Please refer to page 10 for selection details

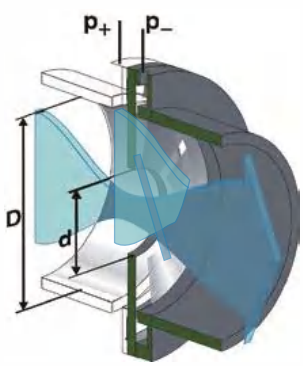
FO70

Orifice Plate, Nozzle, Venturi Flow Meter

Working principle

When the fluid filled in the pipeline flows through the sensor in the pipeline, as shown in the figure, the flow velocity will form a local contraction at the sensor, so the flow velocity will increase and the static pressure will decrease, and then a pressure difference will be generated before and after the sensor. The greater the fluid flow, the greater the pressure difference, so that the flow can be measured according to the pressure difference.

This measurement method is based on the flow continuity equation (law of conservation of mass) and Bernoulli equation (law of conservation of energy). The pressure difference is not only related to the flow rate, but also to many other factors. For example, when the sensor structure or the physical properties (density and viscosity) of the fluid in the pipeline are different, the pressure difference generated under the same flow rate is also different.



Product description

The differential pressure flowmeter is composed of a throttling element and a differential pressure transmitter. The differential pressure throttling element generates corresponding pressure difference with the change of flow velocity.

In addition to providing standard products such as orifice plate, flange orifice plate assembly, orifice flowmeter with front and rear straight pipe sections and pitot tube flowmeter, Rodwig also provides customers with specific product solutions, such as cone flowmeter, venturi flowmeter and wedge flowmeter, which are suitable for more complex media and environments. According to different applications and precision requirements, each differential pressure throttling element has its own advantages and is more suitable than other options.

For all process conditions, the differential pressure throttling element can be designed with different aperture ratio to meet the allowable pressure loss and produce the best differential pressure.

Differential pressure transmitter, which aims to measure differential pressure as accurately as possible. It is particularly important that differential pressure measurement should not be affected by changes in fluid pressure, temperature or other characteristics (such as ambient temperature).

Functional performance

Differential pressure flowmeter is suitable for all liquid, gas or steam measurements.

Even in extreme temperature, high pressure, high flow rate or corrosive medium, it can still work normally, while other flow meters with direct measurement principle are hardly applicable or not available at all.

The differential pressure method has a wide range of applications, and can be used to measure at high pressure up to 420bar/6091psi and temperature range from -270℃ to +600℃.

By choosing a variety of different structural forms and materials, differential pressure flow technology can be adjusted and designed to meet almost unlimited measurement possibilities.

Product application

Oil&gas

chemical industry

petrify

Heating ventilating and air conditioning (HVAC)

energy

Smelting and mining

✆ 400-860-9760

For more product information, please visit www.ludwig-schneider.com.cn

LUDWIG INSTRUMENT

Flow equation

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

$$Q_v = \frac{Q_m}{\rho}$$

Note: The above formula is a principle formula, not a final calculation formula.

Formula: Qm —Mass flow under working condition (kg/h)
Qv — Volume flow under working condition (working condition)(m3/h)
C — efflux coefficient
β — diameter ratio, d/D
ε — Gas expansion coefficient (liquidε=1)
Δp — differential pressure (kPa)
ρ — Fluid density (kg/m3)
d — Aperture of sensor under working conditions (m)

Orifice meter

Orifice flowmeter is the most commonly used differential pressure throttling element and the most economical flow measuring device, with mature technology, globally recognized standard and easy installation and maintenance. Orifice plate works by throttling gas, liquid or steam. According to Bernoulli equation, the pressure decreases with the increase of flow velocity. The differential pressure of the medium is measured at the measuring point to measure the flow rate of the medium.

Bright spot

Clean or dirty media, gas or steam can be specially designed according to the working conditions
High temperature resistance (maximum operating temperature depends on the material of the hole plate)
High pressure resistance
Standard material is stainless steel, the rest according to customer requirements.
The permanent pressure loss is between 40... 95%
The uncertainty of the outflow coefficient is between 0.5% and 0.75% depending on the beta value

Standard orifice plate (flange pressure tapping orifice plate)

According to ISO5167/GBT2624, the orifice plate can be designed into different pressure tapping forms according to the assembly form. The pressure tap of the flange pressure tap is located on the neck welded pressure tap flange equipped with the throttling device. According to ISO5167, the pressure tap must be located one inch (25.4 mm) before and after the throttling element.

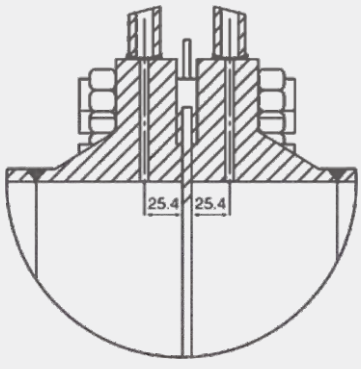
The orifice plate must be installed in conjunction with a suitable flange. The flange must fit with the orifice and pipeline. The following diagram shows a typical orifice plate component schematic:

Orifice flange (pressure flange) is a simple flange with welding grooves used to safely install orifice plates in pipelines.

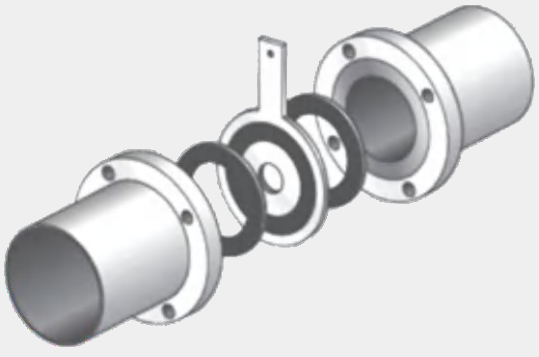
The assembly components of orifice plate and flange include orifice plate, a pair of pressure tapping flanges, a set of gaskets, a set of Threaded fastener, and separation bolts to help separate the flange and orifice plate for inspection.

We can also use RJ face neck welded flanges. This type of flange has a higher design pressure. The orifice plate is located between the bolts, ensuring that the positional deviation does not exceed the tolerance range specified in the standard.

We default to keeping the flange material consistent with the pipeline material.



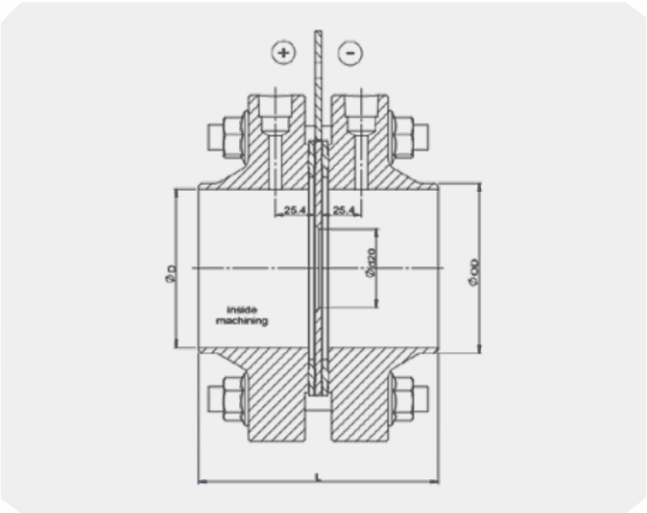
Flange taps



Typical Orifice Plate Assembly

Specification parameters

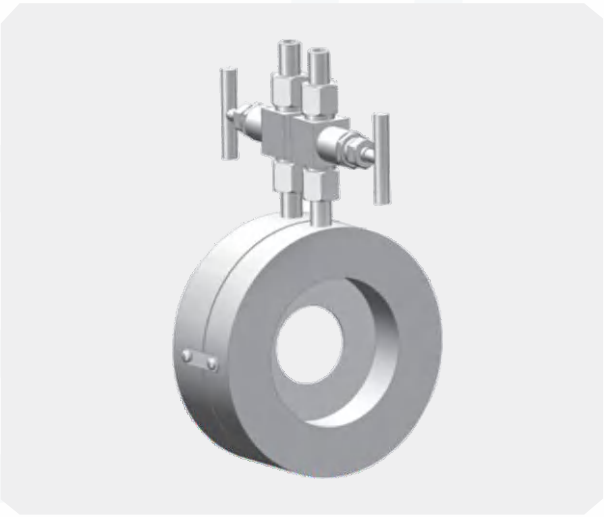
Nominal diameter	DN25-DN2000 (1"- 80")
working pressure	PN16-PN160
	Class150- Class900
	Special designs can be made for greater pressure
maximum temperature	+600°C
Uncertainty	0.5-0.8%
Repeatability	±0.1%
line type	Welding connection
Flange material	Carbon steel: SA105, 20#
	Stainless steel: 304, 316, 316L, etc
Orifice plate material	304, 316, 316L, etc



Application orifice plate (annular chamber orifice plate)

The integration of pressure tapping and annular chamber at the corner of the orifice plate. The orifice plate with an annular chamber has a two part annular chamber. In the annular cavity, flow measurement and the measurement of the average value after interference can be achieved.
Therefore, under complex operating conditions, a more stable pressure signal can be measured and is not easily affected. Suitable for measuring liquid, gas, and steam flow rates.
Orifice plates with annular chambers are used for installation between standard flanges. The use of a split ring cavity design makes it easier for daily maintenance and replacement of orifice plates.

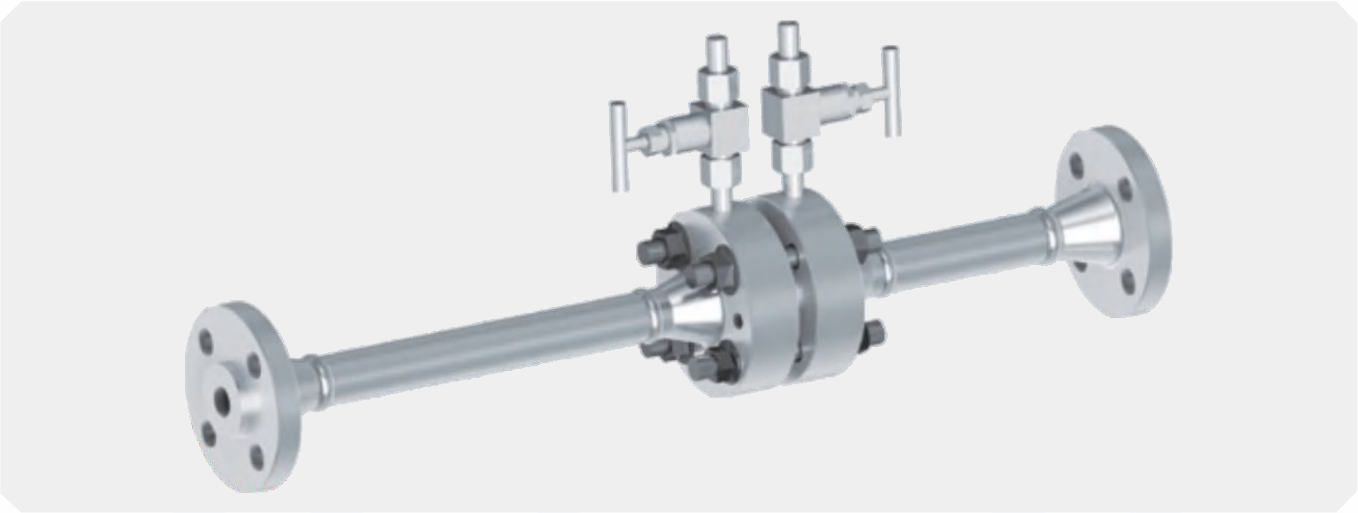
Nominal diameter	DN25-DN2000 (1"- 80")
working pressure	PN16-PN160
	Class150- Class900
	Special designs can be made for greater pressure
maximum temperature	+600°C
Uncertainty	0.5-0.8%
Repeatability	±0.1%
line type	Welding connection
Flange material	Carbon steel: SA105, 20#
	Stainless steel: 304, 316, 316L, etc
Orifice plate material	304, 316, 316L, etc



Application orifice plate (annular chamber orifice plate)

In order to improve accuracy and reduce fluid disturbances during the flow measurement process (such as pipelines with high roughness having a significant impact on flow measurement, especially when the pipeline diameter is very small), orifice plates with straight pipe sections can be used for measurement.

The straight pipe section that has undergone real flow calibration can be assembled on different types of orifice plates or nozzles. The manufacturing requirements and standards of the device comply with ISO 5167. According to ISO TR15377, devices with a diameter less than DN50 can also be used as standard throttling devices.



Nominal diameter	DN15-DN100 (1/2"-4")
working pressure	PN10-PN100
	Class150-Class600
	Special designs can be made for greater pressure
maximum temperature	+400℃
Uncertainty	0.5-0.8%
Repeatability	±0.1%
line type	Flange connection
Flange material	Carbon steel: SA105, 20#
	Stainless steel: 304, 316, 316L, etc
Orifice plate material	304, 316, 316L, etc

Nozzle flowmeter

Nozzles are suitable for high flow rates, non viscous, and corrosive fluids, which can cause sharp edge wear or damage to the orifice plate. The nozzle is used to compensate for the shortcomings of the orifice plate in terms of long-term repeatability and reliability. It is particularly recommended to use nozzles in steam measurement.

A typical nozzle can accurately measure the flow rate of high-speed flowing fluids. The demand for straight pipe sections is much smaller than that for orifice plates, and the larger discharge coefficient of the nozzle results in the same The measured flow rate is approximately 55% higher than the orifice plate under the design differential pressure.

Unlike orifice plates, nozzles do not rely on sharp edges to measure flow (the sharpness of this edge can degrade over time), and have low pressure losses. However, nozzles require higher accuracy in production.

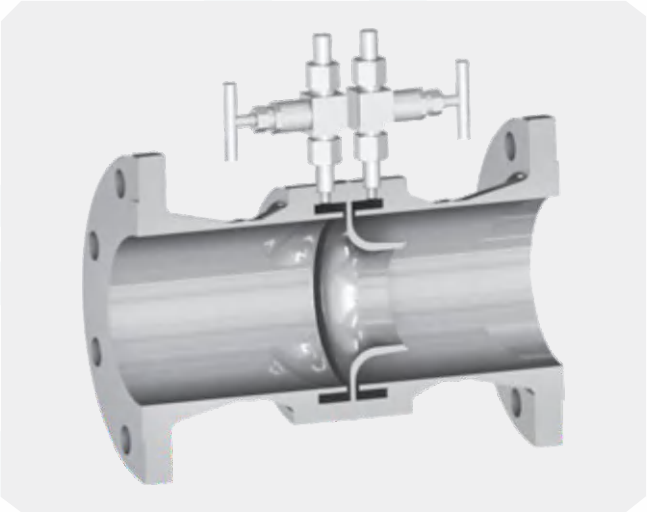
Specification parameters

Suitable for clean, dirty, and abrasive fluids, suitable for measuring gases and vapors
Applicable to measurement of Superheated steam
Available in various material grades
Excellent long-term measurement accuracy
The measured flow rate is higher than the same At least 55% of the lower orifice plate

ISA 1932 nozzle

The ISA 1932 nozzle has a smooth curved inlet leading to the throat of the outlet.

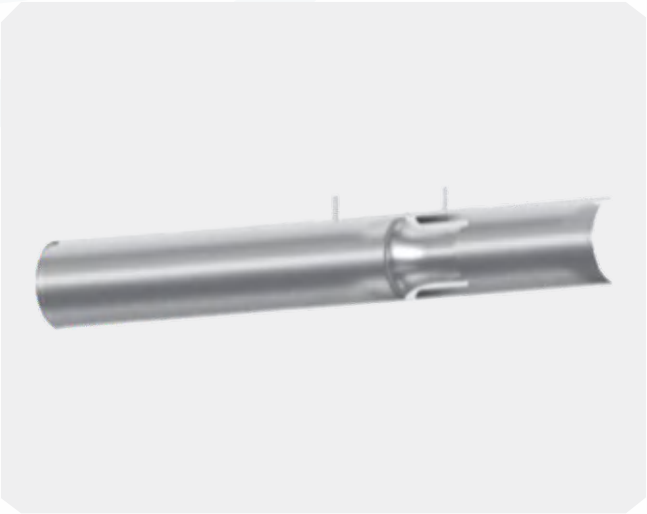
Nominal diameter	DN25-DN600 (1"-24")
working pressure	PN10-PN100
	Class150-Class900
	Higher pressure requires special design
maximum temperature	+600°C
Uncertainty	0.8-1.2%
Repeatability	Welding connection
line type	Carbon steel: SA105, 20#
Material of flange or pipeline	Stainless steel: 304, 316, 316L, etc
	Special materials require special design
Orifice plate material	304, 316, 316L, etc



Long diameter nozzle

The long diameter nozzle is manufactured according to ISO5167/GBT2624. High β Value nozzle (0.25 ≤ β≤ 0.8) and low β Value nozzle (0.20 ≤ β≤ 0.5) Two types. The long diameter nozzle has a smooth elliptical inlet that transitions to a sharp throat outlet. The long diameter nozzle is fixed between the front and rear straight pipe sections through welding.

Nominal diameter	DN25-DN600 (1"-24")
Working pressure	PN10-PN100
	Class150-Class900
	Higher pressure requires special design
Maximum temperature	+600°C
Uncertainty	0.8-1.2%
Repeatability	Welding connection
line type	Carbon steel: SA105, 20#
Material of flange or pipeline	Stainless steel: 304, 316, 316L, etc
	Special materials require special design
Orifice plate material	304, 316, 316L, etc

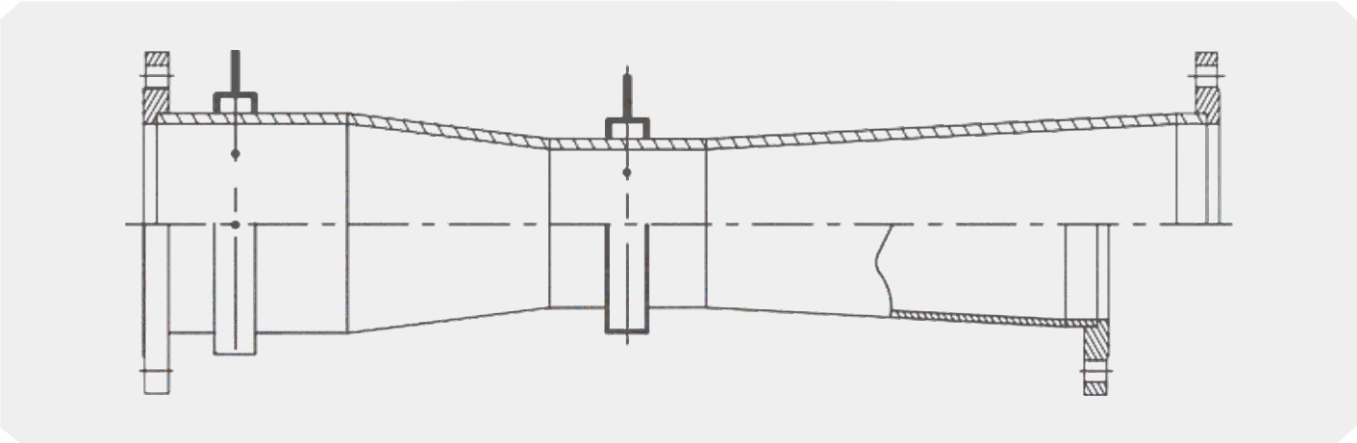


Venturi

The classical Venturi tube has high accuracy and very low pressure loss in flow measurement. Venturi tubes have high strength, long service life, and minimal maintenance workload.The Venturi tube has a conical inlet that contracts backwards, followed by a parallel cylindrical throat and a conical diffuser outlet. It measures the flow rate by integrating the pressure tap on the equalizing ring chamber.Venturi has low requirements for straight pipe sections, and process connections can be flange or welded.

Highlights

Suitable for measuring clean, dirty, or abrasive fluids
Multiple pressure levels available
With long-term measurement accuracy
Process connections are flange or welded connections



Venturi

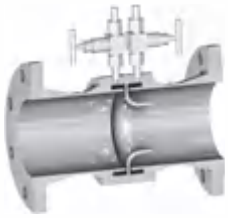
Nominal diameter	DN25-DN600 (1"-24")
Working pressure	PN10-PN160
	Class150-Class900
	Higher pressures require special design
Maximum temperature	+400°C
Uncertainty	3%
Repeatability	Welded joint
line type	Carbon steel: SA105, 20#
Material of flange or pipeline	Stainless steel :304, 316 and 316L, etc
	Special materials require special design
Material of Venturi tube	Carbon steel: SA105, 20#
	Stainless steel :304, 316 and 316L, etc

Product type

Type	FO70-F	FO70-H	FO70-Z
			
	Flange pressure hole plate	**Ring chamber pressure hole plate**	**With front and rear straight pipe segment orifice plate**
Medium	Gases, liquids and vapors	Gases, liquids and vapors	Gases, liquids and vapors
Design criteria	EN ISO 5167: 2003; GBT-2624-2006	EN ISO 5167: 2003; GBT-2624-2006	EN ISO 5167: 2003; GBT-2624-2006
Uncertainty/accuracy	Outflow coefficient uncertainty: ±0.5....0.8%	Outflow coefficient uncertainty: ±0.5....0.8%	Outflow coefficient uncertainty: ±0.5....0.8%
Range ratio	6:1	6:1 (12:1)	6:1 (12:1)
Pressure range	PN16-PN160 Class150- Class900 Higher pressures require special design	PN16-PN40 Class150- Class300 Higher pressures require special design	PN16-PN100 Class150- Class600 Higher pressures require special design
Maximum temperature	+600°C	+400℃	+400℃
Pipe size	DN25-DN2000（1"-80"）	DN25-DN600（1"-24"）	DN15-DN100（1/2"-4"）
Throttle element material	304、316and316L	304、316and316L	304、316and316L
Contact medium part flange or pipe material	Carbon steel: SA105, 20# Stainless steel: 304, 316 and 316L, etc Special materials require special design	Carbon steel: SA105, 20# Stainless steel: 304, 316 and 316L, etc Special materials require special design	Carbon steel: SA105, 20# Stainless steel: 304, 316 and 316L, etc Special materials require special design

Orifice Plate, Nozzle, Venturi Flow Meter

Product type

Type	FO70-P	FO70-C	FO70-W
			
	ISA1932 nozzle	Long diameter nozzle	A venturi tube
medium	Gases, liquids and vapors	Gases, liquids and vapors	Gases, liquids and vapors
Design criteria	EN ISO 5167: 2003; GBT-2624-2006	EN ISO 5167: 2003; GBT-2624-2006	EN ISO 5167: 2003; GBT-2624-2006
Uncertainty/accuracy	Outflow coefficient uncertainty: ±0.8....1.2%	Outflow coefficient uncertainty: ±2%	Outflow coefficient uncertainty: ±3%
Range ratio	6:1	6:1	6:1
Pressure range	PN16-PN160 Class150- Class900 Higher pressures require special design	PN16-PN160 Class150- Class2500 Higher pressures require special design	PN16-PN160 Class150- Class900 Higher pressures require special design
Maximum temperature	+600°C	+400℃	+400℃
Pipe size	DN25-DN600（1"-24"）	DN50-DN600（2"-24"）	DN25-DN600（1"-24"）
Throttle element material	304、316及316L	304、316及316L	304、316及316L
Contact medium part flange or pipe material	Carbon steel: SA105, 20# Stainless steel: 304, 316 and 316L, etc Special materials require special design	Carbon steel: SA105, 20# Stainless steel: 304, 316 and 316L, etc Special materials require special design	Carbon steel: SA105, 20# Stainless steel: 304, 316 and 316L, etc Special materials require special design

transmitter

Differential pressure flowmeters are also intelligent with differential pressure transmitters, which occupy the largest share in the entire industrial flow measurement.

Measuring range	1 kPa
	3 kPa
	10 kPa
	50 kPa
	300 kPa
Pressure rating	PN160
precision	＜0.065%
Operating temperature	-40℃ - 85℃

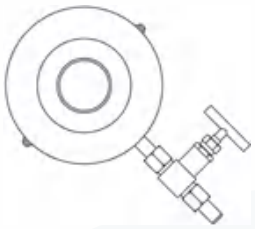
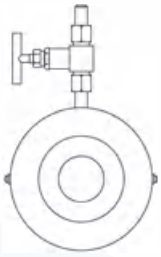
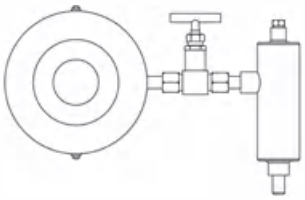
Intelligent 3D calibration enables each differential pressure unit to have a corresponding compensation algorithm. And it will check the accuracy of its compensation many times to ensure its consistency. It is also with the intellectualization of differential pressure transmitters that they occupy the largest share in the entire industrial flow measurement.

Bright spot

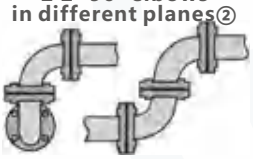
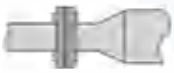
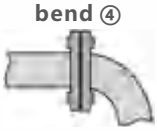
Instantaneous flow display, cumulative flow display (for liquids)
Compact, lightweight design
Rugged overvoltage protection
Multiple languages, Chinese display
Field key operation

High pressure type

In order to better measure the differential pressure signal, different media use different pressure port directions, please know before installation.

	liquid	gas	steam
Pressure tap installation direction			

The differential pressure throttling element is placed between two straight pipe segments under a certain diameter. When the diameter deviation does not exceed 0.4%, the pipe is considered straight. The installation position of the throttle element should meet the requirement that the flow state of the differential pressure throttle element next to the upstream is close to no vortex.
The minimum length of the inlet and outlet straight pipe segments varies with the type and design of the differential pressure throttling element and the type of disturbance. In order to increase the desired accuracy, standards EN ISO 5167 and GBT 2624 describe the requirements for certain inlet and outlet straight pipe lengths. In addition, the straight pipe requirements associated with each application can be obtained in a specific flow calculation for each throttling element.
The inlet or outlet straight pipe segment can be shortened, but the uncertainty of the outflow coefficient is increased by 0.5%.

	Orifice plate				nozzle				The classic Venturi		
	β				β				β		
	0.2	0.4	0.6	0.75	0.2	0.4	0.6	0.8	0.3	0.5	0.75
Single 90°- elbow ① 	6	16	42	44	10	14	18	46	8	9	16
≥ 2 -90° elbows in different planes② 	34	50	65	75	34	36	48	80	8	10	22
Diffused tubes in 1D to 2D lengthsFrom 0.5D to 1D 	6	12	26	36	16	16	22	54	-	-	-
Taper tube/taper tube in 1D lengthThe inside changes from 0.75D to 1 	-	-	-	-	-	-	-	-	2.5	2.5	6.5
The regulator/valve is fully open ③ 	12	12	14	24	12	12	14	30	2.5	3.5	5.5
bend ④ 	4	6	7	8	4	6	7	8	4	4	4

① Suitable for 90° elbow requirements of orifice plates and venturi tubes, excluding T tees.② Hole plate: suitable for two 90° bending on the vertical plane, the vertical distance between each other is less than 5D.③ Only applicable to ball valves or fully open valves; Not applicable to other control valves.Because the length of the outlet part is measured from the negative pressure, the requirements for the back straight section of the venturi tube may be complete or partial. Covered by its own diffused tube.

FO70-Selection and composition

Type selection example **FO70**

F	A	P	U	A	N	X	S	A	K	N	S	Y
1	2	3	4	5	6	7	8	9	10	11	12	13

1.Throttle element type	F		Flange orifice plate
	H		Ring chamber orifice
	Z		Orifice plate with straight pipe section
	P		ISA1932 Nozzle
	C		Long diameter nozzle
	W		A venturi tube
2.Flange specification	A		DN25
	B		DN40
	C		DN50
	D		DN65
	E		DN80
	F		DN100
	G		DN125
	H		DN150
	I		DN200
	J		DN250
	K		DN300
	T( )		Other specifications
3.Flange/pipe material	N		Carbon steel
	O		SA105
	P		304
	Q		316/316L
	T( )		Other materials
4.Sensor material	U		304
	V		316/316L
	T( )		other
5.Pressure rating	A		PN16 (1.6MPa)
	B		PN25 (2.5MPa)
	C		PN40 (4.0MPa)
	D		PN63 (6.3MPa)
	E		PN100 (10.0MPa)
	F		PN160 (16.0MPa)
	G		Class150 (2.0MPa)
	H		Class300 (5.0MPa)
	I		Class600 (11.0MPa)
	J		Class900 (15.0MPa)
6.Connection type	N		Flange connection
	O		Welded joint
	P		Gripper connection
	Q		Insert connection
7.Differential pressure transmitter type	X		SP30-5

FO70-Selection and composition

Type selection example **FO70**

1	2	3	4	5	6	7	8	9	10	11	12	13
F	A	P	U	A	N	X	S	A	K	N	S	Y

8.Explosion-proof type	S	Intrinsic safety
	U	flameproof
	V	Non-explosion proof
9.Product type	A	integrated
	B	split
10.Voltage connection	G	Φ14 looping butt welded stop valve
	H	Φ18 looping butt welded ball valve
	I	Φ23 socket welding stop valve
	J	Φ23 socket welding port
	K	1/2NPT (F)
	L	1/4NPT (F)
11.Pressure interface material	N	304
	O	316/316L
	P	321
12.Number of pressure ports	S	1right
	U	2 right 90°
	W	2 right 180°
13.Condenser pipe	Y	Non-condensing pipe
	Z	Condenser pipe
14.Valve group	A	304 three valve group
	B	316 Three valve groups
	C	304 five valve group
	D	316 Five-valve group
15.Flow direction	G	level
	H	perpendicularity
16.Pressure compensation	N	Pressure compensation
	O	Other user requirements
17.Temperature compensation	P	Temperature compensation
	U	Other user requirements
18.Type of integrator	Z	Integrating instrument
19.Orifice plate selected straight pipe section	A	Front 10 back 5 straight pipe segment
	B	Front 5 back 3 straight pipe segment
	C	Front 3 and back 1 straight pipe segment

Instructions:

It means that FO70 orifice plate, nozzle and venturi flowmeter are flange pressure taking orifice plate (standard orifice plate), flange specification is DN25, flange and pipe material is carbon steel, sensor material is 304 stainless steel, pressure grade PN16 (1.6MPa), flange connection, differential pressure transmitter type is SP30-5, intrinsically safe and explosion-proof, One-piece, pressure inlet 1/2NPT, 304 stainless steel, 1 pair of pressure inlet, no condensing tube, items 14-19 are not required.

Product Certification

Compliance and approval; Rodwig flow meters meet key standards and certifications for process measurement technology;
To ensure the highest reliability in such settings;

CE Ex SIL

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