm round and square pipes, preferably with a nominal diameter of more than 200mm
Applicable media	Single-phase gases, steam and liquids with a viscosity not more than 10 centipoises, which are filled in the pipes and flow unidirectionally
Medium flow velocity requirements	Gas: ≥ 4.5 m/s; liquid: ≥ 6 m/s; steam: ≥ 9.7 m/s

*Square pipes are temporarily quoted according to the short side. In case of any objection, please propose a change.

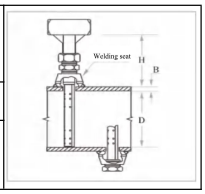
II. Installation

1. Overall Dimensions

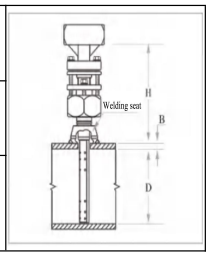
SDB averaging pitot-tube flowmeter consists of SDB averaging pitot-tube flow sensor and differential pressure transmitter. The differential pressure transmitter is mainly provided according to customer requirements. The Company can provide the whole set, or only the averaging pitot-tube flow sensor.

- **Overall dimensions of sensor**

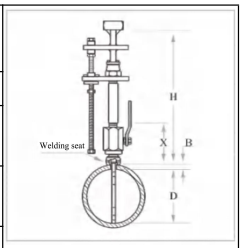
Ferrule type/ferrule type with double-sided supporting (SDB-R/SDB-RS)

Probe model / Dimensions	1/2"	1"	
Welding seat	3/4" NPT	l" NPT	
H (mm)	102	140	

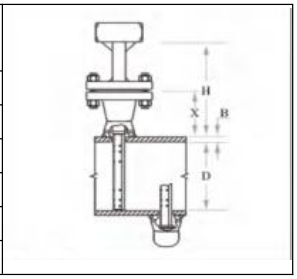
Threaded connection and spring-locked type (SDB-SS)

Probe model / Dimensions	1/2"	1"	1½"	
Welding seat	3/4" NPT	1" NPT	2" NPT	
H (mm)	185	246	282	

Threaded connection and online type (SDB-HS)

Probe model / Dimensions		1/2"	1"	1½"	
Welding seat		3/4" NPT	1"NPT	2"NPT	
X (mm)	Carbon steel ball valve	157	193	231	
	Carbon steel gate valve	165	196	257	
H (mm)	Probe insertion	D+B +X+259	D+B+X+295	D+B+X+345	
	Probe retraction	2(D+B+X) +256	2(D+B+X) +290	2(D+B+X)+338	

Flange connection type/flange connection type with double-sided supporting (SDB-F/SDH-FS)

Probe model / Flange standard and dimensions		1/2"	1"	1½"	
ANSI 150# standard flange	H (mm)	165	194	227	
	X (mm)	84	97	103	
ANSI 300# standard flange	H (mm)	175	203	237	
	X (mm)	90	103	110	
ANSI 600# standard flange	H (mm)	187	219	256	
	X (mm)	97	111	119	

For the overall dimensions of differential pressure transmitters, please refer to the model selection and installation instructions of differential pressure transmitters of corresponding specification.

2. Installation

2.1 Preparation before installation

Product inspection before installation:

- Check contract terms and verify the packing list of products.
- Check the model and tag number on the nameplate of the probe.
- Verify the actual pipe diameter and compare it with the pipe inner diameter on the product nameplate.
- Check the sensor probe surface for damage. The damage to sensor will result in measurement errors.
- Check the circular casing for damage or scratch, which will affect the sealing performance of the metal sealing ring on the probe.

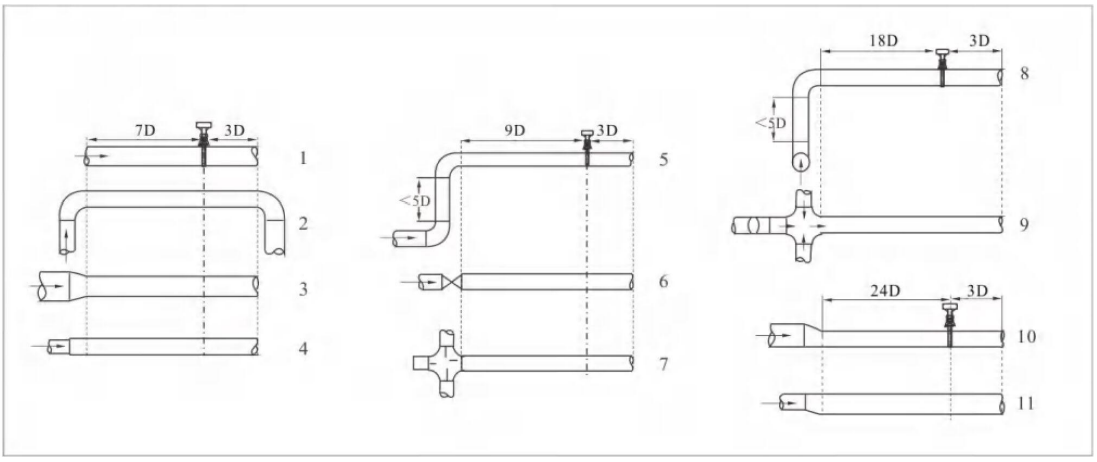
2.2 Installation requirements

2.2.1 Requirements for straight pipe section

In order to ensure accurate measurement, there are specific requirements for the length of the straight pipe section ahead of and behind the probe installation point on the pipe. The requirements for the length of the front and rear straight pipe sections without rectifier are listed below. The flow sensor is installed behind the elbow, and its insertion direction shall be kept in the same plane as the direction of the nearest elbow ahead of the probe. See the following table for specific requirements of straight pipe section:

Type of pipe installation	Installation diagram No.	Front straight pipe section	Rear straight pipe section
Horizontal pipe	1	7D	3D
Elbow	2		
Concentric contracted pipe	3		
Concentric expanded pipe	4		
Two or more elbows on the same plane	5	9D	3D
Open gate valve, ball valve or butterfly valve, etc.	6		
One or more T-pipes, T-joints, etc.	7		
Two or more non-coplanar elbows	8	18D	3D
One or more T-pipes, T-joints, etc.	9		
Eccentric contracted pipe	10	24D	3D
Eccentric expanded pipe	11		

Schematic Diagram of Straight Pipe Section Installation



2.2.2 Installation environment

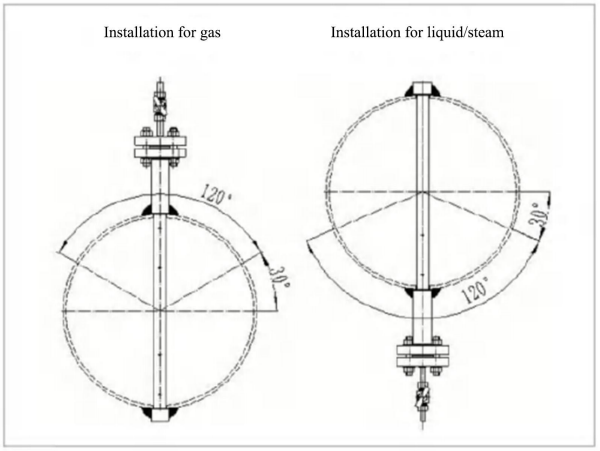
Ferrule type SDB-R/SDB-RS	Installation after pressure relief and drainage of pipes (installation after shutdown)
Spring-locked type SDB-SS	
Flange type SDB-F/SDB-FS	
Online type SDB-HS	Online installation

2.2.3 **Influence of installation position on accuracy**

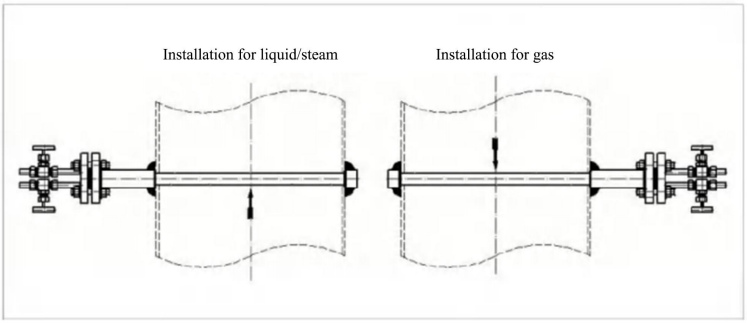
The interference of the pipe layout to the flow can affect the accuracy of the measurement, so it is important to properly install the averaging pitot-tube flowmeter. Please carefully read the following standard operations before selecting the installation position.

■ The flow direction arrow marked on the sensor is the forward flow direction specified by the manufacturer. During the instrument installation, the flow direction arrow on the sensor shall be consistent with the direction of fluid in the on-site pipe and forms an **included angle of less than ±3º with the pipe axis**.

Installation of horizontal pipe



Installation of vertical pipe



(1) Horizontal pipe

• For measurement of the gas medium, it is recommended that the SDB flow sensor be installed above the pipe, so that the condensate in the impulse pipe can flow back into the pipe. If the SDB flow sensor is installed below the pipe, a blowdown valve shall be installed.

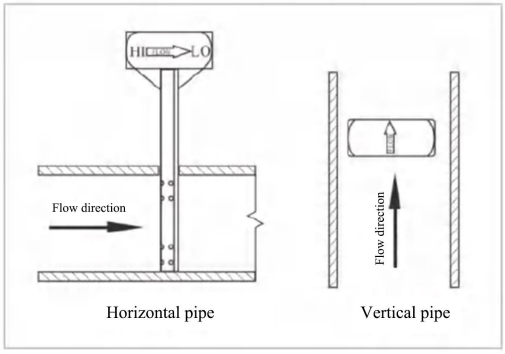
• For measurement of the liquid medium, it is recommended that the SDB flow sensor be installed below the pipe, so that bubbles can flow back into the pipe.

If the SDB flow sensor is installed above the pipe, a vent valve shall be installed.

• For measurement of the steam medium, it is recommended that the SDB flow sensor be installed below the pipe.

(2) Vertical pipe

• For vertical pipe, the SDB averaging pitot-tube may be installed in any orientation within 360° around the vertical pipe.



2.2.4 Position of differential pressure transmitter

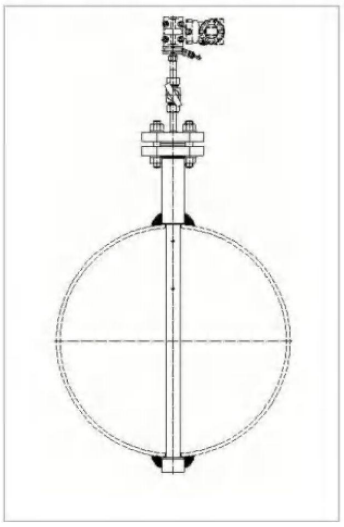
The position of differential pressure transmitter shall be considered for selecting the installation position of SDB averaging pitot-tube flow sensor.

■ For liquid and steam, the transmitter is recommended to be installed lower than the root valve.

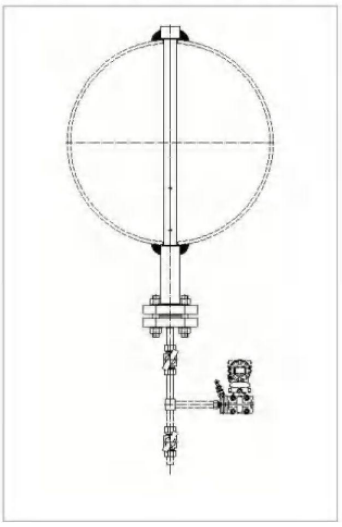
■ For gas, the transmitter is recommended to be installed higher than the root valve.

■ Please read the transmitter manufacturer's instructions carefully to install the transmitter.

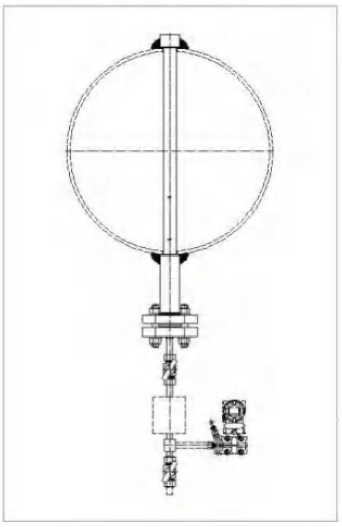
Installation for gas (transmitter above the root valve)



Installation for liquid (transmitter below the root valve)



Installation for steam (transmitter below the root valve)



2.3 **Installation of ferrule type** (SDB-R. SDB-RS)

2.3.1 Drilling on the pipe

Drill holes for installation of SDB after pressure relief and drainage of the pipe.

(1) Drill holes on the pipe in accordance with the drilling diameter dimensions shown in Table 1. Cutting holes through oxygen cutting and other methods, and wrong dimensions will lead to measurement errors.

(2) Clean burrs left inside and outside the pipe after hole drilling.

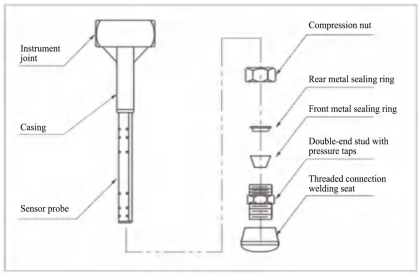
Table 1 SDB-R, SDB-RS Pipe Opening Size

Sensor probe size	Pipe opening size (mm)
1/2”	ϕ13
1”	ϕ 26
1-1/2”	ϕ 39
ϕ 30	ϕ 32
ϕ 45	ϕ48

2.3.2 Welding the threaded connection welding seat on the pipe

(1) As shown in the Exploded View of SDB-R, assemble the parts in sequence and tighten them by hand. Then insert the assembled sensor into the pipe.

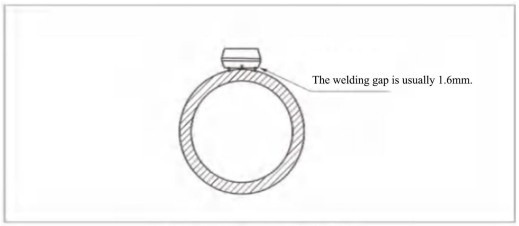
(2) Adjust the threaded connection welding seat, so that its lower arc matches the outer diameter of the pipe and is in good contact. Then estimate the correct welding gap (usually 1.6mm), and fix it to the pipe by spot welding.



Exploded View of SDB-R

(3) Remove other parts except the threaded connection welding seat, and then weld the threaded connection welding seat on the pipe. Conduct spot welding firstly and then weld on the pipe completely. For SDB-RS, weld the welding seat with reverse support on the opposite side. After the weldment is cooled, proceed to the next step.

Note: Protect the threaded part of the threaded connection welding seat. In order to ensure the welding quality, the operators shall hold relevant certificates for technical proficiency.



Welding of threaded connection welding seat

2.3.3 Inserting the sensor

(1) Screw the double-end stud with pressure taps onto the threaded connection welding seat and tighten it with a tool.

Note: Use proper sealing materials to keep tight.

(2) Sleeve the front metal sealing ring, rear metal sealing ring and compression nut into the casing in turn. Pay attention to the sequence and taper direction of the rear metal sealing ring and the front metal sealing ring, as shown in the exploded view.

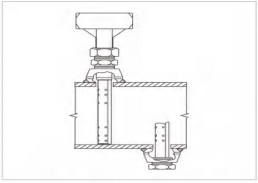
(3) Insert the sensor into the double-end stud with pressure taps, and tighten the compression nut by hand.

(4) Adjust the direction of the instrument joint, so that the fluid direction arrow marked on it is consistent with the flow direction of the fluid in the pipe and forms an included angle of less than ±3° with the pipe axis. Keep it and prepare for the next step.

(5) Press the instrument joint with a force of not less than 25 kg, so that the SDB averaging pitot-tube flow sensor is tightly against the other side of the pipe, tighten the compression nut by hand, and then screw it with a tool for 1.25 turns. This will avoid the vibration caused by the sensor not fully supporting the pipe during operation, and ensure good sealing.

(6) Verify and calibrate the instrument joints again, so that the fluid direction arrow marked on it is consistent with the flow direction of the fluid in the pipe and forms an included angle of less than ±3° with the pipe axis.

Then, the installation of SDB-R/SDB-RS flow sensor is completed.



SDB-R/SDB-RS after Installation

2.4 **Installation of threaded connection and spring-locked type** (SDB-SS)

2.4.1 Drilling on the pipe

Drill holes for installation of SDB after pressure relief and drainage of the pipe.

(1) Drill holes on the pipe in accordance with the drilling diameter dimensions shown in Table 2. Cutting holes through oxygen cutting and other methods, and wrong dimensions will lead to measurement errors.

(2) Clean burrs left inside and outside the pipe after hole drilling.

Table 2 SDB-SS Pipe Opening Size

Sensor probe size	Pipe opening size (mm)
1/2”	ϕ13
1”	ϕ 26
1-1/2”	ϕ 39
ϕ 30	ϕ 32
ϕ 45	ϕ48

2.4.2 Welding the threaded connection welding seat on the pipe

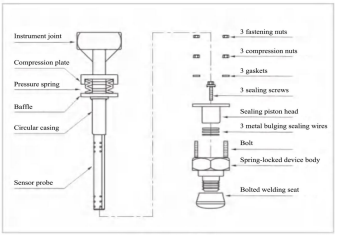
(1) As shown in the Exploded View of SDB-SS, assemble the parts in sequence and tighten them by hand. Then insert the assembled sensor into the pipe.

(2) Adjust the threaded connection welding seat, so that its lower arc matches the outer diameter of the pipe and is in good contact. Then estimate the correct welding gap (usually 1.6mm), and fix it to the pipe by spot welding.

(3) Remove other parts except the threaded connection welding seat, and then weld the threaded connection welding seat on the pipe.

Conduct spot welding firstly and then weld on the pipe completely. After the weldment is cooled, proceed to the next step.

Note: Protect the threaded part of the threaded connection welding seat. In order to ensure the welding quality, the operators shall hold relevant certificates for technical proficiency.



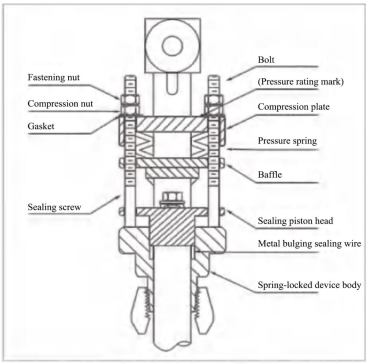
Exploded View of SDB-SS

2.4.3 Installing the spring-locked device body and threaded connection welding seat

(1) Loosen the fastening nut, compression nut and gasket, and pull out the sensor.

(2) Install the spring-locked device body on the threaded connection welding seat, and tighten it with a tool. Do not remove the sealing piston head during installation.

Note: Use proper sealing materials to keep tight.



Section of Spring-locked Device

2.4.4 Inserting the sensor

(1) Insert the sensor through the spring-locked device body into the pipe until the sensor is against the other end of the pipe.

Note: Three bolts shall be screwed through the baffle and compression plate.

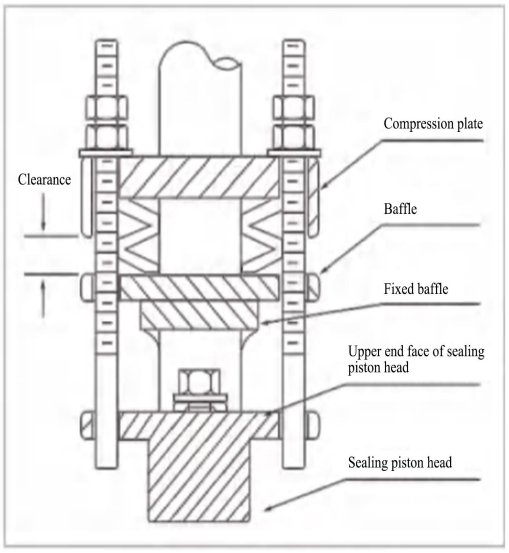
(2) Adjust the direction of the instrument joint, so that the fluid direction arrow marked on it is consistent with the flow direction of the fluid in the pipe and forms an included angle of less than ±3° with the pipe axis. Keep it and prepare for the next step.

(3) Install the gasket and compression nut into three bolts in turn, and tighten the compression nut until the clearance between the compression plate and the baffle is reached as shown in the figure. The clearance is 05" for 1/2" and 1" sensors, and 063" for 1½" sensor. In this way, the spring-locked device is correctly installed.

(4) Install the fastening nuts into the three bolts and tighten them by hand. Then fix the compression nut with a wrench, and then tighten the fastening nut by 1/8 turn.

(5) Finally, tighten the three sealing screws with a wrench.

Note: The fixed baffle shall not come into contact with the upper end face of the sealing piston head. In case of contact, it indicates that the sensor is not pushed against the opposite side of the pipe. Please check the installation or consult the customer service center of the Company.



Clearance of Spring-locked Device

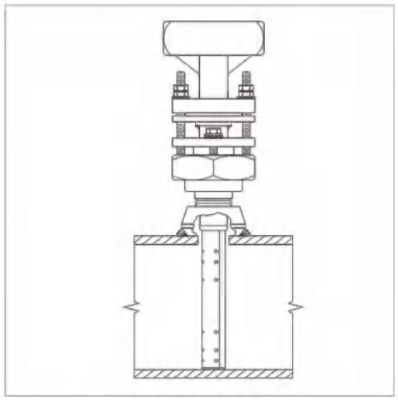
2.4.5 Pipe pressure test and leakage inspection

Pressurize the pipe and check the instrument for leakage. In case of leakage, tighten the three sealing screws. Recheck the clearance between the compression plate and the baffle, and adjust as shown in the figure.

2.4.6 Regular maintenance

SDB-SS shall be checked regularly for leakage, and the three sealing screws shall be tightened in case of leakage.

Then, the installation of SDB-SS flow sensor is completed.



SDB-SS after Installation

2.5. **Installation of threaded connection and online type** SDB-HS **(single-rod drive)**

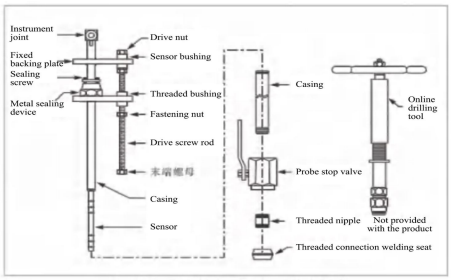
2.5.1 Assembling the SDB kit

- All parts of the averaging pitot-tube flow sensor

after unpacking are not tightened. See the Exploded View of SDB-HS (Single-rod Drive). Please install and assemble according to the following steps.

(1) Install and connect instrument joints

There are several instrument joints available for the SDB averaging pitot-tube, as shown in the Instrument Joint Diagram. If you purchase an instrument joint without a built-in valve, install the instrument stop valve with the appropriate threaded connector and sealing materials. Please confirm that the instrument stop valve is closed before the next step.



Exploded View of SDB-HS (Single-rod Drive

)



R-joint and instrument stop valve 1/2″NPTF threaded interface

T-joint of built-in instrument valve 1/2″NPTF threaded interface

M-joint of built-in three-valve manifold 1/2″NPTF threaded interface

Instrument Joint Diagram

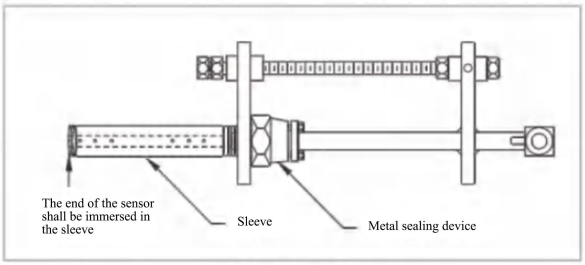
(2) Install the sleeve

Screw the sleeve into the metal sealing device in the correct direction and tighten it with a tool.

Note: Use proper sealing materials to keep tight.

(3) Tighten the metal sealing device

Turn the drive nut with a wrench so that the end of the sensor is flush with the end of the sleeve. Then tighten the three sealing screws of the metal sealing device.



Installation of Sleeve

2.5.2 Welding the threaded connection welding seat on the pipe

Mark the position where the sensor is to be installed. Place the threaded connection welding seat in the center of the mark, and adjust the threaded connection welding seat, so that its lower arc matches the outer diameter of the pipe and is in good contact. Then estimate the correct welding gap (usually 1.6mm), conduct the spot welding firstly and then weld on the pipe completely. After the weldment is cooled, proceed to the next step. For welding, see the welding drawing of threaded connection welding seat (see the figure below).

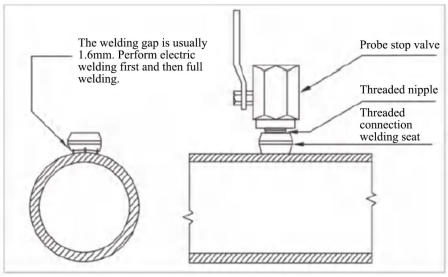
Note: Protect the threaded part of the threaded connection welding seat. In order to ensure the welding quality, the operators shall hold relevant certificates for technical proficiency.

2.5.3 Installing threaded nipples and probe stop valves

Install the threaded nipples and probe stop valves on the threaded connection welding seat in turn, and tighten them with a tool.

Note: Keep the probe stop valve fully open.

Use proper sealing materials to keep the joints tight.



Welding of threaded connection welding seat

2.5.4 Drilling on the pipe

(1) Open the probe stop valve fully, and drill holes in the pipe with a suitable online drilling tool. The hole diameter is shown in Table 3:

(2) After drilling, pull out the drill bit, close the probe stop valve, and then remove the online drilling tool.

Note: The Company can provide online drilling services.

Table 3 SDB-HS Pipe Opening Size

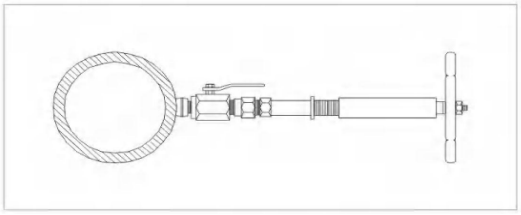
Sensor probe size	Pipe opening size (mm)
1/2”	ϕ13
1”	ϕ 26
1-1/2”	ϕ 39
ϕ 30	ϕ 32
ϕ 45	ϕ48

2.5.5 Installing the part with sensor on the probe stop valve

(1) Screw the part of the installed sleeve into the probe stop valve installed on the pipe as shown in the installation drawing of the sleeve (in the previous page), and tighten it with a tool.

Note: Use proper sealing materials to keep the joints tight.

(2) Adjust the direction of the instrument joint, so that the fluid direction arrow marked on it is consistent with the flow direction of the fluid in the pipe and forms an included angle of less than ±3° with the pipe.



Online drilling tool

2.5.6 Checking the whole for leakage

Close the valve of the instrument stop valve, slowly unscrew the probe stop valve, and check whether there is fluid leakage at each joint. If so, close the probe stop valve and reseal the joint.

2.5.7 Lubricating the drive screw rod

The drive screw rod has been coated with high-temperature lubricating oil before leaving the factory. Before insertion and pulling out, check whether the drive screw rod has been properly lubricated, and lubricate the probe casing and support casing as well.

2.5.8 Inserting the SDB sensor

Warning: When the sensor is inserted, the flow must be below the maximum flow allowed for insertion/pulling out indicated on the probe nameplate.

(1) Before inserting and pulling out the sensor, please check the direction of the instrument joint. The fluid direction arrow marked on it is consistent with the direction of the fluid in the pipe and forms an included angle of less than ±3° with the pipe.

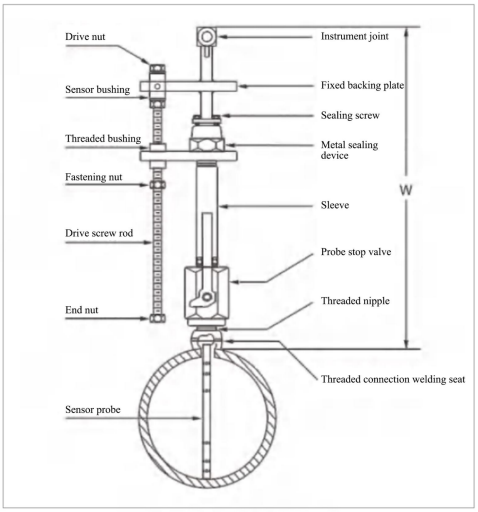
(2) Fully open the probe stop valve, turn the drive nut with a tool and insert the sensor into the pipe.

(3) Apply appropriate force to the end of the sensor to make it tightly against the pipe wall at the bottom of the pipe. Then the distance between the fixed backing plate and the upper part of the metal sealing device is about 58 mm.

■ When the SDB-HS is partially inserted, it is particularly important that the length of W is equal to the length shown on the nameplate.

■ When the sensor has been inserted in a correct length, tighten the fastening nut towards the fixed backing plate. In this way, the drive screw rod can be locked here, and the sensor can be fixed in this position.

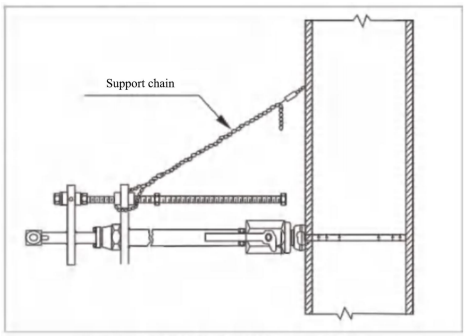
Then, the installation of SDB-HS flow sensor is completed.



SDB-HS after Installation

2.5.9 Pipe support

When the averaging pitot-tube is beyond the pipe for more than 92 cm or installed on a pipe with a very thin wall, it is necessary to take necessary support for SDB. This will reduce the stress on the pipe wall. The support on vertical pipe is shown in the figure.



Support of SDB Averaging Pitot-tube on Vertical Pipe

2.5.10 **Steps to pull out the sensor**

(1) Decrease the flow in the pipe below the maximum flow allowed for insertion/pulling out as indicated on the nameplate.

(2) Close the instrument stop valve.

(3) Loosen the fastening nut and turn the drive nut with a tool, until the end nut is against the support casing.

(4) **Close the probe stop valve completely.** Slowly open the instrument stop valve, release the residual pressure, and remove the sleeve. In this case, the sensor part can be removed.

2.5.11 **Regular maintenance**

During regular inspection, check whether the sealing is in good condition and whether the fastening nuts and sealing screws are loose.

2.6 **Installation of flange connection type** SDB-F/SDB-FS

2.6.1 **Drilling on the pipe**

Drill holes for installation of SDB after pressure relief and drainage of the pipe.

(1) Drill holes on the pipe in accordance with the drilling diameter dimensions shown in Table 4. Cutting holes through oxygen cutting and other methods, and wrong dimensions will lead to measurement errors.

(2) Clean burrs left inside and outside the pipe after hole drilling.

Table 4 SDB-F/SDB-FS Pipe Opening Size

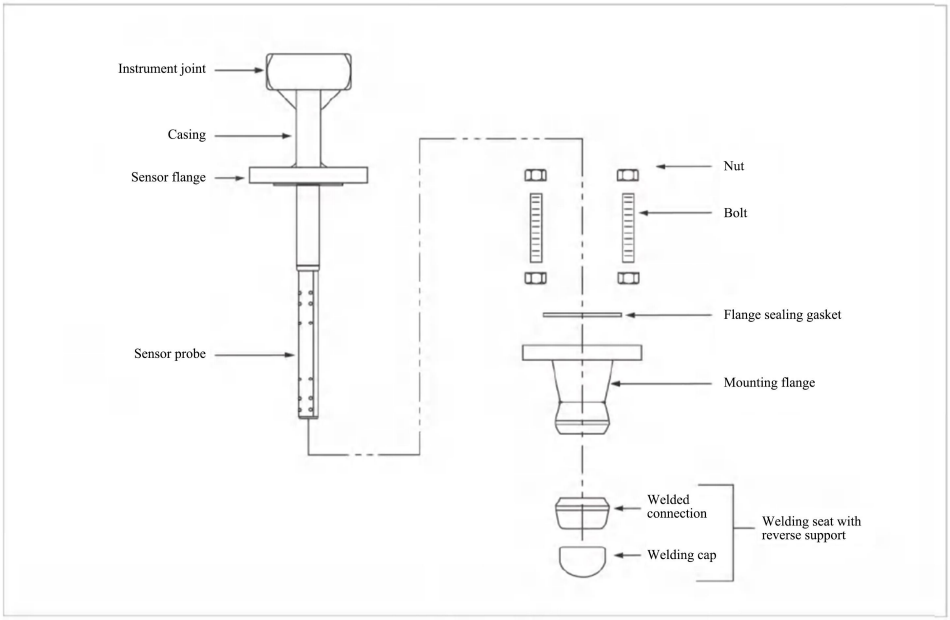
Sensor probe size	Pipe opening size (mm)
1/2”	ϕ13
1”	ϕ 26
1-1/2”	ϕ 39
ϕ 30	ϕ 32
ϕ 45	ϕ48

2.6.2 Welding the mounting flange on the pipe

(1) As shown in the Exploded View of SDB-F/SDB-FS, assemble the parts in sequence, and connect the sensor flange, sealing gasket and mounting flange together with bolts (tighten them by hand). After assembly, insert into the pipe, and adjust the direction of the instrument joint, so that the fluid direction arrow marked on it is consistent with the flow direction of the fluid in the pipe and forms an included angle of less than ±3° with the pipe. The lower arc of the mounting flange shall match the outer diameter of the pipe and be in good contact.

(2) Estimate the correct welding gap (usually 1.6mm), and put the mounting flange in place. Note the orientation of the mounting flange. Bolt holes in mounting flanges shall be symmetrical across the centerline of the pipe. For SDB-FS, adjust the welding seat with reverse support so that the sensor end can be inserted into it.

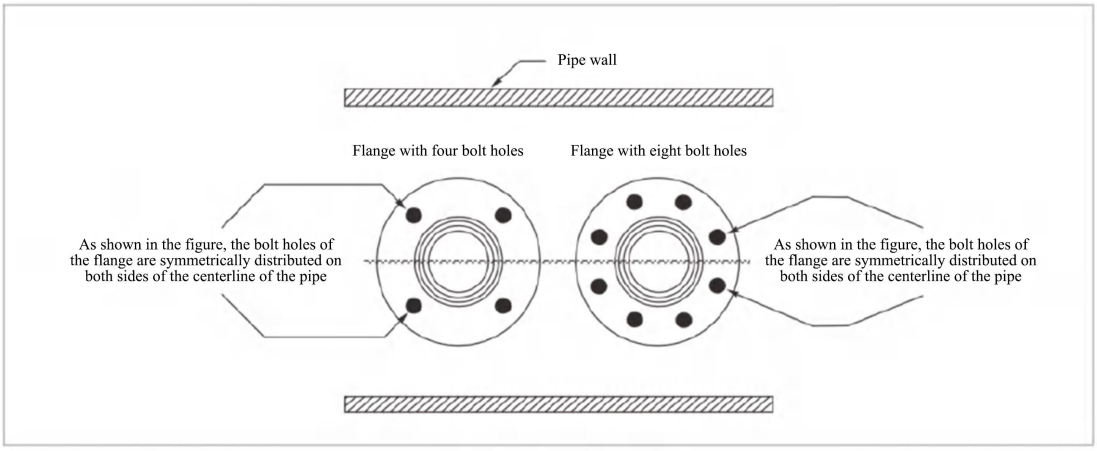
Note: Too small welding gap may cause SDB-F/SDB-FS mounting flange and sensor flange unable to be sealed.



Exploded View of SDB-F/SDB-FS

(3) Remove the sensor flange and then weld the mounting flange. Conduct spot welding firstly and then weld on the pipe completely. For SDB-FS, weld the welding seat with reverse support on the opposite side. After the weldment is cooled, proceed to the next step.

In order to ensure the welding quality, the operators shall hold relevant certificates for technical proficiency.

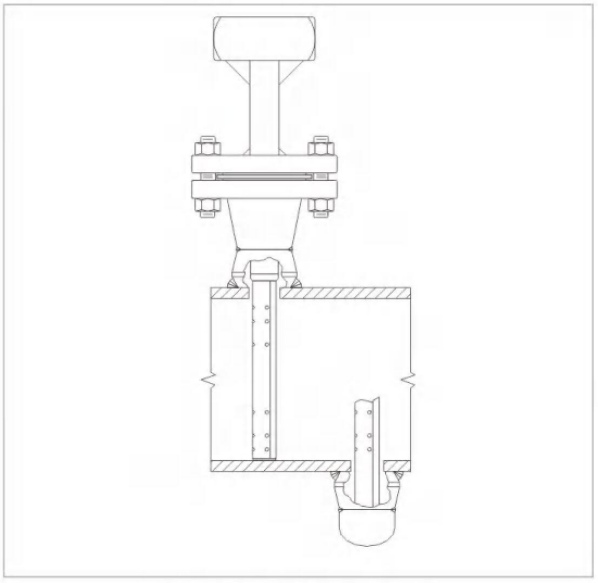


Orientation and Welding of Mounting Flange

2.6.3 **Inserting the sensor**

(1) Fix the sensor flange on the mounting flange, add a flange sealing gasket in the middle, and tighten it with a tool. (The clearance is about 3.18mm after the two flanges are fully tightened)

Then, the installation of SDB-F/SDB-FS flow sensor is completed.



SDB-F/SDB-FS after Installation

Attached Table

Model Selection of SDB Averaging Pitot-tube Flowmeter

Model	Description		
DFB			
Nominal diameter (DN40~DN9000)			
XXX	Three digits: the first and second digits of DN and the number of zeros following the first two digits (unit: mm).※		
Product type			
X	1: Ferrule type SDB-R		4: Threaded connection and online type SDB-HS
	2: Ferrule type (with double-sided support) SDB-RS		5: Flange connection type SDB-F
	3: Threaded connection and spring-locked type SDB-SS		6: Flange connection type (with double-sided support) SDB-FS
Nominal pressure			
X	Range of application: (25~42) MPa		
	1:1.6MPa	2:4.0MPa	4:2.5MPa
	5:1.0MPa	6:6MPa	S: Special
Probe size			
X	1: 1/2"(ϕ18) 2:1"(ϕ30) 3:11/2" 4:2"(ϕ45) S: Special		
Measuring medium			
X	1: Liquid	2: Gas	3: Steam
Operating environment			
X	1: Medium temperature: -196~120°C		2: Medium temperature: -196~300°C
	3: Medium temperature: -196~550°C		S: Special
Connecting flange			
X	0: Non-flange connection	2: ANSI flange connection (up to class 2500)	
	3: Chemical industry standard	S: Special	
Connecting valve (required for online type)			
X	0: Non-online type	1: Carbon steel ball valve	
	2: Stainless steel ball valve	S: Special	
Instrument valve (alternative)			
X	0: Not equipped	1: Carbon steel gate valve	
	2: Stainless steel needle valve	3: Stainless steel ball valve S: Special	
Structure type			
X	1: Split	2: Integrated	
Accuracy grade			
X	C: Class 1.0 (the accuracy class is calculated with the software)		
Pipe direction			
X	H: Horizontal		V: Vertical
Pipe material			
X	1: Carbon steel		2: Stainless steel
	S: Special materials		
Pipe size			
X/X	Outer diameter/wall thickness	(unit: mm)	
	For example, 56/3 means that the outer diameter of the pipe is 56 mm and the wall thickness of the pipe is 3 mm.		

* Rectangular pipes are temporarily quoted according to the short side. In case of any objection, please propose a change.

Note: The following parameters shall be provided for the throttling device to select and quote:

Pipe material and outside diameter X wall thickness, working pressure, working temperature, medium, density, dynamic viscosity, scale flow or maximum flow.

If the medium is gas, the flow unit shall also be provided as standard condition or working condition.

SDB flowmeters are not recommended for trade settlement;

It is not recommended to use SDB flowmeters when the common differential pressure is lower than 150 pa**.**

DF Wing Air Volume Sensor

I. Introduction

1. Overview

DF wing air volume sensor works as follows: with a symmetrical wing hollow cylinder installed in the pipe, when the fluid flows, a differential pressure is generated between the front end and the side of the wing. The fluid flow can be obtained according to the Bernoulli equation. It is connected with the differential pressure transmitter to form a wing air volume flowmeter. This flowmeter is widely used to measure the air volume in large-diameter pipes and the flue gas flow in petroleum, chemical, metallurgy, electric power, mining and other industries. It can be used in combination with regulating instruments and industrial personal computers to form a flow control system.

2. Features and Functions

2.1 Without movable parts, simple structure, long service life and a wide range of application:

2.2 Good long-term stability and high reliability of flow coefficient:

2.3 The detection body is a streamlined wing with the minimum resistance coefficient, thus ensuring small pressure loss, low energy consumption and high measurement accuracy:

2.4 For large pipe diameters, multiple wings are used to improve the measurement accuracy, shorten the pipe length, and reduce the volume and weight:

2.5 Low requirements for medium conditions: The dust and smoke in the medium have little impact on its measurement: 2.6 Low requirements for the length of straight pipe section: The maximum length of straight pipe section is required to be 2D (D is the inner diameter of the pipe)

2.7 Simple operation and convenient use and maintenance:

3. Main Technical Parameters

3.1 Fluid medium: gas;

3.2 Pipe size:

Square pipe: 300×300~3000×3000 (mm):

Circular pipe: φ150~φ2000 (mm):

3.3 Working pressure: ≤60kPa;

3.4 Working temperature: ≤450℃;

3.5 Minimum Reynolds number: R_{cdmin}≥2.5×105 (gas):

3.6 Basic error limit: ±1.5%, ±2.5%:

3.7 Working power supply: 24VDC.

3.8 Ambient temperature: -10~+70℃:

3.9 Atmospheric pressure: 86~106kPa



Wing Air Volume and Flow Sensor

4. Flow Calculation Formula

Flow formula:

$$q_v = \frac{C\varepsilon}{\sqrt{1-m^2}} m \frac{\pi D^2}{4} \sqrt{\frac{2\Delta p}{\rho}}$$ (circular)

$$q_v = \frac{C\varepsilon}{\sqrt{1-m^2}} mHL \sqrt{\frac{2\Delta P}{\rho}}$$ (square)

Where: qv-volume flow, m3/s: (volume flow under working conditions)

C - discharge coefficient: (dimensionless)

ε - expandability coefficient: (dimensionless)

m - ratio of flow area to cross-sectional area of pipe: (dimensionless)

D - inner diameter of circular pipe, m; H, L - height and width of square pipe, m

△p - differential pressure, Pa;

ρ - density of the measured medium under working conditions, kg/m3.

Note: The volume flow under standard conditions shall be obtained by the calculation formula multiplied by the density under standard conditions and divided by the density under standard conditions.

5. Service Conditions for Fluid

5.1 For normal operation of the sensor, the fluid must meet the following requirements:

5.1.1 The fluid must be fully filled in the pipe and the throttling device, and flow continuously through the pipe.

5.1.2 The fluid must be Newtonian fluid, which is physically and thermodynamically homogeneous and single phase, or can be considered single phase.

5.1.3 No phase change occurs when the fluid flows through the throttling element.

5.1.4 The fluid flow does not change over time or changes very slowly.

5.1.5 Before the fluid flows through the throttling element, its flow velocity must be parallel to the pipe axis and there must be no rotating flow.

5.1.6 It is not applicable for flow measurement of pulsating and critical flows.

II. Installation

1. Conditions and Technical Requirements of Installation

The measurement accuracy of the sensor is closely related to whether the installation meets the installation conditions and technical requirements, so users must pay great attention to it.

1.1 Installation position of sensor in the pipe

The sensor can be installed and used on horizontal or vertical pipes. When it is installed vertically, the fluid shall flow from bottom to top. For liquid measurement, the differential pressure transmitter shall be able to easily remove bubbles. Due to the application on vertical pipelines, the positive and negative pressure taps are not on the same horizontal plane, and the height difference shall be corrected as necessary. The sensor can be horizontally, vertically or obliquely installed in the pipeline. However, when the measured medium is liquid, the pressure tapping hole shall be parallel to or lower than the field measuring pipe, that is, the sensor shall be installed on the horizontal plane of the pipe or below the pipe;

1.2 The flow direction mark on the sensor housing shall be consistent with the fluid flow direction:

1.3 If necessary, a flow control valve shall be installed in the downstream of the flowmeter:

1.4 For measurement of the fluid temperature, the temperature transmitter shall be installed at 5D downstream of the flowmeter. For measurement of the fluid pressure, the pressure transmitter shall be installed at 10D upstream of the flowmeter;

1.5 The sensor shall be installed in the conditions free of corrosive gases for operation.

2. Use and Maintenance of Sensors

2.1 Use

Before using the sensor, in addition to the *Operation Instructions of Wing Air Volume and Flow Sensor*, carefully read the *Operation Instructions of Differential Pressure Transmitter* and the *Operation Instructions of Intelligent Flow Indicator,* etc. And pay attention to the followings:

a) After confirming that the installation and wiring are correct, open the valve to fill the process pipe with the measured medium, and temporarily close the sensor measuring system. In this case, open the balance valve of the three-valve manifold, and close the high- and low-pressure valves. The supporting display instrument is powered on and preheated for about 15 minutes.

b) Turn on the measuring system after the display instrument is preheated. Open the high- and low-pressure valves, and keep the balance valve open. Open the blowdown valve on the differential pressure transmitter, and close it after discharge of dirty liquid or gas exhaust. Then close the balance valve on the three-valve manifold. In this way, the sensor will be in a state of the differential pressure measurement. The differential pressure value is sent to the flow totalizer to display the flow of the measured medium.

2.2 Maintenance

Though a little maintenance is needed for the sensor, the following points should be noted:

a) The production process is discontinuous. When the production is suspended, open the balance valve of the three-valve manifold, and close the high- and low-pressure valves. When the production is resumed, open the high- and low-pressure valves and close the balance valve.

b) For some dusty media, such as coal gas, mashgas and natural gas, carry out regular purging. The purging is to blow back the sensor with compressed air. During purging, close the impulse pipeline leading to the differential pressure transmitter, and reopen after purging. When compressed air is not allowed, such as blast furnace gas, steam can be available for purging.

c) When installing a throttling device on a new process pipe, pay special attention to avoiding damage to the throttling element when welding slags and sundries in the process pipe flow through the throttling element. Therefore, use a short pipe for some time before installing the sensor.

d) After the sensor is put into use, the initial condition of inner wall of the sensor may change over time due to long-term contact with the fluid. Therefore, disassemble, clean, inspect or replace the sensor regularly. Make the throttling device in the original design working state to ensure the accuracy and stability of measurement.

Appendix:

Length of straight pipe section of flow sensor

H/D	One 90° elbow or a tee with only one branch	Multiple 90° elbows in the same plane	Multiple 90° (spatial elbows) in different planes	Reducing pipe (from large to small 2D→D1, length ≥3D, from small to large 1/2D→D length ≥1/2D	Fully open stop valve	Full gate valve
1	2	3	4	5	6	7
≤20	(5)	1.5(5)	(5)	2.5(1.5)	(2.5)	(1.5)
30	(1.5)	2.5(5)	(8.5)	5.5(1.5)	(3.5)	(2.5)
40	3.0(1.0)	3.5(2.5)	(18)	8.5(1.5)	(4.5)	(3.5)
50	4.0(2.0)	4.5(2.5)	(28)	15(2.5)	(5.5)	(4.5)

Notes: 1. The numbers listed in the table are multiples of the internal diameter D of the pipe

2. The numbers outside parentheses are the values with an "additional limit relative error" of zero. The numbers in parentheses are the values with an additional limit relative error of ±5%. That is, when the value in parentheses exists in the length of straight pipe section, the limit relative error τq/q of flow measurement shall be arithmetically added by 5%, i.e. (τq/q+5) %.

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