CHONGQING CHUANYI AUTOMATION CO.,LTD.



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QR code of Chuanyi Flowmeter

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DIFFERENTIALPRESSURE TYPE FLOWMETER

CYAC ACCOMPAIES CUSTOMERSAND CUSTOMERS IN THE HEART OF CYAC

May 2026, First Edition

CHONGQING CHUANYI AUTOMATION CO.,LTD. FLOWMETER BRANCH

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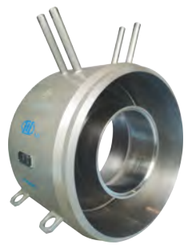
CYAC New Generation DF-type Standard Differential Pressure Flowmeter

Standard differential pressure flowmeters are divided into three types: orifice, nozzle and venturi tube

Structure type	Orifice flowmeter	Nozzle flowmeter	Venturi tube flowmeter
Measuring medium	Gas, steam and liquid		
Measurement diameter	DN50~DN1200 (refer to the quotation for other dimensions)		
Medium temperature	-196℃ ~600℃		
Nominal pressure	(0.25~42) MPa		
Structural advantages	●Simple structure and high adaptability	●High resistance of throttling elements to wear, long-term accuracy and stability, and adaptability to high temperature, high pressure and high flow rate fluids	●High stability and smooth differential pressure ●Low risk of blockage after long-term operation ●Low front and rear straight pipe sections
Pressure tapping mode	Flange, angle joint, D and D/2	Radius, angle joint	Conduit, grading ring
Pressure loss	Relatively great	Moderate	Very small
Product cost	Relatively low	Moderate	Relatively high

Note: D refers to pipe inner diameter







Chapter I
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	Multi-hole orifice (balanced flowmeter)
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
J	Rectangular 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 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 pipe nominal diameter, and the third digit is the number of 0. For example, 150 means DN15, 151 means DN150, and 162 means DN1600. 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 B16.5/1636 (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

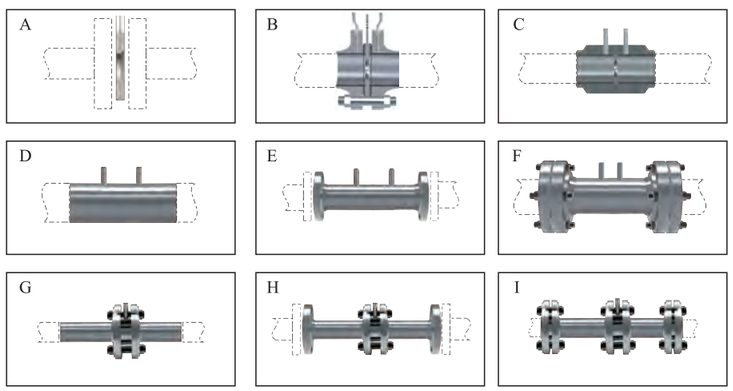
It is directly expressed by three digits. For example, 002 for 0.25 MPa, 006 for 0.6 MPa,
010 for 1.0 MPa, 016 for 1.6 MPa, 025 for 2.5 MPa,
040 for 4.0 MPa, 063 for 6.3 MPa, 100 for 10.0 MPa,
160 for 16.0 MPa, 250 for 25.0 MPa, 320 for 32.0 MPa,
020 for ANSI150, 050 for ANSI300, 110 for ANSI600,
150 for ANSI900, 260 for ANSI1500, 420 for ANSI2500, and
SSS for special

* It is recommended to use welded or tubular device, with a high safety coefficient, for high temperature, high pressure, toxic and harmful media.

Flange types

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

Process connection mode



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	12CrlMoV	5	304L
1	15CrMo	6	321/lCrl8Ni9Ti
2	20#	7	316
3	16Mn/20G/A105	8	316L
4	304	9	Others

Materials of flange and measuring tube

0	12CrlMoV	5	304L
1	15CrMo	6	321/lCrl8Ni9Ti
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;
Note: For conventional valves, the size of DN6 interface is 14 3, and that of DN15 interface is 22 4.

Condenser (optional)

/A With condenser

Integrated structure (optional)

/Y

Real flow calibration (optional)

ZB Calibration certificate of the Company

Real flow calibration (optional)

/C Third-party calibration certificate
Note: The certificate of Chongqing Institute of Metrology and Quality Inspection shall be indicated separately when contracts are delivered in batches.

Oil-free degreasing (optional)

/D

Non-destructive test (optional)

/E

* Remarks:
1. Correct model selection and quotation can be performed only after the brand and model of transmitters and other accessories that can realize proper functions are specified by the customer.
2. Customers can purchase transmitters by themselves, and pay the Company for assembly.
Note: The following parameters shall be provided for the throttling device to select and quote:
Pipe material, outer diameter, 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.

Chapter II
Qualification Certificate for Differential Pressure Flowmeter

1. CNAS Laboratory Accreditation Certificate



中国合格评定国家认可委员会

实验室认可证书

（注册号：CNAS L6467）

兹证明：

重庆川仪自动化股份有限公司流量仪表分公司校准实验室

（法人：重庆川仪自动化股份有限公司）

重庆市北部新区黄山大道中段 61 号川仪工业园，401121

符合 ISO/IEC 17025：2017《检测和校准实验室能力的通用要求》（CNAS-CL01《检测和校准实验室能力认可准则》）的要求，具备承担本证书附件所列服务能力，予以认可。

获认可的能力范围见标有相同认可注册号的证书附件，证书附件是本证书组成部分。

生效日期：2021-09-15

截止日期：2027-09-14

中国合格评定国家认可委员会授权人

中国合格评定国家认可委员会（CNAS）经国家认证认可监督管理委员会（CNCA）授权，负责实施合格评定国家认可制度。CNAS是国际实验室认可合作组织（ILAC）和亚太认可合作组织（APAC）的互认协议成员。

本证书的有效性可登陆www.cnas.org.cn获认可的机构名录查询。

2. Certificate for Qualified Suppliers Issued by China National Nuclear Corporation (CNNC)



中核集团

合格供应商证书

证书编号：CNNC-210091402

重庆川仪自动化股份有限公司

受中核集团委托，依据其合格供应商评价的有关规定，经评审，贵单位具有向中核集团总部及下属单位提供产品（或服务）的资格。

此证书适用于以下产品（或服务）：

1E级仪控系统机柜的设计、制造和服务；1E级阀门驱动装置的设计、制造和服务；工业自动化仪表盘、柜、台、箱系列产品的设计、制造；低压成套开关设备、配电箱、低压无功功率补偿装置的设计、制造；电磁流量计、涡街流量计、差压流量计（文丘里管、楔形、孔板、V 锥）的设计、制造和服务；电动执行机构（含智能型）、电液执行机构的设计开发、生产和服务；宝石轴承（球形刚玉轴承、大通孔宝石轴承、刚玉通孔嵌件轴承）的制造；（未完见续）

注册地址：重庆市北碚区人民村1号

兴原认证中心有限公司

证书专用章（1）

颁证日期：2021年12月03日

有效期至：2024年08月14日[注]

注：在有效期内，供应商每年至少应接受一次监督评审，若监督评审结论合格，资格可顺延一年；若监督评审结论不合格，证书作废。合格供应商证书状态可在www.cnnc.com.cn实时查询。

3. Production License of TS Special Equipment



中华人民共和国
特种设备生产许可证
Production License of Special Equipment
People's Republic of China
（压力管道）

编号：TS2750078-2023

单位名称：重庆川仪自动化股份有限公司流量仪表分公司
住　　所：重庆市北部新区黄山大道中段 61 号
制造地址：
重庆市北部新区黄山大道中段 61 号

经审查，获准从事以下特种设备生产活动：

许可项目	许可子项目	许可参数	备　注
压力管道元件制造	元件组合装置		流量计（壳体）

审批机关：重庆两江新区市场监督管理局　发证机关：
有效期至：2023 年 8 月 21 日　发证日期：2019 年 8 月 [illegible] 日
请于有效期满 6 个月前申请换证

重庆两江新区市场监督管理局

4. EU CE Certificate of Compliance



Certificate – Certificat – Сертификат – 證明書 – Certificado – شهادة – 증명서

Certificate of Compliance

No. 3J200312.CCA0N98

Technical Construction File no. SHH/WL/TCF1.0/MD

Certificate's Holder: Chongqing Chuanyi Automation Co., Ltd. Flowmeter Branch
No. 61 Huangshan Ave, Yubei Distiiet Chongqing, China

Manufacturer: Chongqing Chuanyi Automation Co., Ltd. Flowmeter Branch
No. 61, Middle Section of Huangshan Avenue, New NorthZone, Chongqing, China

Certification ECM Mark: Type Approved

Product: Throttle Device
Model(s): DFKBZ, DFBPH, DFKBF, DFZTZ

Verification to: Standard:
EN 61000-3-2:2014, EN 61000-3-3:2013

related to CE Directive(s):
2014/30/EU (Electromagnetic Compatibility)

Remark: The product(s) has been verified on a voluntary basis. The product(s) satisfies the requirements of the Certification Mark of ECM, in reference to the above listed Standard(s). The above Compliance Mark can be affixed on the product(s) accordingly to the ECM regulation about its release and its use. The regulation can be found at www.entecerma.it. This Certificate of Compliance can be checked for validity at www.entecerma.it
This verification doesn't imply assessment of the production of the product(s).

Additional information, clarification about the CE Marking:
We attest that a TCF for the CE Marking process is in place, Whereas the Manufacturer is Responsible to start the CE *Marking Certification Procedure* and to perform all the necessary activities, as required by the Directive before placing the CE Mark on the product(s).

Date of issue 12 March 2020
Service Manager
Luca Bedeoni

Expiry date 11 March 2025
Deputy Manager
Amanda Payne

Ente Certificazione Macchine Srl
Via Ca' Bella, 243 – Loc. Castello di Serravalle – 40053 Valsamoggia (BO) - ITALY
☎ +39 051 6705141 🖷 +39 051 6705156 ✉ info@entecerma.it 🌍 www.entecerma.it

5. Type Approval Certificate for Measuring Devices







6. Production License for Measuring Devices





7. Metering Certificate for Real Flow Calibration Device









8. Welding Qualification Certificate


Civil nuclear welding qualification


Civil nuclear welding qualification


Civil nuclear welding qualification



FeIV-class welding qualification



FeIII-class welding qualification



FeII-class welding qualification

9. Compulsory Inspection Report









10. Sulfur and Hydrogen Resistance Report

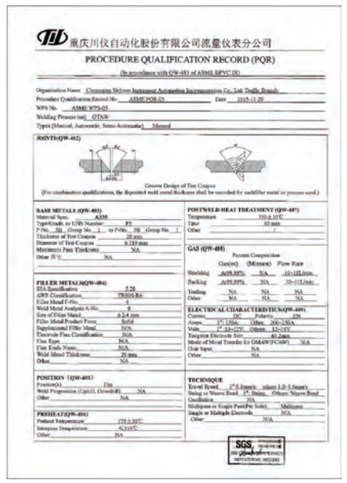




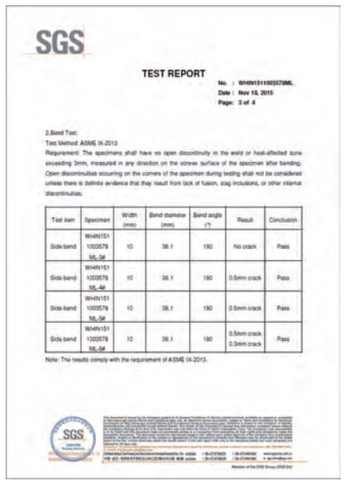




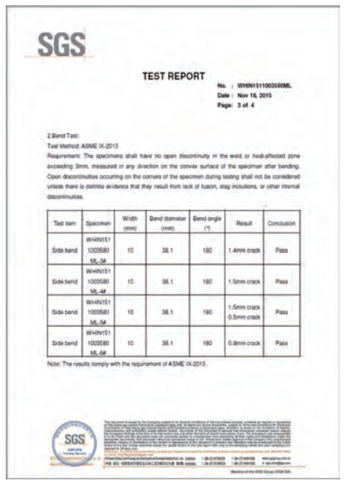
11. Welding Procedure Qualification Certificate


重庆川仪自动化股份有限公司流量仪表分公司

PROCEDURE QUALIFICATION RECORD (PQR)


SGS

TEST REPORT


SGS

TEST REPORT


重庆中宇建设工程质量检测有限公司

金属材料力学性能试验报告


重庆中宇建设工程质量检测有限公司

金属材料力学性能试验报告


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重庆中宇建设工程质量检测有限公司

金属材料力学性能试验报告

Chapter III Differential Pressure Design Standard and Production Standard

1. The standard differential pressure flowmeter is designed and manufactured in strict accordance with the national standard GB/T2624-2006 or the international standard ISO5167, and checked according to the JJG 640-2016 Verification Regulation of Differential Pressure Type Flowmeter.

2. The Company has obtained the certificate for qualified suppliers issued by China National Nuclear Corporation, Production License of TS Special Equipment, EU CE Certificate of Compliance and the Production License for Measuring Devices.

3. Welding personnel of the manufacturer are qualified for pressure vessel and nuclear power grade welding, as well as FeII-class, FeIII-class and FeIV-class welding.

4. 522.6 in national standard GB/T 2624.3-2006 indicates that:

The inner surface roughness of long-radius nozzle: Ra 10-4d;

5.2.6.1 indicates that:

The roughness of long-radius nozzle measuring pipe and upstream pipe: Ra 3.2 10-4D.

5. HG/T 20592~20635-2009 Steel Pipe Flanges, Gaskets and Bolting, and GB/T 9124-2019 Steel Pipe Flanges specify that:

For pipe flanges with nominal pressure greater than or equal to PN100 and greater than or equal to Class 600, the forgings shall be Class III or above; for other pipe flanges, and forgings shall be Class II or above.

6. NB/T47008-2017 Carbon and Alloy Steel Forgings for Pressure Equipment specifies that:

Carbon steel and alloy steel forgings for pressure equipment shall meet the requirements of forgings in the standard. Welded shells shall use forgings of Class III.

7. The national standard - GB/T 5310-2017 Seamless Steel Tubes for High Pressure Boilers specifies that:

Carbon steel and alloy steel pipe materials shall meet requirements of the standard.

8. 2.2 (1) in the TSG 11-2020 Regulation on Safety Technology for Boiler indicates that:

The boiler pressure element and the bearing element welded with the pressure element shall be made of killed steel.

9. NB/T 47013-2015 Nondestructive Testing Requirements for Pressure Equipment specifies that:

For TSG products, the fillet weld shall be subject to a penetration inspection, and qualified at Grade I, and the butt weld shall be subject to a radiographic inspection, with an inspection proportion of 20%, and qualified at Grade II.

10.TS products are designed according to the TSG 11-2020 Regulation on Safety Technology for Boiler and GB/T 16507 Water-tube Boilers, and manufactured according to the GB/T 2624.3-2006 and SJTH [2018] No. 515.

11. The TSG 11-2020 Regulation on Safety Technology for Boiler specifies that:

TS products shall be subject to a penetration inspection, with a proportion of 100%, and be qualified at Grade I;

The NB/T47013-2015 Nondestructive Testing of Pressure Equipment specifies that:

TS products shall be subject to a non-destructive testing according to the requirements in the standard.

12.The manufacturer is provided with a thickness gauge to make sure that the measured pipe thickness meets the requirements of strength calculation and ensure the safety requirements of TS products.

13. Low-temperature alloy steel products shall be preheated before welding, and receive annealing heat treatment after welding, so as to reduce or eliminate the residual stress of welded joints, prevent cracks, and improve the structure and performance of metal in welds and heat affected zones.

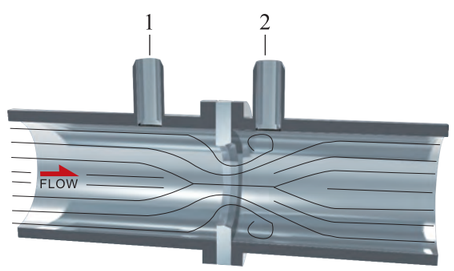
14. The manufacturer is equipped with an alloy analyzer, which can be used for the qualitative analysis on alloy steel materials in the factory, and to recheck the measuring tube, pressure tapping pipe and all welding spots.

15. The Company is equipped with a complete real flow calibration system, which can be used for water and gas calibration in the factory to ensure product accuracy.

Chapter IV
Throttling Device

1. Measurement Principle of Throttling Device

When the fluid filled in the pipeline flows through the throttling devices (orifice, nozzle, etc.) in the pipeline, it will locally contract at the throttling part of the throttling device, 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 devices. The greater the flow rate of the medium, the greater the differential pressure generated ahead of and behind the throttling devices. That is, the fluid flow can be judged by measuring the differential pressure.



Pressure measuring points 1 and 2 are set at appropriate positions ahead of and behind the throttling device. Given the throat diameter of the throttling element is d (mm), the inner diameter of the pipe D (mm), the area of the flow-passing section A, the velocity of the fluid on the flow-passing section v, the position height of the fluid h, the mass flow of the fluid Qm, and the density of the fluid under working conditions ρ (kg/m^3), the velocity and pressure parameters of the fluid on the two pressure measuring 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: $\rho_1 v_1 A_1 = \rho_2 v_2 A_2$

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

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

Where: C - discharge coefficient;
β - diameter ratio of throttling device;
ε - expandability coefficient

It can be seen from the equation that, when the orifice diameter of the throttling element is d and the fluid density ρ is constant, the flow and the static differential pressure Δp are in a square root relationship. The flow can be obtained according to the static differential pressure 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 in the flow-passing section and the energy loss of the fluid flowing through the throttling device, which depends on structure of the throttling device. For this reason, there are domestic and international manufacturing standards for the structure of throttling devices, and the throttling device is divided into two structural forms, i.e. standard and non-standard.

For the standard throttling device, it is assumed that the non-calibrated throttling device is similar to the fully calibrated throttling device in terms of geometry and dynamics. That is, the flowmeter meets all requirements of the standard document (GB/T2624 or IS05167), and its measurement accuracy is within the measurement error specified in the standard. The relationship between mass flow and differential pressure can be determined based on the above flow equation. The conditions for achieving geometric similarity mainly mean that the structural form of throttling device, the pressure tapping device, and the manufacturing and installation of the upstream and downstream straight pipe sections of the throttling

element, etc. fully comply with the standard. The condition for dynamical similarity is equal Reynolds number.

Temperature and pressure compensation

Pressure and temperature are important parameters that affect the accuracy of flow measurement. Temperature and pressure compensation measurement is a method with which the fluid temperature and pressure are measured while the fluid flow is measured by the throttling device, and then the fluid density ρ at temperature T and pressure P is obtained based on the relationship between them, so that the fluid flow can be corrected.

General temperature and pressure compensation formula for throttling device

1. Liquid: In general, temperature and pressure have very small impact on the liquid density, so temperature and pressure compensation is generally not adopted for liquid.

2. Gas: Temperature and pressure changes generally have great impact on the gas density. Therefore, the gas generally needs temperature and pressure compensation.

Temperature and pressure compensation formula for general gas:

$$Q_{compensation} = Q_{measurement} \times \sqrt{\frac{(P_{measurement} + P_{pressure}) \times (T_{design} + 273.15)}{(P_{design} + P_{pressure}) \times (T_{measurement} + 273.15)}}$$

Qcompensation: the flow after temperature and pressure compensation, in the unit as described in the calculation sheet

Qmeasurement: the flow measured according to the flow calculation formula in the calculation sheet, in the unit as described in the calculation sheet

Pmeasurement: the actual pressure value measured on site, in Mpa

Ppressure: the atmospheric pressure of the application area, in Mpa

Pdesign: the design pressure value in the calculation sheet, in Mpa

Tmeasurement: the actual temperature measured on site, in °C

Tdesign: the design temperature value in the calculation sheet, in °C

3. Steam: temperature and pressure compensation is necessary for superheated steam. Only temperature compensation formula or pressure compensation formula is applicable to saturated steam, and pressure compensation is generally adopted.

$$M_{compensation} = M_{measurement} \times \sqrt{\frac{\rho_{Actual}}{\rho_{Design}}}$$

Mcompensation: the flow after temperature and pressure compensation, in Kg/h

Mmeasurement: the flow measured according to the flow calculation formula in the calculation sheet, in Kg/h

ρactual: the density value of steam under on-site working conditions, which is generally found in the data according to the working pressure and working temperature, and can also be estimated by referring to the empirical formula in case of low requirements:

$$\rho_{Actual} = \frac{10.1972 \cdot P_1}{1.256 + 4.71 \cdot 10^{-3} \cdot t - 0.0989 \cdot P_1 + 1.346 \cdot 10^{-4} \cdot P_1 \cdot t}$$

P1: working pressure (absolute pressure) in Mpa

t: working temperature in °C

Remarks: The formula is applicable to a working temperature (t) range of 130~600°C, and absolute pressure (P1) range of 0.3~5MPa

ρdesign: steam density in the calculation sheet, in Kg/m^3

2. Characteristics and Technical Indicators of Throttling Device

2.1 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

2.2 Main technical indicators of throttling device

Throttling devices with the structural form and technical requirements specified in GB/T2624 (or ISO5167) are standard throttling devices, and others are non-standard throttling devices. The accuracy of standard throttling device is still within the

measurement error specified in the standard without receiving the real flow calibration.

1) The uncertainty δc/C in discharge coefficient of the standard orifice is as follows:

The uncertainty is (0.7-β)% when 0.1≤β<0.2

The uncertainty is 0.5% when 0.2≤β≤0.6

The uncertainty is (1.667β-0.5)% when 0.6<β≤0.75

The above values shall be added arithmetically to the following relative uncertainty when D<71.12 mm (2.8 in):

$$0.9(0.75-\beta)\left(2.8-\frac{D}{25.4}\right)\%$$

The above values shall be added arithmetically to the following relative uncertainty when β>0.5 and ReD<10000:

(β refers to the diameter ratio of throttling element)

2) The uncertainty δc/C in discharge coefficient of the standard nozzle is as follows;

The uncertainty is ±0.8% when β≤0.6

The uncertainty is (2β-0 4)% when β>0.6

(β refers to the diameter ratio of throttling element)

3) The uncertainty δc/C in discharge coefficient of the standard venturi is as follows:

Within the specified service limits, the relative uncertainty in discharge coefficient of the clasCYACal venturi tube is equal to:

- 0.7% (for the clasCYAC venturi tube with cast contraction section)
- 1.0% (for the clasCYAC venturi tube with machined contraction section)
- 1.5% (for the clasCYAC venturi tube with rough-welded iron plate contraction section)

Chapter V
Standard Orifice Differential Pressure Flowmeter

1. Measurement Principle of Standard Throttling Elements

The standard throttling element is designed, manufactured and used according to technical specifications such as the international standard ISO5167 and Chinese standard GB/T2624. Standard throttling elements include standard orifice, standard nozzle and standard venturi tube types. The standard orifice type is divided into angle joint pressure tapping type, flange pressure tapping type and radius pressure tapping type. The standard nozzle type is divided into ISA1932 nozzle type and long-radius nozzle type.

When the fluid filled in the pipeline flows through the throttling element (orifice type here), it will contract locally at the orifice, thus increasing the flow rate and reducing the static pressure. Therefore, a pressure drop will occur ahead of and behind the throttling element, i.e. a differential pressure. The greater the flow rate of the medium, the greater the differential pressure generated ahead of and behind the throttling element. Therefore, the fluid flow can be determined by measuring the differential pressure. This measurement method is based on the principles of the flow continuity equation (law of conservation of mass) and the Bernoulli equation (law of conservation of energy).

The flow calculation formula of the orifice is derived from Bernoulli equation and continuity equation, which is as follows:

The calculation formula is as follows:

$$q_m = \frac{C\varepsilon}{\sqrt{1-\beta^4}} \times \frac{\pi}{4} d^2 \sqrt{2\rho_1 \triangle p}$$

Or

$$q_v = \frac{C\varepsilon}{\sqrt{1-\beta^4}} \times \frac{\pi}{4} d^2 \sqrt{\frac{2\triangle p}{\rho_1}}$$

Where:

qm - mass flow (kg/s)

qv - volume flow (m^3/s)

£ - expandability coefficient

ΔP - differential pressure (Pa)

C - discharge coefficient

d - opening diameter of throttling element (m)

β - diameter ratio, β = d/D

D - pipe inner diameter (m)

ρ1 - measured fluid density (kg/m^3)

The discharge coefficient refers to the actual flow through the device versus the theoretical flow determined for an incompressible fluid. It is represented by the following formula:

$$C = \frac{q_m \sqrt{1-\beta^4}}{\frac{\pi}{4} d^2 \sqrt{2\triangle p \rho_1}}$$

Notes: 1. Calibration of a standard primary device with an incompressible fluid (liquid) shows that the discharge coefficient is only related to Reynolds number for a given primary device under a given installation condition.

For different primary devices, the C values are the same as long as the devices are similar in geometry and the Reynolds number of the fluid is the same.

GB/T2624 (all parts) gives equations for calculating C values based on experimentally determined data.

Calibrating flow under suitable laboratory conditions can reduce the uncertainty of C value.

2. The quantity $1/\sqrt{1-\beta^4}$ is called the "asymptotic velocity coefficient" and the product $\frac{1}{\sqrt{1-\beta^4}}$ is called the "flow coefficient".

ε: Expandability coefficient

Considering compressibility coefficient of the fluid:

$$\varepsilon = \frac{q_m \sqrt{1-\beta^4}}{\frac{\pi}{4} d^2 C \sqrt{2\triangle p \rho_1}}$$

Note: Calibration of a given primary device with compressible fluid (gas) indicates that the value below

$$\frac{q_m\sqrt{1-\beta^4}}{\frac{\pi}{4}d^2\sqrt{2\triangle p\rho_1}}$$

depends on the Reynolds number as well as the pressure ratio and isentropic index of the gas.

These variations are expressed by multiplying the expandability (expansion) coefficient ε by discharge coefficient C of the primary device. The discharge coefficient C is determined through direct calibration using liquids with the same Reynolds value.

ε=1 for incompressible fluid (liquid), and ε<1 for compressible fluid (gas).

Experiments show that ε is actually independent of the Reynolds number. ε only depends on the pressure ratio and the isentropic index for a given diameter ratio of a given primary device. Therefore, this method is feasible.

The ε value of orifice given in GB/T2624.2 is based on the experimentally determined data. The ε values of nozzle (see GB/T 2624.3) and venturis tube (see GB/T 2624.4) are based on the general thermodynamic equations applicable to isentropic expansion.

2. Main Characteristics of Orifice

Main advantages of orifice

It complies with the international standard IS05167 and national standard GB/T2624. Standardization is mainly performed to determine the relationship between differential pressure and flow without real flow calibration, and calculate the measurement error accurately with special software according to relevant experimental data results in the standard.

Note: A large number of calibration experiments, distribution range and quality are sufficient to make sure that relevant application systems can be based on the calibration experiment results and coefficients with certain predictable uncertainty limits (extracted from GB/T2624).

• Be suitable for media such as liquid, gas and steam;

• Be applicable to various working conditions such as high temperature, high pressure and ultra-low temperature.

• Have international standards and national standards to follow, a long history, and the most practical application experience.

• Do not have moving part, and have simple structure, stability and reliability;

• Low cost, and be easy to install and maintain.

Main disadvantages of orifice

1. High requirements for on-site installation, and long front and rear straight pipe sections

2. Great pressure loss.

3. The orifice throttling knife edge is easy to wear after long-term use, which affects the accuracy.

3. Basic Structure of Orifice

The orifice mainly has three pressure tapping modes: flange, radius (D and D/2) and angle joint. The typical structure is as follows. For flange pressure tapping, axial lines of the pressure tapping holes on the upstream and downstream sides of the throttling elements are located 25.4 mm from the front and rear end faces of the throttling elements respectively.

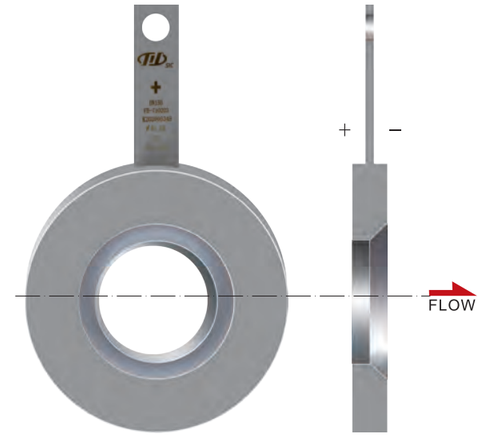
For radius pressure tapping (D and D/2), centerlines of the pressure tapping holes on the upstream and downstream sides of the throttling element are located 1D and 1/2D from the inlet end face respectively.

Angle joint pressure tapping is performed by drilling or in the annular chamber. For the orifice, the pressure tapping holes on the upstream and downstream sides of the throttling element shall be flush with the front and rear end faces of the throttling element.

Standard orifice

(I) Structure of throttling element

The structure of standard orifice is shown in the figure.



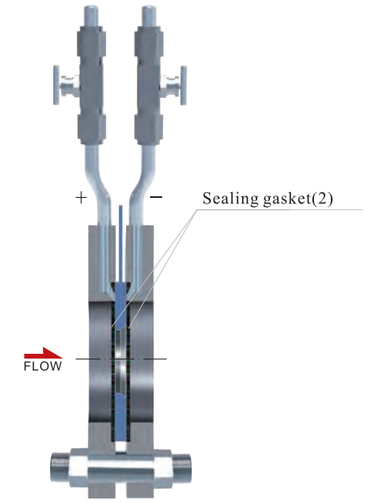
Flange pressure tapping	Angle joint pressure tapping	D and D/2 pressure tapping
d≥12.5		
50mm≤D≤1000mm		
0.1≤ β ≤0.75		
ReD≥5000and ReD≥170β² D	0.1≤β≤0.56 ReD>5000 β>0.56 ReD>16000β²	

Notes: 1. Angle joint pressure tapping includes pressure tapping by drilling and pressure tapping in annular chamber

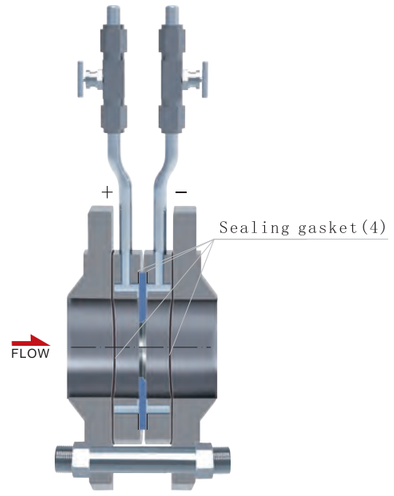
2. d refers to the opening diameter, and D refers to the pipe inner diameter (in mm)

The flow throttling device consists of throttling elements, pressure tapping devices (including pressure tap, impulse pipe and valve), companion flanges and short process pipes.

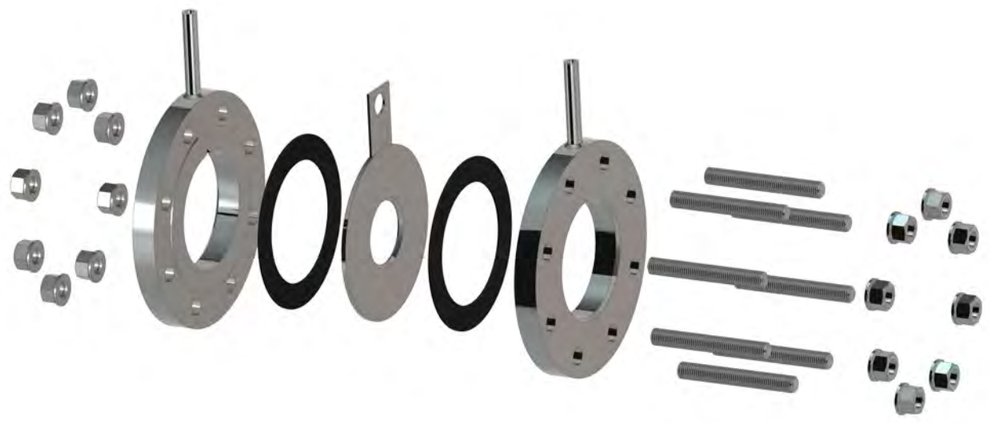
1. Common angle joint pressure tapping orifice (pressure tapping by drilling, pressure tapping in annular chamber)



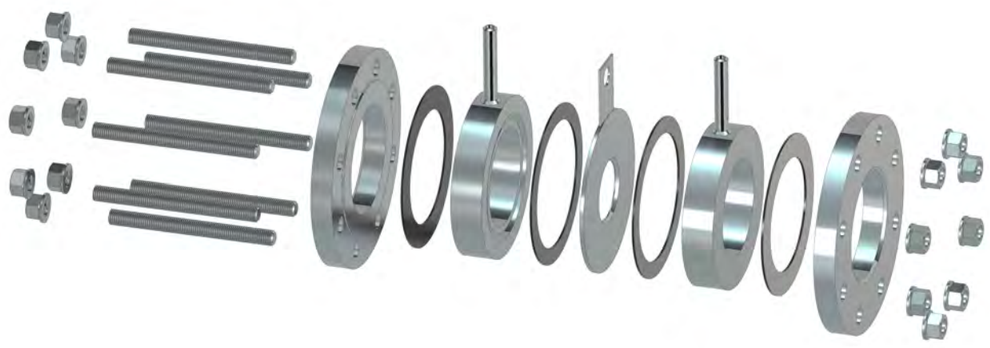
Drilling pressure tapping orifice



Annular chamber pressure tapping orifice

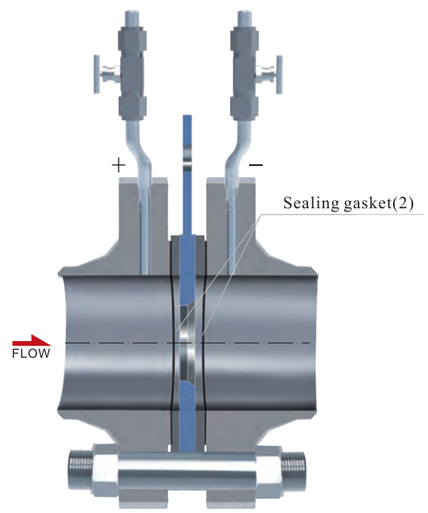


Exploded View of Drilling Pressure Tapping Orifice

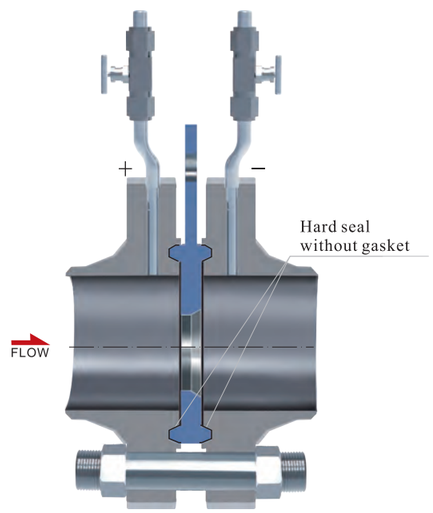


Exploded View of Annular Chamber Pressure Tapping Orifice

2. Common flange pressure tapping orifice assembly (with a pressure ≤ 42.0 MPa, diameter ≤ DN600, and the maximum size of non-standard orifice of DN4000)



RF flange pressure tapping orifice with flat sealing surface



RJ flange pressure tapping orifice wit h trapezoidal sealing surface

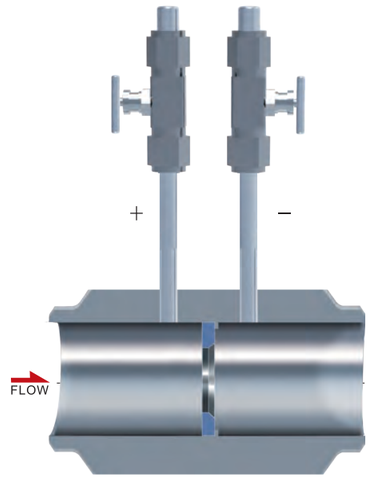


Exploded View of RF Flange Pressure Tapping Orifice with Flat Sealing Face



Exploded View of RJ Flange Pressure Tapping Orifice with Trapezoidal Sealing Surface

3. Welded orifice (with a pressure ≤ 42.0 MPa, and diameter of DN25~DN800)



Welded orifice

Scope of application

The orifice can be used to measure single-phase fluids such as gas, liquid and steam. The fluid runs at a subsonic speed in the measurement section, and meets the following conditions:

The orifice is generally used to measure the unidirectional flow, but can also be used to measure bidirectional flow when the following conditions are met:

• The orifice shall not be beveled.

• Each end face of the orifice shall comply with the provisions on upstream face in 5.1.3 of GB/T2624.

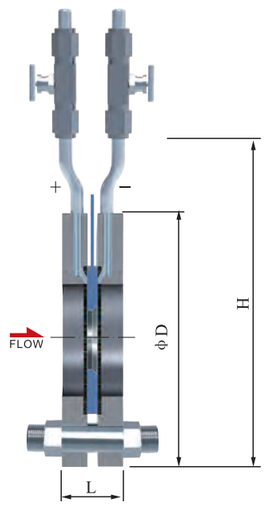
• The orifice thickness E shall be equal to the orifice thickness e specified in 5.1.5 of GB/T2624, so it may be necessary to limit the differential pressure to prevent orifice deformation (see 5.123).

• Two edges of the orifice shall comply with the provisions on upstream edge in 5.1.7 of GB/T2624.

Note: For orifice with radius pressure tapping mode (D and D/2), upstream and downstream pressure tapping devices (i.e. two sets) shall be provided according to different flow directions.

Note: DN25~DN50 shells and orifice are integrated, and are forged integrally with the same material.

4. Installation Dimension of RF Drilling Pressure Tapping Orifice

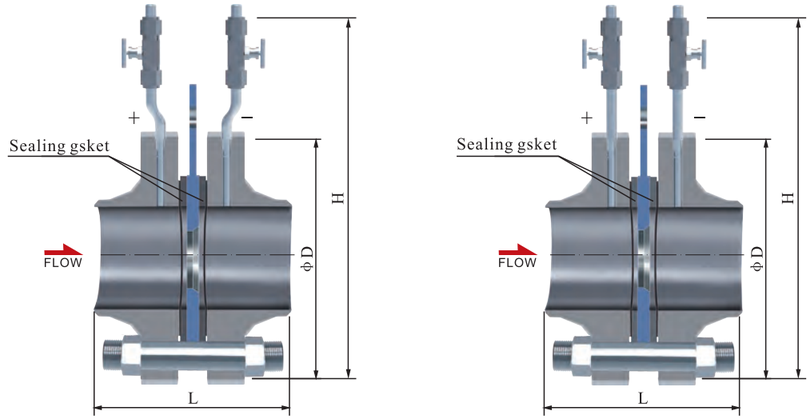


Installation Dimension of RF Drilling Pressure Tapping Orifice

Pressure grade	1.0MPa				1.6MPa			
Nominal diameter /DN	L/mm	D/mm	H/mm	Reference weight/kg	L/mm	D/mm	H/mm	Reference weight/kg
DN50	60	165	345	10.0	60	165	345	10. 0
DN65	60	185	365	11.0	60	185	365	11. 0
DN80	60	200	380	13.5	60	200	380	13. 5
DN100	60	220	400	14.0	60	220	400	14. 0
DN125	60	250	430	16.5	60	250	430	16. 5
DN150	60	285	465	20.5	60	285	465	20. 5
DN200	60	340	520	27.5	60	340	520	27. 5
DN250	60	395	575	35.5	65	405	585	42. 0
DN300	65	445	625	41.0	75	460	640	56. 5
DN350	75	505	685	59.5	85	520	700	79. 5
DN400	80	565	745	80.5	90	510	690	102. 0
DN450	85	615	795	97.0	100	640	820	129. 0
DN500	90	670	850	114.0	110	715	895	176. 5
DN600	100	780	960	161.0	130	840	1020	256. 0

Pressure grade	2.5MPa				4.0MPa			
Nominal diameter /DN	L/mm	D/mm	H/mm	Reference weight/kg	L/mm	D/mm	H/mm	Reference weight/kg
DN50	60	165	345	10. 0	60	165	345	10. 0
DN65	60	185	365	11. 0	60	185	365	11. 0
DN80	60	200	380	13.5	60	200	380	13. 5
DN100	60	235	415	18.0	60	235	415	17. 5
DN125	65	270	450	24.5	65	270	450	22. 5
DN150	70	300	480	31.0	70	300	480	35. 0
DN200	75	360	540	42.5	85	375	555	53. 5
DN250	80	425	605	58.0	95	450	630	82. 0
DN300	90	485	665	78.5	115	515	695	115. 0
DN350	100	555	735	116.5	130	580	760	166. 5
DN400	110	620	800	150.5	150	660	840	232. 0
DN450	125	670	850	179.0	150	685	865	248. 5
DN500	130	730	910	224.5	160	755	935	320. 5
DN600	155	845	1025	338.0	185	890	1070	505. 5

5. Installation Dimension of RF Flange Pressure Tapping Orifice



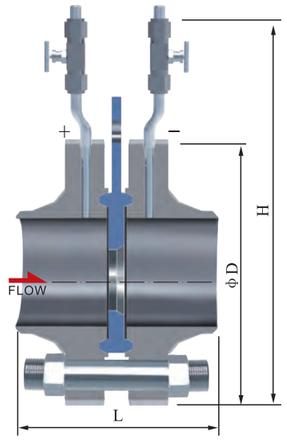
Pressure grade	1.0MPa				1.6MPa				2.5MPa			
Nominal diameter /DN	L/mm	D/mm	H/mm	Reference weight/kg	L/mm	D/mm	H/mm	Reference weight/kg	L/mm	D/mm	H/mm	Reference weight/kg
25	130	115	295	7.4	130	115	295	8.0	130	115	295	8.0
32	134	140	320	10.3	134	140	320	10.5	134	140	320	10.5
40	140	150	330	11.7	140	150	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	220	400	21.0	150	220	400	21.3	168	235	415	25.6
125	152	250	430	25.2	152	250	430	25.6	170	270	450	33.0
150	152	285	465	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	130.2	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	200.0	206	840	1020	308.0	266	845	1025	361.5

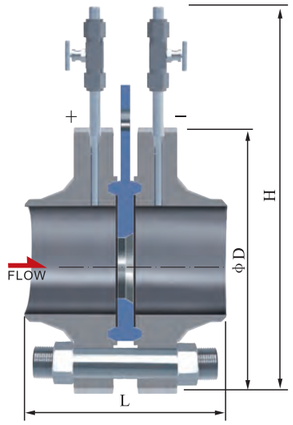
Pressure grade	4.0MPa				6.3MPa				10.0MPa			
Nominal diameter /DN	L/mm	D/mm	H/mm	Reference weight/kg	L/mm	D/mm	H/mm	Reference weight/kg	L/mm	D/mm	H/mm	Reference weight/kg
25	130	115	295	8.0	153	140	320	12.5	153	140	320	12.5
32	134	140	320	10.5	157	155	335	14.3	157	155	335	14.4
40	140	150	330	11.7	158	170	350	15.4	158	170	350	15.4
50	142	165	345	13.6	158	180	360	16.8	166	195	375	20.5
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	190.0
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/mm	D/mm	H/mm	Reference weight/kg	L/mm	D/mm	H/mm	Reference weight/kg	L/mm	D/mm	H/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	20.0	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	50.2	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	70.7	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	160.5	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	310.3	354	915	1095	593.0	436	940	1120	1608.3

Note: The above dimensions are for reference only.

6. Installation Dimension of RJ Flange Pressure Tapping Orifice





Pressure grade	6.3MPa				10.0MPa				16.0MPa			
Nominal diameter /DN	L/mm	D/mm	H/mm	Reference weight/kg	L/mm	D/mm	H/mm	Reference weight/kg	L/mm	D/mm	H/mm	Reference weight/kg
25	153	140	320	12.5	153	140	320	12.5	153.0	140.0	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	170.0	350	15.4
50	174	180	360	17.1	182	195	375	20.8	182.0	195.0	375	20.8
65	186	205	385	22.5	194	220	400	27.4	194.0	220.0	400	27.4
80	190	215	395	23,9	194	230	410	28.8	194.0	230.0	410	28.8
100	198	250	430	32.0	210	265	445	38.2	210.0	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	430.0	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	370.0	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/mm	D/mm	H/mm	Reference weight/kg	L/mm	D/mm	H/mm	Reference weight/kg	L/mm	D/mm	H/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	20.4	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	40.3	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	71.3	260	445	625	110.7	330	510	690	217.4
300	256	485	665	106.2	288	520	700	160.8	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	160.2	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	378.0	915.0	955	596.3	436	940	1120	1111.2

Pressure grade	ANSI900				ANSI1500				ANSI2500			
Nominal diameter /DN	L/mm	D/mm	H/mm	Reference weight/kg	L/mm	D/mm	H/mm	Reference weight/kg	L/mm	D/mm	H/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.

7. Installation requirements

The fluid flows from upstream face to downstream face of the orifice. The orifice and the pipe must be concentric (or centered in the annular chamber), and the eccentric distance CX (the distance between the centerline of throttling element and the centerline of upstream and downstream pipes) shall not be greater than 0.0025D/ (0.1+2.304) or 0.015D (1/β-1).

The pipeline in the measurement section must be filled with fluid.

If a regulating valve must be installed, it is recommended to install it behind the downstream 5D straight pipe section.

If an isolation valve must be installed upstream of the throttling element, the valve shall be a gate valve and must be fully open.

Packing and sealing rings shall be manufactured and installed so that they do not protrude into the inner cavity of pipe or obstruct the pressure tapping hole or groove at any point.

The packing (if any) between the throttling element or the annular chamber shall be as thin as possible and shall not protrude into the annular chamber cavity.

Throttling elements shall be embedded between two straight pipe sections with uniform cross section. The requirements for minimum straight pipe section length on the upstream and downstream sides of orifice are shown in the following table:

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

Values expressed in multiples of the pipe inner diameter DGB/T2624.2-2006/IS05167-2:2003

Diameterratio β	Upstream (inlet) of orifice plate																				Downstream (outlet) of orifice plate	
	Two 90° elbows on any plane of a single 90° elbow (S>30D)[a]		Two 90° elbows on the same plane: S-shaped structure (30D≥S>10D)[a]		Two 90° elbows on the same plane: S-shaped structure (10D≥S)[a]		Two 90° elbows on mutually perpendicular planes (30D≥S≥5D)[a]		Two 90° elbows on mutually perpendicular planes (5D>S)[ab]		Two 90° miter elbow of single 90° tee with or without extension		Two 45° elbows on the same plane of a single 45° elbow (S≥2D)[a]		Concentric reducing pipe (changed from 2D to D within the length of 1.5D~3D)		Concentric diverging pipe (changed from 0.5D 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] ≤0.03D[d]		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[f]	A[e]	B[f]	A[e]	B[f]	A[e]	B[f]	A[e]	B[f]	A[e]	B[f]	A[e]	B[f]	A[e]	B[f]	A[e]	B[f]	A[e]	B[f]	A[e]	B[f]	A[e]	B[f]	A[e]	B[f]
≤0.20	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
0.40	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
0.50	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
0.60	42	13	30	18	42	18	44	18	65	25	29	18	30	18	9	5	26	11	14	7	30	15	5	3	7	3.5
0.67	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
0.75	44	20	44	18	44	20	44	20	75	18	44	18	44	18	13	8	36	18	24	12	30	15	5	3	8	4

Notes: 1. The shortest straight pipe section required is the straight pipe section between various pipe fittings upstream or downstream of the orifice and the orifice. 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.
2. The radius of curvature of most elbows on which the straight pipe section 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 0.03D~0.13D can be installed. However, this installation is not recommended.
e Column A for each type of pipe fitting gives a straight pipe section with a diameter corresponding to "zero additional uncertainty".
f Column B for each type of pipe fitting gives a straight pipe section with a diameter corresponding to "0.5% 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 If S<2D, 95D is required for ReD>2×10⁶.

Chapter VI
Nozzle Differential Pressure Flowmeter

1. Measurement Principle of Nozzle

The measurement principle of nozzle is based on the throttling principle of hydromechanics. When the fluid filled in the pipeline flows through the nozzle in the pipeline, it will contract locally in the nozzle, thus increasing the flow rate and reducing the static pressure. Therefore, a pressure drop or differential pressure will occur ahead of and behind the nozzle. The greater the medium flow, the greater the differential pressure generated ahead of and behind the nozzle. Therefore, the fluid flow can be determined by measuring the differential pressure.

The nozzle is of an arc-shaped profile structure, therefore, its pressure loss is small, the straight pipe section required is short and the precision is high.

Flow calculation formula:

$$q_m = \frac{C\varepsilon}{\sqrt{1-\beta^4}} \times \frac{\pi}{4} d^2 \sqrt{2\rho_1 \triangle p}$$

Or

$$q_v = \frac{C\varepsilon}{\sqrt{1-\beta^4}} \times \frac{\pi}{4} d^2 \sqrt{\frac{2\triangle p}{\rho_1}}$$

Where:
qm - mass flow (kg/s)
qv - volume flow (m^3/s)
ε - expandability coefficient
△P - differential pressure (Pa)
C - discharge coefficient
d - opening diameter of throttling element (m)
β - diameter ratio, β = d/D;
D - pipe inner diameter (m)
ρ1 - measured fluid density (kg/m^3)

2. Characteristics of Nozzle

The standard nozzle flowmeter is characterized by high temperature and high pressure resistance, impact resistance, long service life, large measuring range and high measurement accuracy. It is suitable for the measurement of high-speed fluid flow in high-temperature and high-pressure steam heating network pipelines of power plants.

The standard nozzle is designed and manufactured according to the national standard GB/T2624-2006 (or ISO5167) and verified according to JJG640-2016. Standardization is mainly performed to determine the relationship between differential pressure and flow without real flow calibration, and estimate the measurement error accurately with special software.

- Simple structure and convenient installation.
- Smaller loss than that of orifice, and shorter straight pipe section required.
- Resistance to high temperature, high pressure and impact.
- High corrosion resistance and long service life.
- High precision, good repeatability and stable discharge coefficient.
- Adoption of integral forging (without welding) and integral numerical control processing technology with high cost.

3. Structural Form of Nozzle

The standard nozzle consists of an inlet plane perpendicular to the axis, an arc-shaped curved surface, an inlet contraction part formed, a cylindrical throat and a protective groove required to prevent edge damage. It adopts the angle joint pressure tapping mode at the upstream and the downstream, or at a far downstream.

Product classification: annular chamber nozzle, welded nozzle and long-radius nozzle.

3.1 Nozzle (ISA1932)

(I) Structure of throttling element

The nozzle structure is shown in the following figure.

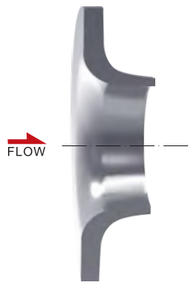
(II) Scope of application

50mm≤D≤500mm

0.3≤β≤0.8

70000 ≤ ReD ≤ 107 when 0.30 ≤ β < 0.44

20000 ≤ ReD ≤ 107 when 0.44 ≤ β < 0.80



Nozzle Structure

3.2 Annular chamber pressure tapping nozzleassembly

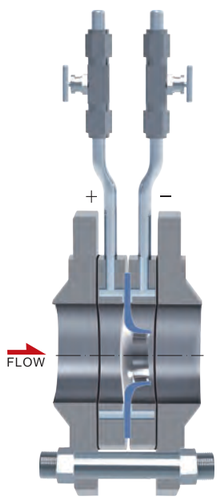
(I) Product structure

The structure of annular chamber pressure tapping nozzle is shown in the following figure.

(II) Scope of application

Pressure ≤ 10.0 MPa

Diameter of DN40~DN600



3.3 Welded nozzle assembly

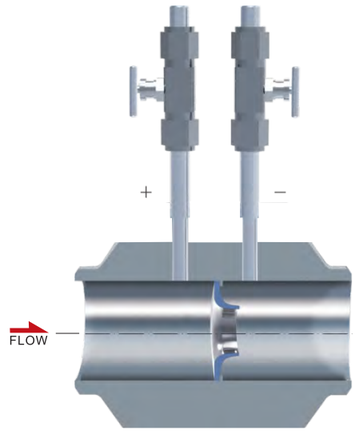
(I) Shell structure

The structure of welded nozzle is shown in the following figure.

(II) Scope of application

Pressure ≤ 42.0 MPa

Diameter of DN65~DN1500



Welded nozzle

3.4 Long-radius nozzle

(I) Structure of throttling element

The structure of long-radius nozzle is shown in the following figure.

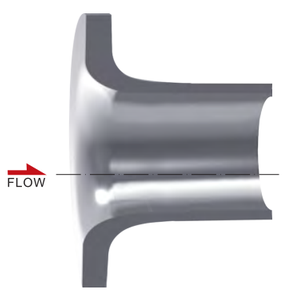
(II) Scope of application

Diameter of DN25~DN600

0.2≤β≤0.8

10^4≤ReD≤10^7

Note: For special diameter, please refer to the quotation for selection.



Structure of Long-radius Nozzle

3.5. Radius pressure tapping long-radius nozzle assembly

(I) Shell structure

The radius pressure tapping long-radius nozzle consists of an inlet contraction part, a cylindrical throat and a downstream end plane, and it adopts the D-D/2 radius pressure tapping mode.

There are two types of long-radius nozzles:

High ratio nozzle 0.25≤β≤0.8

Low ratio nozzle 0.25≤β≤0.5

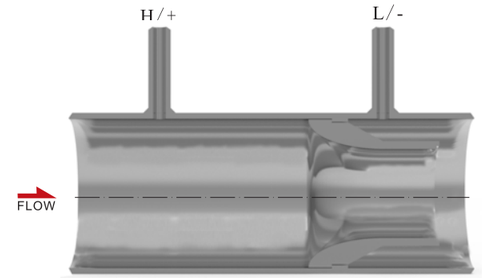
Any type of long-radius nozzle can be adopted if the value of β is between 0.25 and 0.5.

(II) Advantages of long-radius nozzle

The long-radius nozzle is mainly used for main steam, main feed water or desuperheating water in the power industry or high-temperature and high-pressure sites. It is characterized by wide range ratio, impact resistance, small pressure loss, long service life, large measuring range and high measurement accuracy.

It is designed and manufactured according to the national standard GB/T2624-2006 (or ISO5167);

and verified according to JJG640-2016, without real flow calibration.



*1. In order to ensure the measurement accuracy, the inner wall of measuring pipe of the long-radius nozzle is processed by special equipment.

*2. In order to ensure the product safety, the long-radius nozzle measuring pipe and the positioning ring shall be integrally processed and formed, without circumferential welds.

*3. The roughness of inner hole shall meet the national standard GB/T2624.3-2006.

4. Precautions for Installation

The installation shall ensure that the pipe is filled with liquid.

The impulse pipeline shall be installed according to the standard, with positive and negative pressure tapping points at the same level to prevent errors.

It shall be avoided from high-concentration corrosive gases in the surrounding environment as much as possible.

The nozzle flowmeter shall be installed to avoid negative pressure in the measuring pipe as much as possible.

The nozzle flowmeter shall be installed in a place with small vibration, especially for integrated instruments.

The nozzle flowmeter shall be installed downstream of the section where the reaction is fully completed during the measurement of chemical reaction pipeline.

The nozzle flowmeter shall be installed without large motors, large transmitters, etc. nearby to avoid interference with the nozzle field.

Straight Pipe Sections Required by Nozzle and Venturi Nozzle

Values expressed in multiples of the pipe inner diameter D

Diameter ratio β	Upstream (Inlet) Side of Primary Device																				Downstream (Outlet) Side of Primary Device	
	Single 90° elbow or tee (flowing from one branch only)		Two or more 90° elbows on the same plane		Two or more 90° elbows on different planes		Reducing pipe (changed from 2D to D within the length of 1.5D~3D)		Diverging pipe (changed from 0.5D to D within the length of D~2D)		Spherical valve fully open		Full-hole ball valve or gate valve fully open		Sudden symmetrical contraction		Thermometer pocket or thermowell with diameter ≤ 0.03D		Thermometer pocket or thermowell with diameter of 0.03D~0.13D		Various pipe fittings (columns 2 to 8)	
1	2		3		4		5		6		7		8		9		10		11		12	
	A [c]	B [d]	A [c]	B [d]	A [c]	B [d]	A [c]	B [d]	A [c]	B [d]	A [c]	B [d]	A [c]	B [d]	A [c]	B [d]	A [c]	B [d]	A [c]	B [d]	A [c]	B [d]
0. 20	10	6	14	7	34	17	5	e	16	8	18	9	12	6	30	15	5	3	20	10	4	2
0. 25	10	6	14	7	34	17	5	e	16	8	18	9	12	6	30	15	5	3	20	10	4	2
0. 30	10	6	16	8	34	17	5	e	16	8	18	9	12	6	30	15	5	3	20	10	5	2. 5
0. 35	12	6	16	8	36	18	5	e	16	8	18	9	12	6	30	15	5	3	20	10	5	2. 5
0. 40	14	7	18	9	36	18	5	e	16	8	20	10	12	6	30	15	5	3	20	10	6	3
0. 45	14	7	18	9	38	19	5	e	17	9	20	10	12	6	30	15	5	3	20	10	6	3
0. 50	14	7	20	10	40	20	6	5	18	9	22	11	12	6	30	15	5	3	20	10	6	3
0. 55	16	8	22	11	44	22	8	5	20	10	24	12	14	7	30	15	5	3	20	10	6	3
0. 60	18	9	26	13	48	24	9	5	22	11	26	13	14	7	30	15	5	3	20	10	7	3. 5
0. 65	22	11	32	16	54	27	11	6	25	13	28	14	16	8	30	15	5	3	20	10	7	3. 5
0. 70	26	14	36	18	62	31	14	7	30	15	32	16	20	10	30	15	5	3	20	10	7	3. 5
0. 75	36	18	42	21	70	35	22	11	38	19	36	18	24	12	30	15	5	3	20	10	8	4
0. 80	46	23	50	25	80	40	30	15	54	27	44	22	30	15	30	15	5	3	20	10	8	4

Notes: 1. The shortest straight pipe section required is the section between the various pipe fittings upstream or downstream of the primary device and the primary device. All straight pipe sections shall be measured from upstream end face of the primary device.
2. The length of these straight pipe sections is not based on the latest data.

a Not all βvalues are permitted for some types of primary devices.
b The thermowell or jack shall be installed without changing the shortest upstream straight pipe section required for other pipe fittings.
c Column A of various pipe fittings gives a value equivalent to "zero additional uncertainty" (6.2.3).
d Column B of various pipe fittings gives a value equivalent to "0.5% additional uncertainty" (6.2.4).
e Zero additional uncertainty is given for the straight pipe section in column A, and there is currently no shorter straight pipe section data available to give the straight pipe section required in column B.

Chapter VII
Standard Venturi Differential Pressure Flowmeter

1. Classic Venturi

Venturi tube is a differential pressure device for flow measurement. Its name comes from the Italian physicist G.B. Venturi who invented it. It consists of an equal-diameter inlet section, a contraction section, an equal-diameter throat and a diffusion section. Its measurement principle is as follows: when the fluid filled in the pipeline flows through the throttling element in the pipeline, it will contract locally at throat neck of the venturi tube, thus increasing the flow rate and reducing the static pressure, and resulting in a differential pressure ahead of and behind throat neck of the venturi tube. The greater the fluid flow, the greater the differential pressure generated, so that the flow can be determined based on the differential pressure. This measurement method is based on the flow continuity equation (law of conservation of mass) and the Bernoulli equation (law of conservation of energy). It is widely used for the flow measurement of air, natural gas, gas, water, steam and other fluids.

Venturi tube is a throttling flow sensor developed based on Venturi effect and is a standard throttling device. Venturi tubes are divided into standard type and general type according to the structure.

Standard (classic) venturi tubes are divided into the standard venturi tube with rough-cast contraction section, standard venturi tube with machined contraction section, and standard venturi tube with rough-welded iron plate contraction section according to their manufacturing methods.

The standard venturi is designed and manufactured according to the national standard GB/T2624-2006, and verified according to the national standard JJG640-2016.

In addition to advantages such as high accuracy, good repeatability, small pressure loss and short front straight pipe required of the standard venturi tube, the general venturi series flow sensor also has the advantages of small size and anti-blocking performance. It can be used to measure complex flow such as two-way flow, mixed-phase flow, low flow rate, large pipe diameter and special-shaped pipe.

Venturi is divided into standard venturi, general venturi, venturi flow tube, small-diameter venturi, rectangular venturi and other structures according to the manufacturing process and purpose.

The flow calculation formula of venturi is derived from Bernoulli equation and continuity equation, which is as follows:

$$q_m = \frac{C\varepsilon}{\sqrt{1-\beta^4}} \times \frac{\pi}{4} d^2 \sqrt{2\rho_1 \triangle p}$$

Or

$$q_v = \frac{C\varepsilon}{\sqrt{1-\beta^4}} \times \frac{\pi}{4} d^2 \sqrt{\frac{2\triangle p}{\rho_1}}$$

Where:

q_m - mass flow (kg/s)
q_v = volume flow (m^3/s)
ε - expandability coefficient
△P - differential pressure (Pa)
C - discharge coefficient
d - opening diameter of throttling element (m)
β - diameter ratio, β = d/D
D - pipe inner diameter (m)
ρ_1 - measured fluid density (kg/m^3)

C: Discharge coefficient

It is a coefficient that represents the relationship between the actual flow through the device and the theoretical flow, and is determined for an incompressible fluid. It is represented by the following equation:

$$C = \frac{q_m \sqrt{1-\beta^4}}{\frac{\pi}{4} d^2 \sqrt{2\triangle p \rho_1}}$$

Notes: 1. Calibration of a standard primary device with an incompressible fluid (liquid) shows that the discharge coefficient is only related to Reynolds number for a given primary device under a given installation condition.

For different primary devices, the C values are the same as long as the devices are similar in geometry and the Reynolds number of the fluid is the same.

GB/T2624 (all parts) gives equations for calculating C values based on experimentally determined data.

Calibrating flow under suitable laboratory conditions can reduce the uncertainty of C value.

2. The quantity $1\sqrt{1-\beta^4}$ is called the "asymptotic velocity coefficient" and the product is $C\frac{1}{\sqrt{1-\beta^4}}$ called the "flow coefficient".

ε: Expandability coefficient

Considering compressibility coefficient of the fluid:

$$\varepsilon=\frac{q_m\sqrt{1-\beta^4}}{\frac{\pi}{4}d^2C\sqrt{2\triangle p\rho_1}}$$

Note: Calibration of a given primary device with compressible fluid (gas) indicates that the value below

$$\frac{q_m\sqrt{1-\beta^4}}{\frac{\pi}{4}d^2\sqrt{2\triangle p\rho_1}}$$

depends on the Reynolds number as well as the pressure ratio and isentropic index of the gas.

These variations are expressed by multiplying the expandability (expansion) coefficient ε by discharge coefficient C of the primary device. The discharge coefficient C is determined through direct calibration using liquids with the same Reynolds value.

ε=1 for incompressible fluid (liquid), and ε<1 for compressible fluid (gas).

Experiments show that ε is actually independent of the Reynolds number. ε only depends on the pressure ratio and the isentropic index for a given diameter ratio of a given primary device. Therefore, this method is feasible.

The ε value of orifice given in GB/T2624.2 is based on the experimentally determined data. The ε values of nozzle (see GB/T 2624.3) and venturis tube (see GB/T 2624.4) are based on the general thermodynamic equations applicable to isentropic expansion.

2. Characteristics of Venturi Tube

1. The classic venturi tube is designed and manufactured according to ISO5167-2003 and GB/T2624-2006, and does not need to be verified.

2. The front and rear straight pipe sections required by the venturi tube are short, and the shortest part can be 2.5D in front section and 1.5D in rear section.

3. The permanent pressure loss of venturi tube is small. Generally, the pressure loss is only about 1/8 of the differential pressure value. Its pressure loss is the minimum compared with other throttling devices (such as orifice, nozzles, etc.).

4. High stability, smooth differential pressure and high reliability.

5. It is an environment-friendly and energy-saving product with accurate calculation, low energy consumption and great energy saving.

6. It can be used for various dirty media such as liquid, gas, steam and two-phase flow.

7. It is a pure mechanical structure without rotating parts, and with simple structure, easy installation, convenient maintenance and long service life.

Main advantages of venturi tube

• It complies with the international standard ISO5167 and national standard GB/T2624. Standardization is mainly performed to determine the relationship between differential pressure and flow without real flow calibration, and estimate the measurement error accurately.

• It is applicable to liquid, gas, steam and other media, and has greater advantages over other flowmeters in measuring high-temperature and high-pressure fluids;

• There are international standards and national standards to follow, the application history is long, and the practical application experience is the most;

• It has no moving part, but is structurally simple, stable and reliable:

• Among other standard throttling devices, it requires the shortest upstream and downstream straight pipe sections and the minimum permanent pressure loss.

• The calculation is accurate and energy consumption is low.

• It can be used for various dirty media such as liquid, gas, steam and two-phase flow.

• The standard venturi body is longer, which is about 2~5 times the pipe diameter (determined by the ratio of venturi opening diameter).

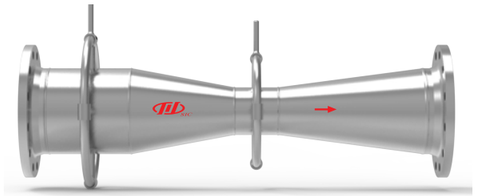
Main disadvantages of venturi tube:

• High manufacturing requirements

• High material and manufacturing costs.

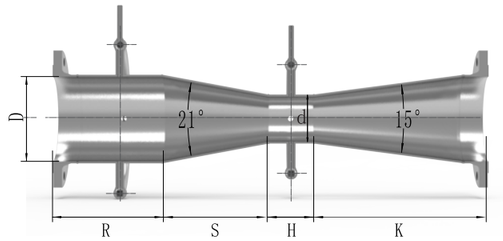
3. Structure of Venturi Tube

The venturi tube generally adopts grading ring for pressure tapping (single or two pressure taps are also used for the measurement of high-pressure medium), with the typical structure shown as follows:



Structure Drawing of Classic Venturi Tube

The length of venturi is calculated by the national standard formula, which has a direct impact on the β value. The following is an example in case of diameter DN100 and different β values.



D (pipe inner diameter)	100. 00	100. 00	100.00	100.00
β （diameter ratio)	0. 40	0. 50	0.60	0.70
d (throat)	40. 00	50. 00	60.00	70.00
R (length of inlet section)	100. 00	100. 00	100.00	100.00
S (length of contraction section)	161. 87	134. 89	107.91	80.93
H (length of throat)	40. 00	50. 00	60.00	70.00
K (length of diffusion section)	227. 87 529. 74	189. 89 474. 78	151.92	113.94
Total length			419.83	364.87

4. Application Scope of Venturi Tube

The venturi tube can be used to measure single-phase fluids such as gas, liquid and steam. The flow runs at a subsonic speed in the measurement section. The venturi tubes are generally divided into three types, i.e. cast type, machined type, and rough-welded iron plate type, based on their manufacturing methods. The application scope of standard venturi tubes is related to the manufacturing method.

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

1. The application scope of venturi tube with rough-cast contraction section is as follows:

100mm≤D≤800mm 0.3≤β≤0.75

$2\times10^5\leq ReD\leq2\times10^6$

2. The application scope of venturi tube with machined contraction section is as follows:

50mm≤D≤250mm 0.4≤β≤0.75

$2\times10^5\leq ReD\leq10^6$

3. The application scope of venturi tube with rough-welded iron plate contraction section is as follows:

20mm≤D≤1200mm 0.4≤β≤0.7

$2\times10^5\leq ReD\leq2\times10^6$

Note: If the above parameters are exceeded, non-standard design can be carried out.

RT will be carried out randomly to ensure product welding quality.

5. Installation Requirements for Venturi Tube

Fluid flows from inlet section to diffusion section of the venturi tube. The venturi tube must be installed coaxially with the pipeline, and the non-concentricity shall be within ±1°.

The pipeline in the measurement section must be filled with fluid.

If a regulating valve must be installed, it is recommended to install it behind the downstream 5D straight pipe section.

If an isolation valve must be installed upstream of the throttling element, the valve shall be a gate valve and must be fully open.

The sealing ring shall not protrude into the inner cavity of pipeline or block the pressure tap or groove.

Throttling elements shall be embedded between two straight pipe sections with uniform cross section. The requirements for minimum straight pipe section length on the upstream and downstream sides of venturi tube are shown in the following table:

Straight Pipe Sections Required by Classic Venturi Tube

Values expressed in multiples of the pipe inner diameter D

Diameter ratio β	Single 90° elbow		Two or more 90° elbows on the same plane or diff erent planes		Reducing pipe (changed from 1.33D to D within the length of 2.3D)		Diverging pipe (changed from 0.67D to D within the length of 2.5D)		Reducing pipe (changed from 3D to D within the length of 3.5D)		Diverging pipe (changed from 0.75 to D within the length of D)		Full-hole ball valve or gate valve fully open	
1	2		3		4		5		6		7		8	
	A[b]	B[c]	A[b]	B[c]	A[b]	B[c]	A[b]	B[c]	A[b]	B[c]	A[b]	B[c]	A[b]	B[c]
0.30	8	3	8	3	4	d	4	d	2.5	d	2.5	d	2.5	d
0.40	8	3	8	3	4	d	4	d	2.5	d	2.5	d	2.5	d
0.50	9	3	10	3	4	d	5	4	5.5	2.5	2.5	d	3.5	2.5
0.60	10	3	10	3	4	d	6	4	8.5	2.5	3.5	2.5	4.5	2.5
0.70	14	3	18	3	4	d	7	5	10.5	2.5	5.5	3.5	5.5	3.5
0.75	16	8	22	8	4	d	7	6	11.5	3.5	6.5	4. 5	5.5	3.5

Notes: 1. The shortest straight pipe section required is the section between various pipe fittings upstream of the classic venturi tube and the classic venturi tube. The straight pipe section shall be measured from the downstream end of the nearest (or only) elbow curved portion or from the downstream end of the curved or conical portion of the reducing or diverging pipe to the upstream pressure tap plane of the classic venturi tube.

2. The thermometer pocket or thermowell (if any) fitted upstream of the classic venturi tube shall have a diameter not exceeding 0.13D, and be located at least 4D upstream of the upstream pressure tap plane of the venturi tube.

3. For downstream straight pipe section, pipe fittings or other chokes (as shown in this table) or densitometer pockets located at least 4 times the throat diameter downstream of the throat pressure tap plane shall not affect the measurement accuracy.

a. The radius of curvature of elbow shall be greater than or equal to the pipe diameter.

b .Column A of various pipe fittings gives a value corresponding to "zero additional uncertainty".

c .Column B of various pipe fittings gives a value corresponding to "0.5% additional uncertainty".

d .Zero additional uncertainty is given for the straight pipe section in column A, and there is currently no shorter straight pipe section data available to give the straight pipe section required in column B.

Chapter VIII
Non-standard Throttling Element

Non-standard throttling elements are not designed, manufactured or used in full accordance with the international standards ISO5167 and technical specifications GB/T2624. Non-standard throttling elements include double orifice, notched orifice, 1/4 round nozzle, V-shaped inner cone types, etc.

1. Low Reynolds Number Throttling Element

Low Reynolds number throttling elements include conical inlet orifice type and 1/4 round orifice type.

(I) Structure



1/4 round orifice plate　　Conical inlet orifice plate

(II) Features

It is applicable to medium and small diameter, low flow rate and high viscosity fluids.

(III) Application conditions

Conical inlet orifice:

25mm≤D≤500mm　　0.1≤β≤0.316

80≤ReD≤2×105β

1/4 round orifice:

d≥15mm　　D≤500mm

0.245≤β≤0.6　　245≤ReD≤105β

2. Segmental orifice plate

(I) Structure of throttling element



Segmental orifice plate

(II) Features

The fluid is disturbed forcibly by the throttling element, which is conducive to measuring the dirty medium.

(III) Applicable pipe diameter

50mm≤D≤1600mm

0.3≤β≤0.8

ReD>10000

3. Other Throttling Devices



PTFE restriction orifice



PTFE built-in orifice



Integrated pipe orifice (two pairs of pressure taps)



Anti-corrosion wedge flowmeter



PVC orifice



Corrosion-resistant balanced multi-hole

CYAC New Generation DFYT-type Integrated Orifice Flowmeter

1. Product Introduction

The integrated orifice flowmeter consists of integral orifice (which can be replaced separately), three-valve manifold and differential pressure transmitter, clamping flange, process connecting flange, straight pipe section (optional) and other main components. Users can use it by only connecting a flow indicator. It will be a complete flowmeter if the transmitter is replaced with a multi-parameter transmitter, and will have the temperature and pressure compensation function if equipped with thermal resistance or thermocouple. Due to the overall design and manufacturing, the straight pipe section is processed by drilling and boring, with high processing accuracy, and with smaller dimensional error and roughness compared with the straight steel pipe section. The orifice, straight pipe section and flange are positioned coaxially, and high-quality transmitters are selected. Real flow calibration of coefficient can be performed after the overall pressure test before leaving the factory, so that the integrated orifice flowmeter has outstanding advantages such as simple installation and maintenance, high positioning accuracy, high measurement accuracy, stable and reliable performance, etc. It is more and more widely used, especially in the flow measurement of small-diameter pipelines.

2. Product Features

- Integrated differential pressure flow measurement system

Primary element is integrated with differential pressure transmitter to become a single flowmeter

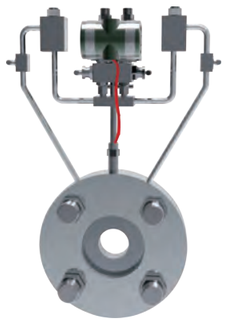
- Integrated flowmeter, which is used for overall pressure test of elbow assembly
- Higher reliability, no leakage
- Mass flow signal, equipped with integrated temperature measuring element
- Integrated multivariable transmitter and temperature measuring element, only one set is required to read the gas mass and corrected volume flow directly
- Integrated pressure connection
- No impulse pipeline is required
- Reusable differential pressure connections are provided throughout the installation site
- Lower installation cost
- Only one-piece installation is required
- It is unnecessary to provide or connect manifold, transmitter and impulse pipeline separately



Flange Clamped
Integrated orifice plate



Flange Clamped
Integrated orifice plate



Integrated Orifice with Thermal Resistance Compensation and CondenserIntegrated orifice plate

3. Product Advantages

• Integration: Which reduces the installation cost

• Integrated transmitters, manifolds, and pressure taps are designed to eliminate the need for impulse pipeline and have the following advantages:

- Ensure higher positioning and installation accuracy of pressure taps

- Reduce the likelihood of blockage of impulse pipelines

• Minimum pressure loss, highest measurement accuracy and optimal measurement dynamics

• Measurement method complying with ISO 5167 international standard

• Symmetrical orifice structure, which can be used for bi-directional measurement

• Solid instrument structure, and no movable part

• Differential pressure transmitters and valve manifolds installed in factory and specially configured

• Comprehensive leakage test and configuration completed in the factory

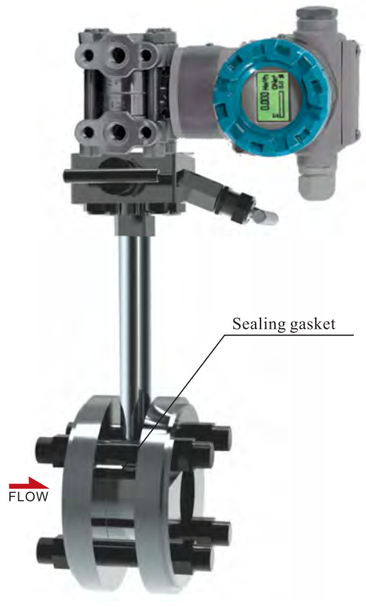
4. Structural Form Diagram

Comparison of Process Connection Characteristics of DFYT-type Integrated Orifice

No.	Process Connection Code	Features
1	A/B	Low price, and removable orifice
2	E/F	Built-in straight pipe section, accurate measurement, non-removable orifice, firmly welded orifice to avoid leakage, and moderate price
3	H/I	Built-in straight pipe section, accurate measurement, removable orifice, and high price



Temperature and Pressure Compensation
Integrated Pipe-type Multi-hole



Process Connection: A/B



Process Connection: E/F

Process Connection: H/I

5. Product Applications

• Gas, natural gas and steam measurement: with full compensation (differential pressure, pipeline pressure and temperature measurement);

Saturated steam: with differential pressure and pipeline pressure or differential pressure and temperature measurement;

Liquids: with differential pressure and temperature measurement. Liquids at stable temperature: with differential pressure measurement.

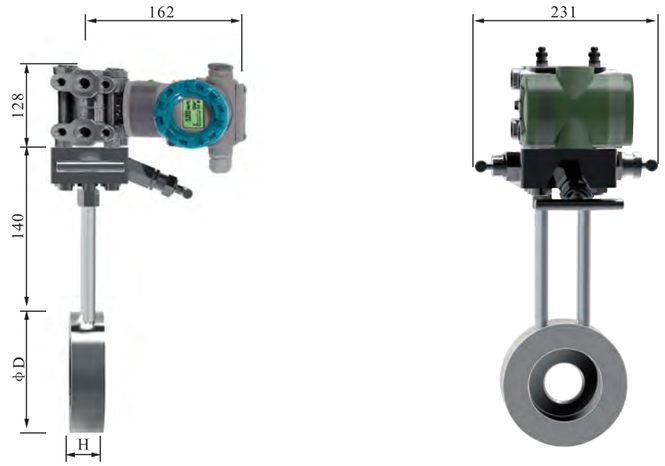


6. Main technical parameters

Type	Integrated orifice flowmeter
Accuracy grade	Grade: 0.5, 1.0
Diameter (mm)	DN15~DN1000
Nominal pressure (MPa)	(0.25~42) MPa
Flange	Various flange standards
Throttling materials	Stainless steel/special requirements
Medium temperature	-40℃~500℃
Minimum Reynolds number	8000 (good repeatability when the Reynolds number is between 400 and 8000)
β value range	0.25~0.65
Range ratio	3:1 - 10:1
Repeatability	0.25%~0.5%
Applicable media	Gas, liquid, steam, etc.

7. Overall Dimensions

• Structural dimension of orifice sheet

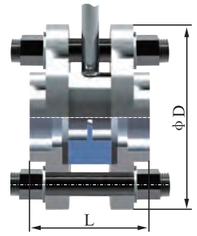


Standard Orifice Structure

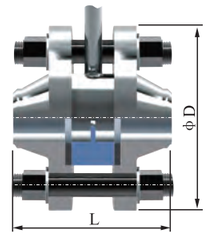
Specifications	Orifice outer diameter D(MF sealing surface structure)	Orifice thickness H	Weight (kg)
DN15(1/2")	ϕ66	34	1.10
DN20(3/4")	ϕ66	34	1.07
DN25(1")	ϕ66	34	1.02
DN32(1-1/4")	ϕ66	34	0.94
DN40(1-1/2")	ϕ76	34	1.11
DN50(2")	ϕ88	34	1.34
DN65(2-1/2")	ϕ110	34	1.90
DN80(3")	ϕ121	34	1.97
DN100(4")	ϕ150	34	2.88
DN125(5")	ϕ176	34	3.48
DN150(6")	ϕ204	34	4.28
DN200(8")	ϕ260	34	6.07

Note: The above orifice impulse pipeline shall be of φ14×3×80 (or φ14×3×130 if radiator is provided), with the pressure grade of 0-PN25.0 MPa; unless there are special requirements

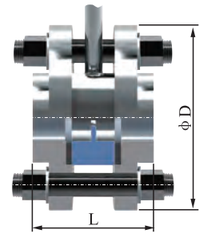
• Overall dimensions of orifice clamping flange



Socket Welding Flange



Welding Neck Flange



Slip-on Flange

EN 1902-1 (HG20592-97) Overall Dimensions of Orifice Clamping Flange

Specifications	Pressure grade	Socket Weld Clamping Flange		Welding Neck Clamping Flange		Hubbed Flat Welding Clamping Flange	
		L	D	L	D	L	D
DN15	PN1.0/1.6	100	140	124	140	100	140
	PN2.5/4.0	100	140	124	140	100	140
	PN6.3	104	155	160	155	/	/
	PN10.0	108	155	160	155	/	/
	PN16.0	/	/	160	155	/	/
	PN25.0	/	/	190	165	/	/
DN20	PN1.0/1.6	100	140	124	140	100	140
	PN2.5/4.0	100	140	124	140	100	140
	PN6.3	104	155	160	155	/	/
	PN10.0	108	155	160	155	/	/
	PN16.0	/	/	160	155	/	/
	PN25.0	/	/	190	165	/	/
DN25	PN1.0/1.6	100	140	124	140	100	140
	PN2.5/4.0	100	140	124	140	100	140
	PN6.3	104	155	160	155	/	/
	PN10.0	108	155	160	155	/	/
	PN16.0	/	/	160	155	/	/
	PN25.0	/	/	190	165	/	/
DN32	PN1.0/1.6	100	140	124	140	100	140
	PN2.5/4.0	100	140	124	140	100	140
	PN6.3	104	155	160	155	/	/
	PN10.0	108	155	160	155	/	/
	PN16.0	/	/	160	155	/	/
	PN25.0	/	/	190	165	/	/
DN40	PN1.0/1.6	104	150	130	150	104	150
	PN2.5/4.0	104	150	130	150	104	150
	PN6.3	108	170	164	170	/	/
	PN10.0	112	170	164	170	/	/
	PN16.0	/	/	168	170	/	/
	PN25.0	/	/	200	185	/	/

EN 1902-1 (HG20592-97) Overall Dimensions of Orifice Clamping Flange (Continued)

Specifications	Pressure grade	Socket Weld Clamping Flange		Welding Neck Clamping Flange		Hubbed Flat Welding Clamping Flange	
		L	D	L	D	L	D
DN50	PN1.0/1.6	108	165	136	165	108	165
	PN2.5/4.0	108	165	136	165	108	165
	PN6.3	116	180	164	180	/	/
	PN10.0	120	195	176	195	/	/
	PN16.0	/	/	190	195	/	/
	PN25.0	/	/	210	200	/	/
DN65	PN1.0/1.6	/	/	136	185	104	185
	PN2.5/4.0	/	/	144	185	116	185
	PN6.3	/	/	176	205	/	/
	PN10.0	/	/	192	220	/	/
	PN16.0	/	/	204	220	/	/
	PN25.0	/	/	230	230	/	/
DN80	PN1.0/1.6	/	/	140	200	108	200
	PN2.5/4.0	/	/	156	200	120	200
	PN6.3	/	/	184	215	/	/
	PN10.0	/	/	196	230	/	/
	PN16.0	/	/	212	230	/	/
	PN25.0	/	/	244	255	/	/
DN100	PN1.0/1.6	/	/	144	220	120	220
	PN2.5/4.0	/	/	170	235	128	235
	PN6.3	/	/	196	250	/	/
	PN10.0	/	/	220	265	/	/
	PN16.0	/	/	240	265	/	/
	PN25.0	/	/	280	300	/	/
DN125	PN1.0/1.6	/	/	150	250	128	250
	PN2.5/4.0	/	/	176	270	136	270
	PN6.3	/	/	216	295	/	/
	PN10.0	/	/	250	315	/	/
	PN16.0	/	/	270	315	/	/
	PN25.0	/	/	320	340	/	/
DN150	PN1.0/1.6	/	/	150	285	128	285
	PN2.5/4.0	/	/	190	300	144	300
	PN6.3	/	/	230	345	/	/
	PN10.0	/	/	270	355	/	/
	PN16.0	/	/	296	355	/	/
	PN25.0	/	/	360	390	/	/
DN200	PN1.0/1.6	/	/	164	340	128	340
	PN2.5/4.0	/	/	200/216	360/375	144/152	360/375
	PN6.3	/	/	260	415	/	/
	PN10.0	/	/	300	430	/	/
	PN16.0	/	/	320	430	/	/
	PN25.0	/	/	420	485	/	/

ANSI B16.5 (HG20615-97) Overall Dimensions of Orifice Clamping Flange

Specifications (")	Pressure grade	Socket Weld Clamping Flange		Welding Neck Clamping Flange		Hubbed Flat Welding Clamping Flange	
		L	D	L	D	L	D
1/2	CLass150	82	115	156	115	82	120
	CLass300	94	135	172	135	94	135
	CLass400/600	102	135	178	135	102	135
	CLass900/1500	/	/	190	160	126	160
	CLass2500	/	/	234	185	/	/
3/4	CLass150	82	115	156	115	82	120
	CLass300	94	135	172	135	94	135
	CLass400/600	102	135	178	135	102	135
	CLass900/1500	/	/	190	160	126	160
	CLass2500	/	/	234	185	/	/
1	CLass150	82	115	156	115	82	120
	CLass300	94	135	172	135	94	135
	CLass400/600	102	135	178	135	102	135
	CLass900/1500	/	/	190	160	126	160
	CLass2500	/	/	234	185	/	/
$1^{1}/_{4}$	CLass150	82	115	156	115	82	120
	CLass300	94	135	172	135	94	135
	CLass400/600	102	135	178	135	102	135
	CLass900/1500	/	/	190	160	126	160
	CLass2500	/	/	234	185	/	/
$1^{1}/_{2}$	CLass150	86	125	164	125	84	130
	CLass300	102	155	178	155	100	155
	CLass400/600	108	155	184	155	108	155
	CLass900/1500	/	/	210	180	132	180
	CLass2500	/	/	266	205	/	/
2	CLass150	92	150	168	150	90	150
	CLass300	108	165	180	165	106	165
	CLass400/600	118	165	190	165	118	165
	CLass900/1500	/	/	248	215	158	215
	CLass2500	/	/	298	235	/	/
$2^{1}/_{2}$	CLass150	98	180	180	180	98	180
	CLass300	118	190	194	190	116	190
	CLass400/600	126	190	202	190	126	190
	CLass900/1500	/	/	254	245	172	245
	CLass2500	/	/	330	265	/	/
3	CLass150	102	190	180	190	100	190
	CLass300	126	210	200	210	126	210
	CLass400/600	136	210	210	210	136	210
	CLass900/1500	/	/	248/278	240/265	152	240
	CLass2500	/	/	380	305	/	/

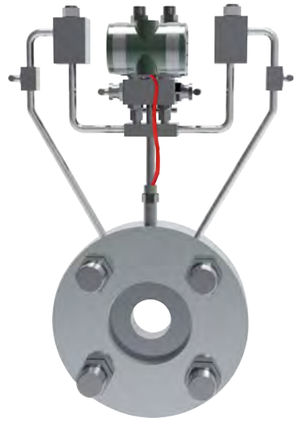
ANSI B16.5 (HG20615-97) Overall Dimensions of Orifice Clamping Flange (Continued)

Specifications (")	Pressure grade	Socket Weld Clamping Flange		Welding Neck Clamping Flange		Hubbed Flat Welding Clamping Flange	
		L	D	L	D	L	D
4	CLass150	/	/	194	230	104	230
	CLass300	/	/	212	255	134	255
	CLass400/600	/	/	222/248	255/275	146/150	255/275
	CLass900/1500	/	/	272/292	290/310	182	290
	CLass2500	/	/	424	355	/	/
5	CLass150	/	/	218	255	110	255
	CLass300	/	/	238	280	140	280
	CLass400/600	/	/	248/272	280/330	152/162	280/330
	CLass900/1500	/	/	298/356	350/375	200	350
	CLass2500	/	/	502	420	/	/
6	CLass150	/	/	218	280	118	280
	CLass300	/	/	238	320	142	320
	CLass400/600	/	/	250/278	320/355	158/176	320/355
	CLass900/1500	/	/	324/386	380/395	214	380
	CLass2500	/	/	590	485	/	/
8	CLass150	/	/	244	345	126	345
	CLass300	/	/	264	380	162	380
	CLass400/600	/	/	278/310	380/420	180/196	380/420
	CLass900/1500	/	/	368/470	470/485	246	470
	CLass2500	/	/	680	550	/	/

• Schematic Diagram of Type B Structure with Temperature and Pressure Compensation and Condenser



Integrated Orifice Structure
with Thermal Resistance Compensation



Integrated Orifice with Thermal Resistance Compensation and Condenser
with Thermal Resistance Compensation

• Schematic Diagram of H-shaped Structure with Front and Rear Straight Pipe Sections and Temperature and Pressure Compensation

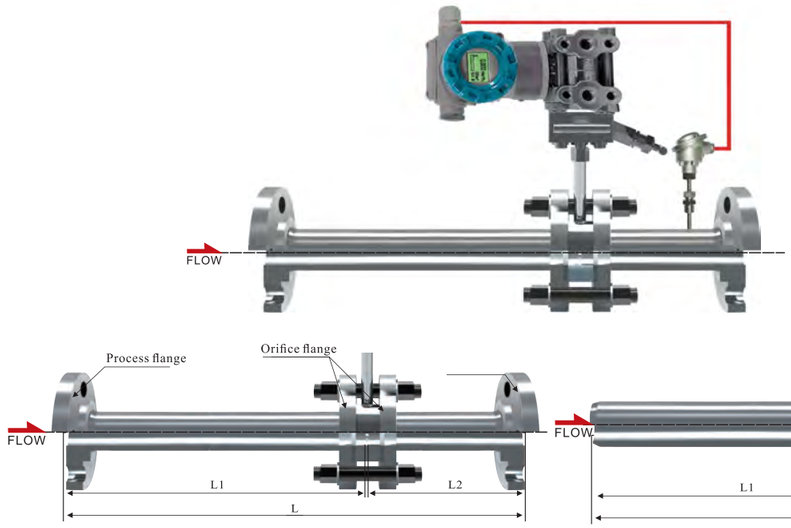


Fig.A

Fig.B

Note: The flange structure type is determined by the specific type selection.

Specifications	Front straight pipe section L1 (mm)	Rear straight pipe section L2 (mm)	Total length L (mm)
DN15(1/2") ~ DN25(1")	500	196	700
DN32(1-1/4") ~ DN40(1-1/2")	800	296	1100
DN50(2") ~ DN65(2-1/2")	800	346	1150
DN80(3")	900	446	1350
DN100(4")	1000	496	1500
DN125(5")	1300	646	1950
DN150(6")	1600	796	2400
DN200(8")	2000	996	3000

* Refer to Page P03 for the type spectrum

8. Remarks

Such high-performance differential pressure transmitter is used to measure the level, density, and pressure of liquid, gas, or steam. It can also be used to measure the differential pressure and static pressure accurately, show them on the multi-function LCD, and monitor them remotely through digital communication. BRAIN, HA RT, and FOUNDATION Fieldbus communication protocols are available.



Multi-parameter Transmitter

CYAC New Generation DFPH-type Multi-hole Orifice (Balanced Orifice Flowmeter)

1. Product Introduction

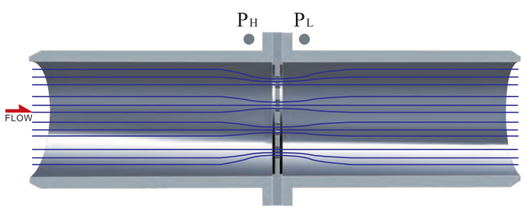
The multi-hole balanced orifice flowmeter is a third-generation throttling device, with a measurement accuracy 5~10 times that of the traditional throttling device, a flow noise reduced to 1/15, a permanent pressure loss of about 1/3, a pressure recovery increased by 2 times, the minimum straight pipe section of 1D, and without moving parts. Its installation and use are very convenient and simple, so that long straight pipe sections are unnecessary, and the energy consumption required for fluid operation is reduced greatly. Therefore, it is an energy-saving instrument with bright application prospects.

Application

• Measure the flow of gas, steam and liquid

• Balance the flow field, reduce vortex, vibration and signal noise, and improve stability of the flow field greatly

• Ensure the smooth passage of dirty media with the multi-hole and symmetrical design, and measure various dirty media, such as coke oven gas, blast furnace gas, residual oil, recycled oil, coal water slurry, etc.



• Be suitable for extremely low temperature fluids and prevent gasification effectively

Advantages

Effective measurement of any clean or dirty fluid

Liquid, gas, steam, multi-phase flow

High and low temperature fluids

Vapor-liquid two-phase, slurry

• Balanced rectification of the flow field

• Bi-directional flow measurement

• Extremely short upstream and downstream pipelines, which shall be at least 3D in the front section and 2D in the rear section

•High accuracy, which is within ±1% of indication

• Wide measuring range up to 3:1 to 10:1

• Multi-hole symmetrical design, resistance to dirt and low risk of blockage

• Integrated structure, which is easy to use, check and troubleshoot

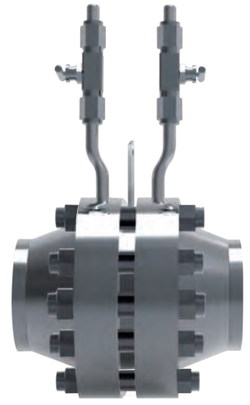




Flat Flange Wafer
Balance Flowmeter



Integrated
Balance Flowmeter



Welded Flange Wafer
Balance Flowmeter

2. Measurement Principles

The traditional throttling device has been greatly improved by the multi-hole balance orifice, 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.



Multi-hole rectifier　Standard orifice　Multi-hole balanced throttling element

The calculation formula is as follows:

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

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

q_m - mass flow (kg/s)
q_v - volume flow under working conditions (m^3/s)
△p - differential pressure (Pa)
ε - expandability coefficient, ε=1 for liquid; ε<1 for compressible fluids such as gas and steam
β - equivalent diameter ratio
C - discharge coefficient
D - pipe inner diameter (m)

3. Product Features

1. High measurement accuracy

With the multi-hole symmetrical structure, it can be used for balanced rectification of the flow field, thus reducing the vortex, vibration and signal noise, improving stability of the flow field greatly, and increasing the linearity by 5~10 times compared with traditional throttling devices.

2.Short straight pipe section

The sensor can stabilize the flow field and restore the pressure twice as fast as the traditional throttling device, which reduces the requirements for straight pipe section significantly. Generally, the straight pipe section shall be 2D in the front part and 2D in the rear part.

3. Wide range ratio

It is 4:1 under normal circumstances, and can reach 10:1 if appropriate parameters are selected.

4. Low permanent pressure loss

The balanced design reduces the formation of vortex and turbulent friction, and reduces the kinetic energy loss.

The permanent pressure loss is about 1/3 of that of conventional throttling devices when the differential pressure value is the same.

5. Resistance to dirt and low risk of blockage

The multi-hole and symmetrical design reduces the formation of vortex and the turbulent friction, reduces the dead zone of flow field, and ensures that the dirty medium passes through the function hole smoothly. Therefore, it can be used to measure various dirty media, such as coke oven gas, blast furnace gas, residual oil, recycled oil, coal water slurry, etc.

6.Wide applicable scope

It has a wide measuring range, which covers various gases, liquids and steam. The fluid conditions can range from deep low temperature to supercritical state, with the process temperature up to 850°C and the maximum working pressure up to 42 MPa.

7. Low signal-to-noise ratio

It is generally less than 1%. The semi-annular voltage-sharing structure of the multi-hole orifice reduces fluctuation of the output signal, thus reducing the signal-to-noise ratio and eliminating the measurement error caused by signal fluctuation.

4. Main technical parameters

Type	Multi-hole balanced orifice flowmeter
Accuracy grade	Class 1.0
Diameter (mm)	DN25~DN3000
Pressure grade (MPa)	(0.25~42)MPa
Flange	Various flange standards, carbon steel/stainless steel/ other special requirements
Materials of throttling element	304 stainless steel/special material requirements
Medium temperature	(-196~600)℃
Reynolds number range	200≤ReD≤107
Opening ratio (β)	0.3, 0.4, 0.5, 0.6, 0.7, 0.75
Range ratio	3:1 - 10:1
Repeatability	±0.2%
Upper limit of viscosity of the measured medium	100mPa.s
Long-term stability	±0.2%F.S/Y

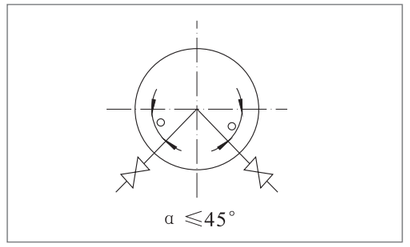
5. Installation requirements

5.1 Requirements for installation of straight pipes (values are expressed in multiples of pipe diameter D)

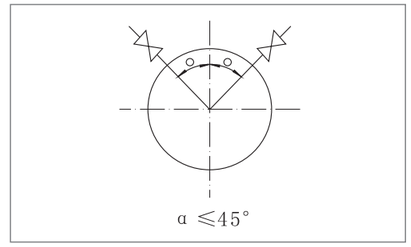
Equivalent β	Minimum Length of Upstream Straight Pipe Section				Minimum Length of Downstream Straight Pipe Section
	90° elbow	Tee joint	Ball valve	Gate valve (fully open)	
0.3	3D	3D	3D	3D	2D
0.45	3D	3D	3D	3D	2D
0.60	4D	4D	4D	4D	2D
0.75	4D	4D	4D	4D	2D

5.2 Installation of horizontal pipeline (as shown in the following figure):

When liquid medium is adopted, the pressure port and transmitter shall be installed within a range of 45°C below the pipeline. When gas medium is adopted, the pressure port and transmitter shall be installed within a range of 45°C above the pipeline. When steam medium is adopted, the pressure port shall be horizontal and a condensing device shall be installed.



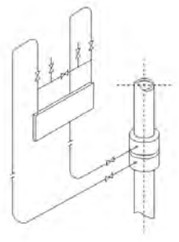
a When the measured fluid is liquid



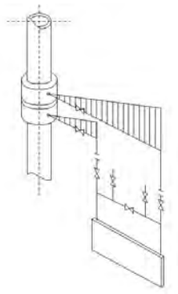
b When the measured fluid is gas

5.3 Installation of vertical pipeline (as shown in the following figure):

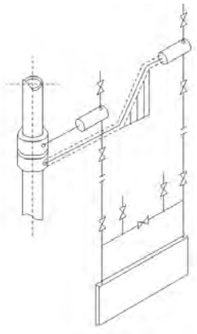
When liquid medium is adopted, the transmitter shall be installed below the pressure pipe. When gas medium is adopted, the transmitter shall be installed above the pressure pipe. When steam medium is adopted, the pressure port shall be horizontal and a condensing device shall be installed.



When the measured fluid is gas



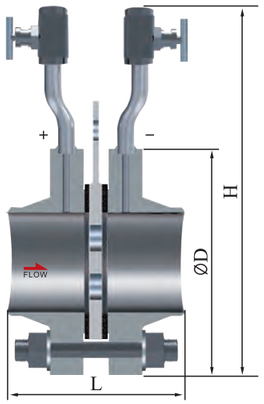
When the measured fluid is liquid

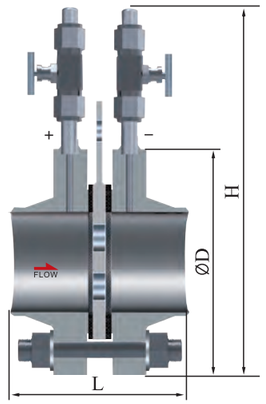


When the measured fluid is steam

6. Installation Dimension Diagram

6.1. Flange clamped multi-hole orifice (balanced orifice)

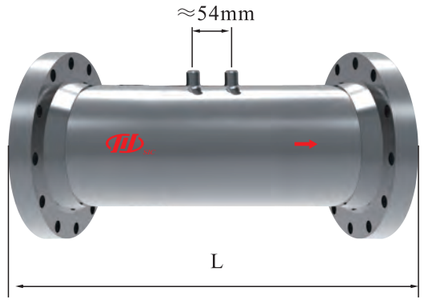




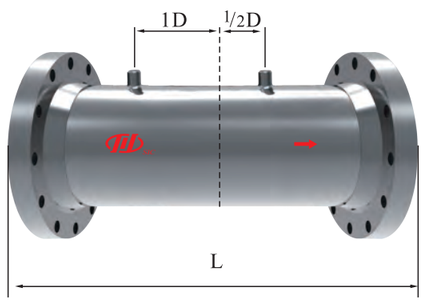
Pressure grade	1.0MPa				1.6MPa				2.5MPa			
Nominal diameter /DN	L/mm	D/mm	H/mm	Reference weight/kg	L/mm	D/mm	H/mm	Reference weight/kg	L/mm	D/mm	H/mm	Reference weight/kg
25	130	115	295	7.4	130	115	295	8.0	130	115	295	8.0
32	134	140	320	10.3	134	140	320	10.5	134	140	320	10.5
40	140	150	330	11.7	140	150	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	220	400	21.0	150	220	400	21.3	168	235	415	25.6
125	152	250	430	25.2	152	250	430	25.6	170	270	450	33.0
150	152	285	465	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	130.2	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	200.0	206	840	1020	308.0	266	845	1025	361.5

Pressure grade	4.0MPa				6.3MPa				10.0MPa			
Nominal diameter /DN	L/mm	D/mm	H/mm	Reference weight/kg	L/mm	D/mm	H/mm	Reference weight/kg	L/mm	D/mm	H/mm	Reference weight/kg
25	130	115	295	8.0	153	140	320	12.5	153	140	320	12.5
32	134	140	320	10.5	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	20.5
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	190.0
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/mm	D/mm	H/mm	Reference weight/kg	L/mm	D/mm	H/mm	Reference weight/kg	L/mm	D/mm	H/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	20.0	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	50.2	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	70.7	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	160.5	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	310.3	354	915	1095	593.0	436	940	1120	1608.3



DN25-DN700



DN80-DN700

Diameter	Pressure Grade ≤10MPa or ≤ CL600
	L
Dn25 (1")	400
DN32 (1¼")	400
DN40 (1½")	400
DN50 (2")	400
DN65 (2½")	400
DN80 (3")	400
DN100 (4")	400
DN125 (5")	400
DN150 (6")	450
DN200 (8")	500
DN250 (10")	550
DN300 (12")	550
DN350 (14")	600
DN400 (16")	600
DN450 (18")	600
DN500 (20")	600
DN600 (24")	600
DN700 (28")	700

Note: The above dimensions are for reference only.

Diameter	Pressure Grade ≤ 10MPa or ≤ CL300
	L
DN80 (3")	400
DN100 (4")	500
DN125 (5")	500
DN150 (6")	600
DN200 (8")	700
DN250 (10")	900
DN300 (12")	1000
DN350 (14")	1100
DN400 (16")	1200
DN450 (18")	1200
DN500 (20")	1200
DN600 (24")	1200
DN700 (28")	1400

Note: D refers to pipe inner diameter

CYAC New Generation DFX-type Wedge Flowmeter

Application

• Measure the flow of gas, steam and liquid

• It is suitable for polluted environment and medium where fluid is easy to be blocked. 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.

Advantages

Effective measurement of any clean or dirty fluid

Rough, high viscosity fluid

Liquid, gas, steam, multi-phase flow

High and low temperature fluids

•For low Reynolds number measurement, the square root relationship between flow and differential pressure can still be maintained when ReD=300.

•Bi-directional flow measurement

•Extremely short upstream and downstream pipelines, which shall be at least 5D in the front section and 3D in the rear section

•High accuracy, which is within ±1% of indication

•State-of-the-art non-cutting pipe wedge welding technology

•Provide calcium carbide wear-resistant wedge type

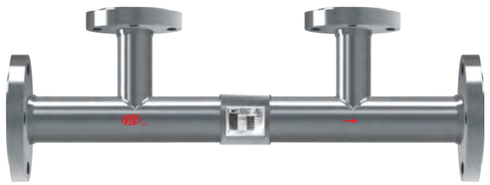
•Provide multi-pressure tap wedge type

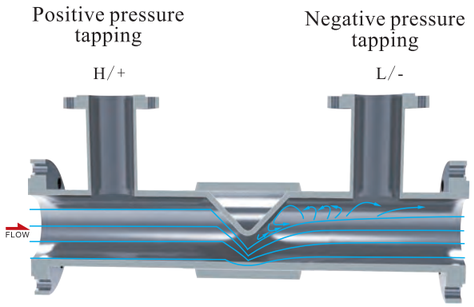


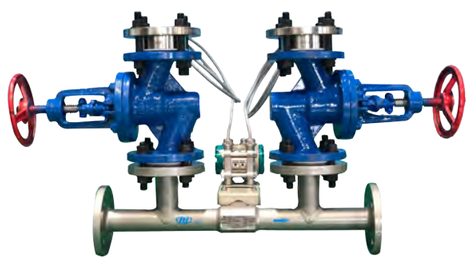


1. Product Introduction

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.







2. Working principle

Wedge flowmeter is a flowmeter based on the principle of differential pressure. Differential pressure △p will be generated upstream and downstream of the wedge throttling element when the measured fluid passes through the 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:

$$q_{v}=\frac{C\varepsilon}{\sqrt{1-m^2}}m\frac{\pi}{4}D^2\sqrt{\frac{2\triangle P}{\rho}}$$

Or

$$q_{m}=\frac{C\varepsilon}{\sqrt{1-\beta^4}}\beta^2\frac{\pi}{4}D^2\sqrt{2\triangle P\rho}$$

q_m - mass flow (kg/s)

q_v - volume flow (m^3/s)

C - efflux coefficient

ε - expandability coefficient

β - diameter ratio, β = d/D;

m - throttling area ratio, $m=\frac{S_1}{\pi\cdot(D/2)^2}=\beta^2$

S_1 - bow flow area (m^2)

ρ - density of the measured medium under working condition (kg/m^3)

△p - differential pressure (Pa)

D - pipe inner diameter (mm)

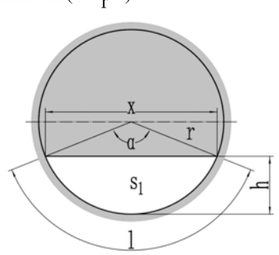
Calculation of S_1:

$$S_l=\frac{1}{2}[rl-x(r-h)]$$

$$x=2\sqrt{h(2r-h)}$$

$$l=0.01745ra$$

$$a=2\arccos(1-\frac{h}{r})$$



3. Product Features

It is suitable for a wide range of media, especially for the measurement of mud, coal tar pitch, suspended coal-water and other high viscosity fluids.

It can be used to measure corrosive media, and is equipped with the diaphragm-type double-flange differential pressure transmitter. Corrosive media cannot enter impulse pipe or differential pressure transmitter. The instrument can be used to measure corrosive media if the wedge throttling element is processed with corrosion-resistant materials.

It is characterized by simple structure and convenient installation, use and maintenance. For the separated wedge flowmeter, its measuring range can be expanded or changed by replacing the wedge.

• The flow rate increases when the fluid approaches the wedge, and the high-speed fluid can clean the wedge and the inner wall of pipe, and will not adhere to or precipitate on the throttling element.

• The wedge sensor is of V-shaped design, and the top of the V-shaped sensor is an arc of R3-R10, so that its wear resistance can be increased greatly, and the size and throttling area of the throttling element can remain unchanged for a long time. There is no movable part or vulnerable part, so that the measurement accuracy, stability and reliability of instrument can be maintained for a long time.

• The pressure loss is low, which is only 1/2-1/3 of that of the orifice.

• The integrated structure design makes it possible to display temperature, pressure and differential pressure on the LCD screen at the same time. So that it is unnecessary to use the impulse pipe, blockage and leakage caused by the pipe can be avoided, and the installation is convenient.

• Wedge sensors can be configured by any transmitter designated by the user to output (4-20) mA, differential pressure, or flow signals.

4. Main technical parameters

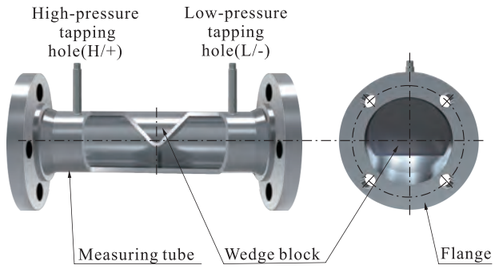
Type	Wedge flow sensor
Accuracy grade	Class 1.0
Diameter (mm)	DN25~DN1500
Nominal grade	(0.25~42) MPa
Flange	Various flange standards, carbon steel/stainless steel/ other special requirements
Wedge material	304 stainless steel/special material requirements
Medium temperature	(-196~600)℃
Reynolds number range	300≤ReD≤10^6
Wedge ratio (h/d)	0.2, 0.3, 0.4, 0.5
Range ratio	3:1 - 10:1
Repeatability	±0.3%
Upper limit of viscosity of the measured medium	500mPa.s
Long-term stability	±0.2%F.S/Y

5. Structure type

It can be divided into the integrated type and separated type according to the connection form of wedge flow sensor and differential pressure transmitter.

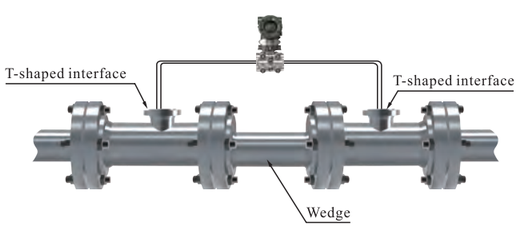
5.1 Integrated type

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 thread or flange.



5.2 Separated type

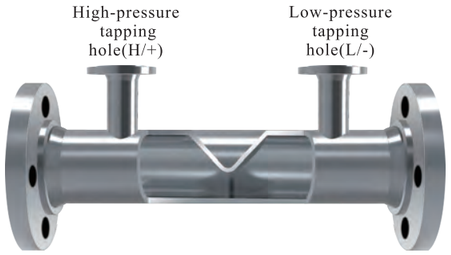
The separated pressure tap is T-shaped, and the positive and negative pressure taps are arranged upstream and downstream the throttling element respectively. The distance to the upstream and downstream pressure taps is equal. The measuring tube equipped with the throttling element can be replaced to 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.



5.3 Pressure tapping mode

The pressure tapping modes include nozzle pressure tapping and flange pressure tapping according to the actual service conditions.

As shown in the figure:



Flange pressure tapping

Conduit Pressure Tapping (Nozzle Pressure Tapping)

5.4 Jacketed wedge flowmeter

Jacketed pipes are added outside the main measuring pipes, which are generally used for steam tracing to ensure the stability of medium temperature.



Jacketed Wedge Flowmeter

6. Strong Wear-resistant Structure

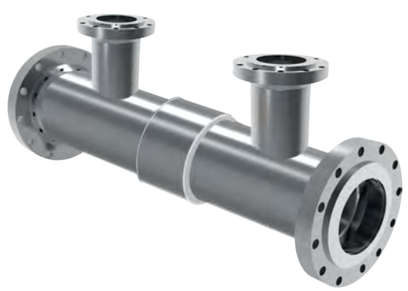
It is specially designed for the measurement and control of black water and grey water in the coal chemical gasification section. Due to the great abrasion and high temperature of black water and grey water, our wedge flowmeter adopts the integral hot-cast tungsten carbide technology to improve the abrasion resistance greatly. The wedge flowmeter is preferred in the black water and grey water measurement control section because its structure is particularly suitable for measuring liquids with high particle concentrations.

6.1 Integral sintered wedge shall be adopted for diameter ≤ DN150

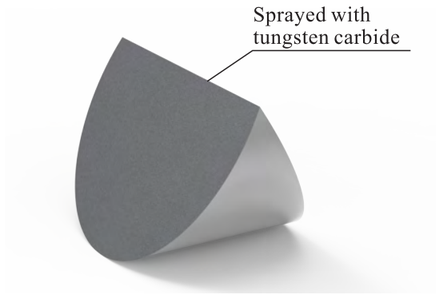




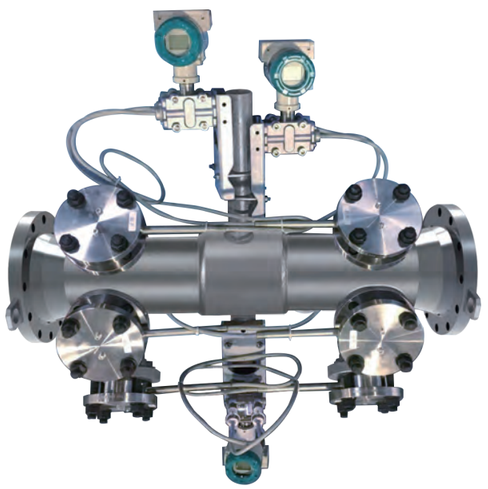
Integral sintered wedge



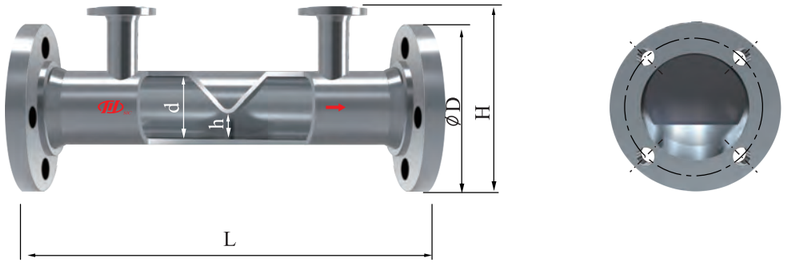
6.2 Sintered tungsten carbide plates are used for the wedge throttling element with a diameter ≥ DN200



6.3 Flange pressure tapping is adopted for wedge flowmeter under special working conditions, and the three pressure tapping methods can be combined



7. Installation Dimensions



Pressure grade	Nominal diameter	L(mm)	ΦD(mm)	H(mm)	Notes
0.25MPa 0.6MPa	DN25 (1")	600	100	221	Length L may be greater than the size in the table if the pressure rating is greater than the value in the table or the pressure tap is greater than or equal to DN80. H will be increased by 20 mm if the pressure tapping flange is greater than or equal to DN80.
	DN32 (1¼")	600	120	234	
	DN40 (1½")	600	130	243	
	DN50 (2")	600	140	254	
	DN65 (2½")	600	160	273	
	DN80 (3")	650	190	295	
	DN100 (4")	750	210	314	
	DN125 (5")	800	240	342	
	DN150 (6")	900	265	367	
	DN200 (8")	1000	320	425	
	DN250 (10")	1100	375	479	
	DN300 (12")	1200	440	538	
1.0MPa	DN25 (1")	600	115	229	
	DN32 (1¼")	600	140	244	
	DN40 (1½")	600	150	253	
	DN50 (2")	600	165	266	
	DN65 (2½")	600	185	286	
	DN80 (3")	650	200	300	
	DN100 (4")	750	220	327	
	DN125 (5")	800	250	357	
	DN150 (6")	900	285	385	
	DN200 (8")	1000	340	435	
	DN250 (10")	1100	395	489	
	DN300 (12")	1200	445	540	

Pressure grade	Nominal diameter	L(mm)	ΦD(mm)	H(mm)	Notes
1.6MPa	DN25 (1")	600	115	229	Length L may be greater than the size in the table if the pressure rating is greater than the value in the table or the pressure tap is greater than or equal to DN80. H will be increased by 20 mm if the pressure tapping flange is greater than or equal to DN80.
	DN32 (1¼")	600	140	244	
	DN40 (1½")	600	150	253	
	DN50 (2")	600	165	266	
	DN65 (2½")	600	185	286	
	DN80 (3")	650	200	300	
	DN100 (4")	750	220	327	
	DN125 (5")	800	250	357	
	DN150 (6")	900	285	385	
	DN200 (8")	1000	340	435	
	DN250 (10")	1100	405	494	
	DN300 (12")	1200	460	548	
2.5MPa	DN25 (1")	600	115	229	
	DN32 (1¼")	600	140	244	
	DN40 (1½")	600	150	253	
	DN50 (2")	600	165	266	
	DN65 (2½")	600	185	286	
	DN80 (3")	650	200	300	
	DN100 (4")	750	235	327	
	DN125 (5")	800	270	357	
	DN150 (6")	900	300	385	
	DN200 (8")	1000	360	445	
	DN250 (10")	1100	425	504	
	DN300 (12")	1200	485	560	
4.0MPa	DN25 (1")	600	115	229	
	DN32 (1¼")	600	140	244	
	DN40 (1½")	600	150	253	
	DN50 (2")	600	165	266	
	DN65 (2½")	600	185	286	
	DN80 (3")	650	200	300	
	DN100 (4")	750	235	327	
	DN125 (5")	800	270	357	
	DN150 (6")	900	300	385	
	DN200 (8")	1000	375	452	
	DN250 (10")	1100	450	517	
	DN300 (12")	1200	515	575	

Pressure grade	Nominal diameter	L(mm)	ΦD(mm)	H(mm)	Notes
6.3MPa	DN25 (1")	600	140	298	Length L may be greater than the size in the table if the pressure rating is greater than the value in the table or the pressure tap is greater than or equal to DN80. H will be increased by 20 mm if the pressure tapping flange is greater than or equal to DN80.
	DN32 (1¼")	600	155	301	
	DN40 (1½")	600	170	320	
	DN50 (2")	600	180	331	
	DN65 (2½")	600	205	353	
	DN80 (3")	650	215	364	
	DN100 (4")	750	250	391	
	DN125 (5")	800	295	426	
	DN150 (6")	900	345	464	
	DN200 (8")	1000	415	529	
	DN250 (10")	1100	470	584	
	DN300 (12")	1200	530	640	
10MPa	Dn25 (1")	600	140	304	
	DN32 (1¼")	600	155	315	
	DN40 (1½")	600	170	326	
	DN50 (2")	600	195	344	
	DN65 (2½")	600	220	366	
	DN80 (3")	650	230	378	
	DN100 (4")	750	265	405	
	DN125 (5")	800	315	442	
	DN150 (6")	900	355	475	
	DN200 (8")	1000	430	543	
	DN250 (10")	1100	505	607	
	DN300 (12")	1200	585	673	
ANSI150	Dn25 (1")	600	110	227	
	DN32 (1¼")	600	115	234	
	DN40 (1½")	600	125	242	
	DN50 (2")	600	150	260	
	DN65 (2½")	600	180	283	
	DN80 (3")	650	190	295	
	DN100 (4")	750	230	327	
	DN125 (5")	800	255	353	
	DN150 (6")	900	280	379	
	DN200 (8")	1000	345	437	
	DN250 (10")	1100	405	494	
	DN300 (12")	1200	485	560	

Pressure grade	Nominal diameter	L(mm)	ΦD(mm)	H(mm)	Notes
ANSI300	DN25 (1")	600	125	235	Length L may be greater than the size in the table if the pressure rating is greater than the value in the table or the pressure tap is greater than or equal to DN80. H will be increased by 20 mm if the pressure tapping flange is greater than or equal to DN80.
	DN32 (1¼")	600	135	244	
	DN40 (1½")	600	155	257	
	DN50 (2")	600	165	268	
	DN65 (2½")	600	190	288	
	DN80 (3")	650	210	305	
	DN100 (4")	750	255	340	
	DN125 (5")	800	280	365	
	DN150 (6")	900	320	399	
	DN200 (8")	1000	380	455	
	DN250 (10")	1100	445	514	
	DN300 (12")	1200	520	578	
ANSI600	DN25 (1")	600	125	310	
	DN32 (1¼")	600	135	319	
	DN40 (1½")	600	155	332	
	DN50 (2")	600	165	343	
	DN65 (2½")	600	190	363	
	DN80 (3")	650	210	380	
	DN100 (4")	750	275	425	
	DN125 (5")	800	330	465	
	DN150 (6")	900	355	492	
	DN200 (8")	1000	420	550	
	DN250 (10")	1100	510	622	
	DN300 (12")	1200	560	673	

8. Sensor Selection

8.1 Selection of sensor diameter

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

Flow Range Reference Table of Wedge Flowmeter

Nominal diameter	Wedge ratio h/D	Flow Range (Working Temperature of 20°C, Pressure of 0.5 MPa)			
		Water (m^3/h)	Reference differential pressure range (kpa)	Air (Nm^3/h) (101.325 kPa at 20°C)	Reference differential pressure range (kpa)
DN25	0.2	0.3～3	1～100	19～190	1～100
	0.3	0.5～5	1～100	34～340	1～100
	0.4	0.8～8	1～100	53～530	1～100
	0.5	1.2～12	1～100	75～750	1～100
DN32	0.2	0.5～5	1～100	31～310	1～100
	0.3	0.9～9	1～100	56～560	1～100
	0.4	1.3～13	1～100	86～860	1～100
	0.5	1.9～19	1～100	120～1200	1～100
DN40	0.2	0.7～7	1～100	47～470	1～100
	0.3	1.3～13	1～100	86～860	1～100
	0.4	2～20	1～100	130～1300	1～100
	0.5	2.9～29	1～100	186～1860	1～100
DN50	0.2	1.1～11	1～100	74～740	1～100
	0.3	2～20	1～100	134～1340	1～100
	0.4	3.1～31	1～100	205～2050	1～100
	0.5	4.5～45	1～100	290～2900	1～100
DN65	0.2	2～20	1～100	129～1290	1～100
	0.3	3.5～35	1～100	233～2330	1～100
	0.4	5.5～55	1～100	358～3580	1～100
	0.5	7.8～78	1～100	506～5060	1～100
DN80	0.2	2.7～27	1～100	182～1820	1～100
	0.3	4.9～49	1～100	329～3290	1～100
	0.4	7.5～75	1～100	505～5050	1～100
	0.5	11～110	1～100	715～7150	1～100
DN100	0.2	4.4～44	1～100	288～2880	1～100
	0.3	8～80	1～100	520～5200	1～100
	0.4	12～120	1～100	800～8000	1～100
	0.5	17.5～175	1～100	1130～11300	1～100

Nominal diameter	Wedge ratio h/D	Flow Range (Working Temperature of 20°C, Pressure of 0.5 MPa)			
		Water (m^3/h)	Reference differential pressure range (kpa)	Air (Nm^3/h) (101.325 kPa at 20°C)	Reference differential pressure range (kpa)
DN125	0.2	6.5~65	1~100	427~4270	1~100
	0.3	12~120	1~100	772~7720	1~100
	0.4	18~180	1~100	1180~11800	1~100
	0.5	26~260	1~100	1680~16800	1~100
DN150	0.2	9~90	1~100	6480~6480	1~100
	0.3	17~170	1~100	1170~11700	1~100
	0.4	26~260	1~100	1800~18000	1~100
	0.5	37~370	1~100	2540~25400	1~100
DN200	0.2	17~170	1~100	1110~11100	1~100
	0.3	30~300	1~100	2010~20100	1~100
	0.4	47~470	1~100	3080~30800	1~100
	0.5	67~670	1~100	4360~43600	1~100
DN250	0.2	26~260	1~100	1720~17200	1~100
	0.3	47~470	1~100	3100~31000	1~100
	0.4	72~720	1~100	4750~47500	1~100
	0.5	104~1040	1~100	6730~67300	1~100
DN300	0.2	36~360	1~100	2400~24000	1~100
	0.3	66~660	1~100	4340~43400	1~100
	0.4	102~1020	1~100	6660~66600	1~100
	0.5	146~1460	1~100	9420~94200	1~100

It is recommended that the user should try to select the wedge ratio and flow range in the above table in order to ensure the measurement accuracy and timely delivery of the product.

8.2 Selection of flanges

The wedge flow sensor shall be connected with the process pipeline by flanges, including flanges complying with national standards and standards of the Machinery Department. The US ANSI standards, Germany DIN standards and relevant domestic industry standards can also be adopted according to the requirements of different industries. If companion mounting flanges are required, please specify them at the time of ordering.

8.3 Working environment

Requirements of flowmeter for external environment:

There must be sufficient installation space around the flowmeter in order to facilitate installation and maintenance.

8.4 Precautions

(1) The wedge flow sensor is generally not equipped with an external flange or root valve when leaving the factory,which shall be explained during selection if necessary.

(2) Special requirements shall be explained at the time of ordering.

9. Installation requirements

(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) Installation direction

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

• Fluid shall flow from bottom to top when the sensor is installed on a vertical pipe. The measurement error caused by the height of positive and negative pressure taps not on the same horizontal plane shall be corrected as necessary.

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

• The sealing gasket shall not protrude into the flowmeter pipeline during the installation of flange.

•The flow regulating valve is installed downstream of the flowmeter sensor.

• The installation of differential pressure signal pipeline shall meet the on-site pipeline installation requirements according to the nature of the measured medium, and relative position of the wedge sensor and the differential pressure transmitter.

• For the wedge flowmeter installed on horizontal or inclined process pipeline, the drain hole (if any) shall be directly above the pipeline if liquid medium is adopted, and shall be directly below the pipeline of gas or steam is used.

(3) Requirements for straight pipe section

When the differential pressure instrument 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 long enough straight pipe section shall be provided ahead of the differential pressure instrument. The requirements for the shortest straight pipe section upstream of the wedge flowmeter are shown in the following table:

Wedge ratio	Minimum Length of Upstream Straight Pipe Section			
	Elbow 90º	Tee joint	Ball valve	Gate valve (fully open)
0.2	6D	6D	10D	6D
0.3	8D	8D	11D	6D
0.4	12D	12D	14D	8D
0.5	14D	14D	16D	10D

* Refer to Page P02 for the type spectrum

CYAC New Generation DFJ-type Rectangular Flowmeter

Application:

• Measurement of gas, steam and liquid.

• High viscosity fluid, high friction (containing solid particles) fluid, corrosive fluid and other media under harsh working conditions, such as oil slurry, black water, residual oil, heavy oil, ore pulp and sewage, are widely used in coal chemical industry, polysilicon, and power industry, etc.

• Measurement under micro-pressure and low-pressure loss conditions, such as air supply from electronic factory and heating furnace.

Advantages

• Many media can be measured

• High accuracy

• The rectangular flowmeter is not calibrated to an accuracy of 1%, while the measured value can be calibrated to an accuracy of 0.25% if necessary.

• Wide range

• Long service life

• Small pressure loss

• Small installation space, and short front and rear straight pipe sections required

• Integrated and simplified installation



Comparison with wedge flowmeter

• Long service life, which is 3~4 times that of wedge flowmeter

• Small pressure loss, which is 1/2~1/3 of that of wedge flowmeter

• Small installation space, requiring a front straight section shorter than that of wedge flowmeter

• High precision, which can be calibrated to Grade 0.25

• Wide range ratio, which is 2~3 times that of wedge flowmeter

Disadvantages

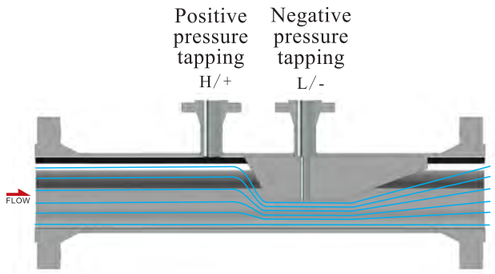
• High cost and long manufacturing cycle

• Real flow calibration required

1. Product Overview

Rectangular flowmeter is a throttling element that generates differential pressure signal. The flow of fluid can be measured accurately by the relationship between differential pressure signal and flow according to the hydrodynamic equation. The throttling block of a rectangular flowmeter has some characteristics of the throttling wedge of a wedge flowmeter and most characteristics of a venturi flowmeter.





2. Working principle

The rectangular flowmeter has the same flow section as the wedge flowmeter, and adopts calculation formula of the wedge flowmeter:

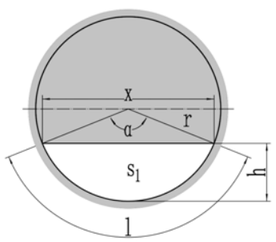
$$q_{v}=\frac{C\varepsilon}{\sqrt{1-m^2}}m\frac{\pi}{4}D^2\sqrt{\frac{2\triangle P}{\rho}}$$

Or

$$q_{m}=\frac{C\varepsilon}{\sqrt{1-\beta^4}}\beta^2\frac{\pi}{4}D^2\sqrt{2\triangle P\rho}$$

qm - mass flow (kg/s)
q_v - volume flow (m^3/s)
C - discharge coefficient
ε - expandability coefficient
β - diameter ratio, β = d/D
m - throttling area ratio, $m=\frac{S_1}{\pi\cdot(D/2)^2}$
S_1 - bow flow area (m^2)
ρ - density of the measured medium under working condition (kg/m^3)
△p - differential pressure (Pa)
D - pipe inner diameter (mm)
Calculation of S_1;

$$S_1=\frac{1}{2}[rl-x(r-h)]$$
$$x=2\sqrt{h(2r-h)}$$
$$l=0.01745ra$$
$$a=2\arccos(1-\frac{h}{r})$$



3. Product Features

Generally, the measuring elements of flowmeters are not resistant to high-pressure wear. The current wedge flowmeter can be used to measure fluids with low flow rate, low Reynolds number and high viscosity, and is far superior to other measuring elements when being used in highly abrasive fluids, but its wear resistance is limited. The throttling block of rectangular flowmeter is obtuse-angled or circular arc, without wedge-shaped edges. The fluid flows from contraction section to the throat smoothly, which can reduce wear greatly. At the same time, the rectangular flowmeter adopts a streamlined throttling channel and a throat of appropriate length. The throat plays a role of rectification and controls the fluctuation of fluid effectively. In addition, the rear pressure recovery section extends this streamlined flow channel, so that no vortex and vibration will be generated inside the whole flowmeter, thus avoiding wear caused by vortex. The rectangular flowmeter can be used for 3 consecutive years without changing the measurement accuracy, and its service life is more than 4 times that of the wedge flowmeter.

At the same time, the throttling block of rectangular flowmeter may be solid and hardened, and calcium carbide or stellite alloy can be welded on the surface. The inside of pipeline may also be hardened and preservative treated, and the flowmeter can be designed as a corrosion-resistant structure (lined with PTFE, ceramic or rubber).

• Small pressure loss and great differential pressure

General throttling devices, such as wedge flowmeters, are used to measure flow by throttling and generating differential pressure with throttling blocks, and the pressure of throttling element is freely restored based on the principle of hydromechanics, in which case the pressure loss is often great. The higher the measurement accuracy, the greater the range ratio, and the greater the pressure loss, which is generally 30%~60% of the measured differential pressure. The structure of rectangular flowmeter is similar to the head recovery section of the venturi flowmeter, which can restore the pressure to the maximum extent, and the pressure loss is 15%~25% of the measured differential pressure.

The rectangular flowmeter is widely used in the measurement of micro-pressure and low-pressure loss conditions, such as air supply and suction of power plants and air supply of heating furnaces, because the throat center is used for pressure tapping, and a differential pressure much higher than that of other flowmeters can be obtained according to Bernoulli equation due to the maximum flow rate in the center.

• High accuracy

The rectangular flowmeter is not calibrated to an accuracy of 1%, while the measured value can be calibrated to an accuracy of 0.5%-0.25% if necessary.



Rectangular Block

4. Main technical parameters

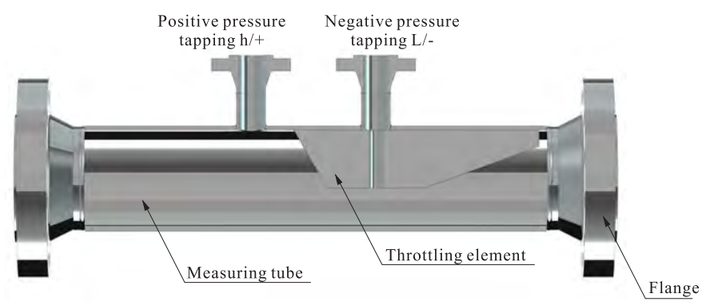
Type	Rectangular flow sensor
Accuracy grade	1.0 (which can be calibrated to Grade 0.25)
Diameter (mm)	DN25~DN600
Nominal grade	(0.25~42) MPa
Flange	Various flange standards, carbon steel/stainless steel/ other special requirements
Wedge material	304 stainless steel/special material requirements
Medium temperature	(-196~600)°C
Reynolds number range	300≤ReD≤106
Wedge ratio (h/d)	0.2, 0.3, 0.4, 0.5
Range ratio	2:1 - 10:1
Repeatability	±0.3%
Upper limit of viscosity of the measured medium	500mPa.s
Long-term stability	±0.2%ES/Y

5. Structure type

•There are three types of rectangular flowmeters: split type, integrated type and the type with temperature compensation sensor.

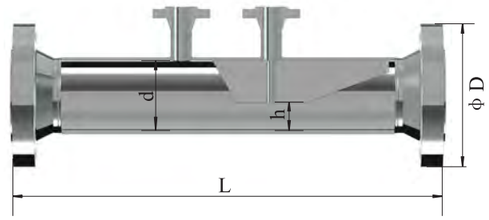
• There are two connection modes for pipelines: flange connection and direct butt welding.

• Pressure tapping mode: flange pressure tapping mode and impulse pipe pressure tapping mode.



Structure Diagram of Rectangular Flowmeter

6. Installation Dimensions



Pressure grade	ANSI150		ANSI300		ANSI600	
Caliber	L/mm	D/mm	L/mm	D/mm	L/mm	D/mm
DN50	650	150	680	165	710	165
DN80	680	190	710	210	760	210
DN100	750	230	800	255	850	275
DN150	950	280	1000	320	1150	355
DN200	1050	345	1100	380	1250	420
DN250	1150	405	1200	445	1350	510
DN300	1250	485	1300	520	1450	560
DN350	1450	535	1500	585	1650	605
DN400	1550	595	1600	650	1750	685
DN450	1850	635	1900	710	2050	745
DN500	2050	700	2100	775	2200	815
DN600	2250	815	2300	915	2350	940

Users are recommended to select the conventional dimensions in the above table, and refer to the quotation for other dimensions.

7. Installation requirements

(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) Installation direction

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

• Fluid shall flow from bottom to top when the sensor is installed on a vertical pipe. The measurement error caused by the height of positive and negative pressure taps not on the same horizontal plane shall be corrected as necessary.

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

• The flow regulating valve is installed

downstream of the flowmeter sensor.

• The installation of differential pressure signal pipeline shall meet the on-site pipeline installation requirements according to the nature of the measured medium, and relative position of the rectangular sensor and the differential pressure transmitter.

• For the wedge flowmeter installed on horizontal or inclined process pipeline, the drain hole (if any) shall be directly above the pipeline if liquid medium is adopted, and shall be directly below the pipeline of gas or steam is used.

(3) Requirements for straight pipe section

To make sure that the flow coefficient is a linear constant within the specified Reynolds number range, a large number of experimental studies and investigations have been performed on the impact of installation in the process of development, proving that the downstream straight pipe section is unnecessary for the rectangular flowmeter, and the minimum upstream straight pipe section depends on the disturbance to the fluid flow state caused by the specific design of upstream process pipeline.

Requirements for Minimum Straight Pipe Section Upstream of Diffuser Rectangular Flowmeter

Equivalent diameter ratio β=d/D	Single 90° short radius elbow	Two or more 90° elbows on the same plane	Two or more 90° elbows on different planes	Reducing pipe changed from 3D to D within the length of 3.5D	Diverging pipe changed from 0.75D to D within the length of D	Fully open ball valve or gate valve
0.30	0.5	1.5（0.5）	（0.5）	0.5	1.5（0.5）	1.5（0.5）
0.35	0.5	1.5（0.5）	（0.5）	1.5（0.5）	1.5（0.5）	2.5（0.5）
0.40	0.5	1.5（0.5）	（0.5）	2.5（0.5）	1.5（0.5）	2.5（1.5）
0.45	1.0（0.5）	1.5（0.5）	（0.5）	4.5（0.5）	2.5（1.0）	3.5（1.5）
0.50	1.5（0.5）	2.5（1.5）	（8.5）	5.5（0.5）	2.5（1.5）	3.5（1.5）
0.55	1.5（0.5）	2.5（1.5）	（12.5）	6.5（0.5）	3.5（1.5）	4.5（2.5）
0.60	3.0（1.0）	3.5（2.5）	（17.5）	8.5（0.5）	3.5（1.5）	4.5（2.5）
0.65	4.5（1.5）	4.5（2.5）	（23.5）	9.5（1.5）	4.5（2.5）	4.5（2.5）
0.70	4.0（2.0）	4.5（2.5）	（27.5）	10.5（2.5）	5.5（3.5）	5.5（3.5）
0.75	4.5（3.0）	4.5（3.5）	（29.5）	11.5（3.5）	6.5（3.5）	5.5（3.5）

Note:

1.The length of the shortest straight pipe section is expressed as a multiple of the diameter D of the process pipe.

2.The roughness of the upstream straight pipe section measured from the plane of the upstream pressure tap shall not exceed accuracy of the smooth pipe commercially available (about K/D ≤ 10).

3.Values without parentheses are "zero additional uncertainty". Values within parentheses are "0.5% additional uncertainty".

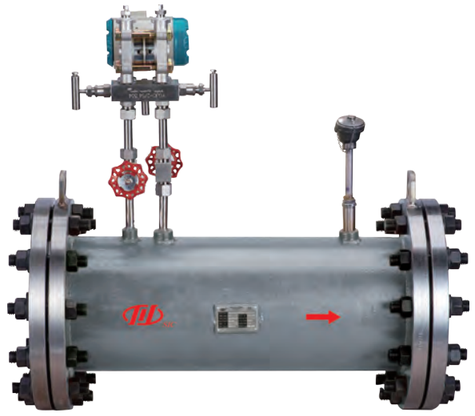
4.The bending radius of elbow is equal to or greater than the pipe diameter.

5.Pipe fittings or other chokes located at least 4 times the throat diameter downstream of the throat pressure tap shall not affect the measurement uncertainty.

CYAC New Generation DFV-type V-cone Flowmeter

1. Product Overview

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 rate, which reaches its maximum value at the maximum diameter of the V cone, so that the static pressure drops, forming a low pressure end at downstream end of the V cone. So that a differential pressure △P is generated ahead of and behind the V cone. The positive differential pressure is the static pressure PH measured before the upstream fluid contracts. The negative differential pressure is the static pressure PL measured at the center of downstream end face of the V cone. Therefore, the flow of fluid can be measured by measuring the differential pressure △P generated ahead of and behind the cone according to the relationship between the square root of differential pressure and the flow of fluid.



1.1 Application

• Measure the flow of gas, steam and liquid

• The flowmeter is designed as a fluid sweep structure, which is impossible to intercept any entrained gas, liquid or solid pollutants in the fluid. It is very suitable for flow measurement of dirty fluids, such as coke oven gas and wet gas, especially blast furnace gas. It has a self-cleaning effect and the impulse pipe is not easy to be blocked.

1.2 Advantages

It can be used for effective measurement of any clean or dirty fluid, such as liquid, gas, steam, and high temperature and low temperature fluid

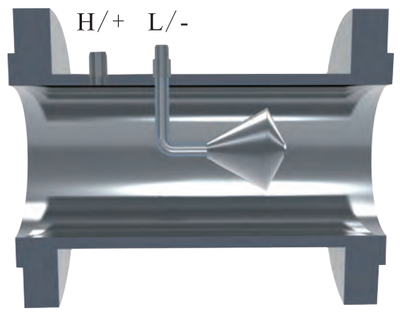
• Wide range ratio of 4:1 to 10:1

•Self-rectification function, requiring only extremely short straight pipe section ((1~3)D in the front part and 2D in the rear part)

•Self-cleaning function, so it is capable of measuring dirty and easily scaled fluids, and is suitable for blast furnace gas and other media with many impurities

•High accuracy, which is within ±1% of indication

•Self-protection function, so that key parts of throttling elements will not wear, and long-term stable operation can be ensured



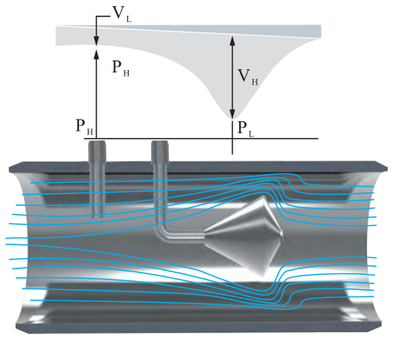
2. Working principle

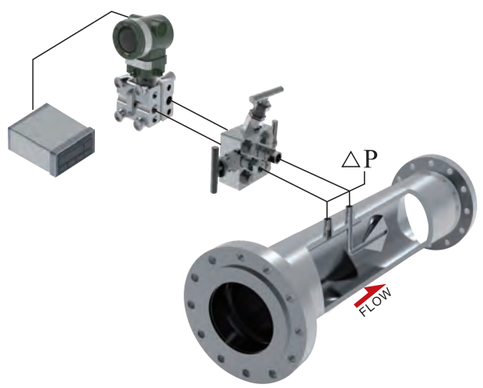
The flow formula is as follows:

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

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

q_m - mass flow (kg/s)
q_v - volume flow under working conditions (m^3/s)
△p - differential pressure (Pa)
ε - expandability coefficient, ε=1 for liquid;
ε<1 for compressible fluids such as gas and steam
β - equivalent diameter ratio
C - discharge coefficient
D - pipe inner diameter (m)





3. Instrument Characteristics

• High accuracy

The accuracy of primary element of V-cone flowmeter reaches 0.5%

• High repeatability

The repeatability of primary element of the V-cone flowmeter reaches 0.25%

• Low requirements for installation of straight pipe section

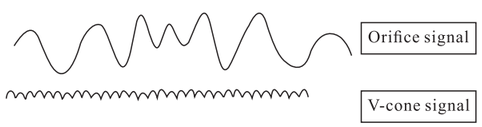
The special structure of V-shaped cone can weaken the convex shape in the velocity distribution and achieve the characteristic of rectification. It is this self-rectification characteristic that greatly reduces the requirements for the front and rear straight pipe sections. The section is generally (2~3)D long upstream and (0~1)D downstream.

• Low pressure loss, which is only 60% of the orifice pressure loss.

• Signal stability

The β value can remain unchanged for a long time and long-term accurate measurement can be ensured.

Only high-frequency and low-amplitude small vortices will be generated downstream of the V-cone due to its special shape. In this way, on the one hand, the differential pressure signal generated is relatively stable, and on the other hand, the sensitivity to small signals is higher than that of the central contracting throttling device (such as orifice), so that high measurement accuracy and stability can still be ensured at low flow and low differential pressure.

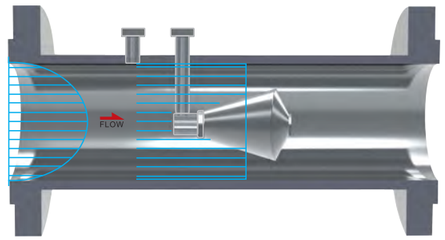


• Long-term stability

Due to structural characteristics of the V-cone itself, the flow rate in the center reduces and that near pipe wall increases gradually when the fluid approaches the V-cone, which will lead to the following results:

a.No impurity entrained in the fluid can be intercepted, thus achieving the effect of self-cleaning.

b. A boundary layer forms around the V-cone, and the fluid will be led away from the edge of the cone tail as the fluid flows through the V-cone. This self-protection function reduces the wear caused by dirty medium, decreases the geometric deformation of V-cone greatly, ensures the stability of discharge coefficient in a long time, and increases the service life of flowmeter.

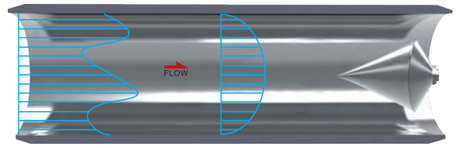


Rectification Effect of V-shaped Inner Cone

•The integrated structure design makes it possible to display temperature, pressure and differential pressure on the LCD screen at the same time. So that it is unnecessary to use the impulse pipe, blockage and leakage caused by the pipe can be avoided, and the installation is convenient.

•V-cone sensors can be configured by any transmitter designated by the user to output (4-20) mA, differential pressure, or flow signals.

•The V-cone has the function of self-mixing. The non-homogeneous phase fluid will mix automatically and become an average-velocity fluid when flowing through the V-cone, thus achieving effective flow measurement. The instrument is calibrated and delivered one by one on the standard device to ensure the measurement accuracy.



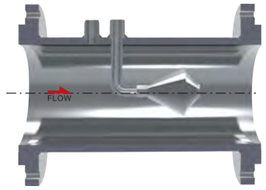
Rectification Effect of Inner Cone

4. Main technical parameters

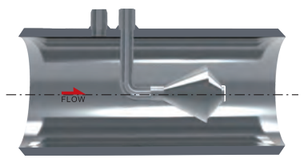
Type	V-cone flow sensor
Accuracy grade	Class 1.0
Diameter (mm)	DN25~DN3000
Nominal pressure	(0.25~16) MPa
Flange	Various flange standards
V cone material	Stainless steel/special requirements
Medium temperature	-200℃~500℃
Minimum Reynolds number	8000 (good repeatability when the Reynolds number is between 400 and 8000)
β value range	0.35~0.8
Range ratio	4:1 - 10:1 (with maximum differential pressure and higher Reynolds number)
Repeatability	0.5%
Applicable media	Gas, liquid, steam, ideal for dirty media (e.g. coke oven gas, wet gas), etc.
* Transmitters to be selected shall match working conditions and parameters.	

5. Structure type

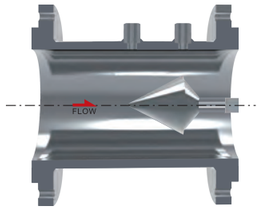
The connection forms between the V-cone flow sensor and the process pipeline are mainly as follows:



(1) Flange connection type

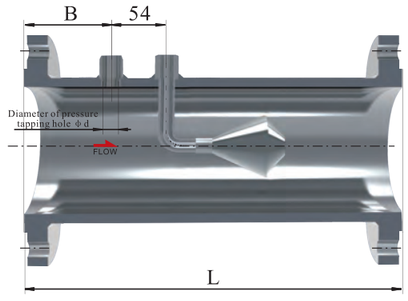


(2) Direct welding type



(3) Flange clamping type

6. Installation Dimension of V-cone Flow Sensor



(1) Flange connection type

Dimensions of flange connection

Nominal diameter DN (mm)	Dimension (mm)		
	Total length L	B	Diameter of pressure tapping hole 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

7. Installation requirements

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.

Installation direction

Sensors can be installed horizontally or vertically.

When the sensor is installed on a vertical pipe, the measurement error caused by the height of positive and negative pressure taps not on the same horizontal plane shall be corrected as necessary.

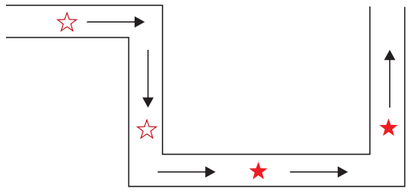
Requirements for straight pipe section

Generally, the front straight pipe section is (5~10)D, and the rear straight pipe section is (2~3)D.

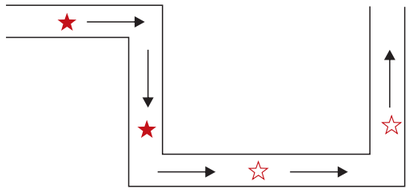
Selection of installation position

★ represents the installation position recommended

☆ represents the installation position not recommended



Liquid Installation Position



Gas and Steam Installation Positions

8. Precautions for Use

(1) Before using a new V-cone flowmeter or restarting a V-cone flowmeter which has been out of service for a period of time, check the pressure tapping pipeline for blockage and leakage. When liquid medium is adopted, fill the pressure tapping pipeline with clean water or other impulse liquids, and discharge the gas mixed in the pipeline. When gas medium is adopted, discharge the accumulated liquid in the pipeline.

(2) It is recommended to provide a settler or isolator during the measurement of fluids containing suspended solids or dirt. The pressure tapping pipeline and sewage outlet shall be located properly to achieve the purpose of sewage discharge.

Prompt for high product operation risks
Due to the special structure, the V-cone flowmeter may be subject to the risk of cone falling off due to external impact such as high temperature, high pressure, high flow rate, water hammer effect and fatigue vibration. It is recommended to maintain it regularly, or use it when there is no operation risk.

9. Fluids Suitable for Measurement:

(1) Gas

Gas: coke oven gas, blast furnace gas, city gas

Natural gas: including natural gas with a moisture content of greater than 5%

Various hydrocarbon gases: alkane gases, olefin gases, etc.

Various pure gases: hydrogen, nitrogen, oxygen, etc.

Corrosive gas: wet chloride gas, etc.

Air: including air containing water and dust, compressed air, etc.

Flue gas: flue gas discharged from various boilers and heating furnaces

(2) Steam: saturated and superheated steam

(3) Liquid oil: crude oil, fuel oil, aqueous emulsified oil, diesel oil, hydraulic oil, etc.

Water: raw water, drinking water, production water, sewage, etc.

Various aqueous solutions: acid, alkali, saline solution, etc.

Organic chemicals: methanol, ethylene glycol, xylene, etc.

(4) Special fluids

Oil + HC gas + sand

Aerated water; $H_2O + N_2$ + air; $H_2O + CO_2$, etc.

* Refer to Page P02 for the type spectrum

CYAC New Generation DFB-type SDB Averaging Pilot-tube Flowmeter

1. Introduction

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

Application

- Measure the flow of gas and liquid
- Be mainly used in power industry, metallurgical industry, water treatment and chemical industry
- Be applicable to the measurement of high-temperature and high-pressure liquid, air volume of large and medium-diameter pipes, and flue gas pipes
- Be applicable to the measurement of large-diameter gases such as blast furnace gas, coke oven gas, converter gas and cold air of blast furnace hot stove in the metallurgical industry

Advantages

It can be used for effective measurement of any clean or slightly dusty fluid, such as liquid, gas, and high temperature and low temperature fluid

- Stable and good measurement signals
- Intrinsic anti-blocking design of probe
- Upstream and downstream pipelines, which shall be at least 7D in the front section and 3D in the rear section
- High accuracy, which is within ±1% of indication
- Wide measuring range up to 3:1 to 10:1
- High-strength monolithic dual-cavity structure of probe
- Being able to be inserted and pulled out online, which is convenient for maintenance
- Integrated structure, which is easy to use, check and troubleshoot

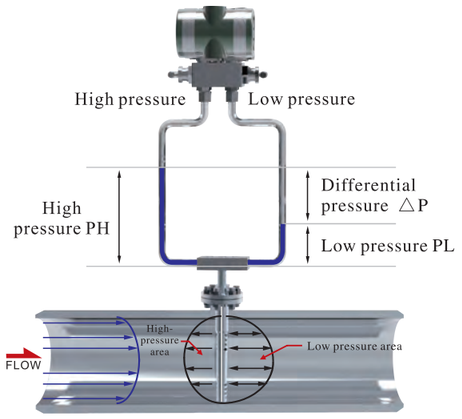


Clamped type　　Flange type

* High-pressure connection
* It should not be selected when the common differential pressure is lower than 100 Pa
* The product accuracy is determined by the transmitter for lower differential pressure

2. Working principle

The SDB flow sensor is inserted into the pipe, a high-pressure distribution area is generated in front of the probe according to the fluid continuity equation and Bernoulli's principle when the fluid flows through it, and the pressure in the high-pressure distribution area is slightly higher than the static pressure of pipe. When the fluid flows through the probe, it is split into two streams to flow through the averaging pitot-tube probe. In this case, the fluid speeds up, and a low-pressure distribution area is generated behind the probe, with a pressure slightly lower than the static pressure of pipe. The fluid flow is accurately measured by measuring the pressure difference △P between the average positive pressure PH in the high-pressure area and the average negative pressure PL in the low-pressure area.



Flow calculation equation:

$$q_{m=K\varepsilon\frac{\pi}{4}D^2\sqrt{2\triangle P\rho}}$$ Or $$q_{v=K\varepsilon\frac{\pi}{4}D^2\sqrt{\frac{2\triangle P}{\rho}}}$$

qm - mass flow M (kg/s)
qv - volume flow (m^3/s)
K - flow coefficient
ε - expandability coefficient
ρ - density of the measured medium under working condition (kg/m^3)
△p - differential pressure (Pa)
D - pipe inner diameter (mm)

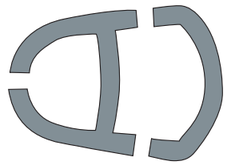
3. Features

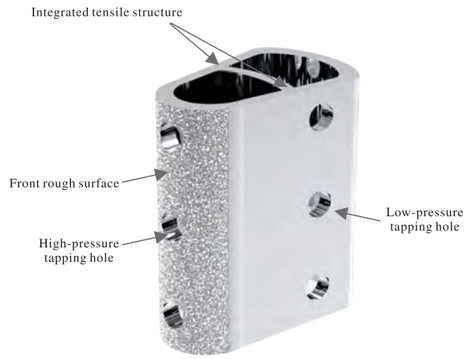
- Unique profile shape, which can realize high flow range ratio
- Double-averaging function, which improves the accuracy
- Integral monolithic dual-cavity structure, which provides the best strength
- Suitable pipe diameter: 200 mm to 6000 mm
- Being suitable for the pipe with square or rectangular section
- Being provided as a hot tap, which can be inserted into the pressure pipe
- Optional direct-mounting transmitter layout
- Zero coefficient drift, which ensures long-term stability
- Small permanent pressure loss, which is only 5% of that of the orifice

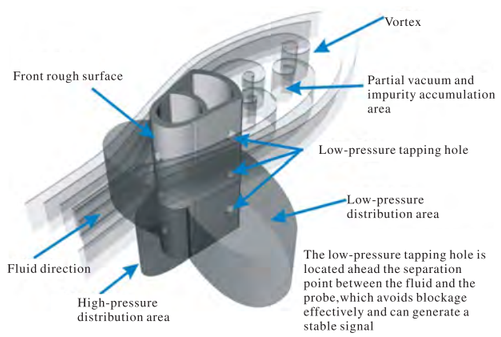
4. Main technical parameters

Instrument type	SDB averaging pitot-tube flowmeter
Accuracy grade	Class 1.0
Nominal pressure	(0.25~10) MPa
Medium temperature	(-196~600)℃
Upper limit of measurement	Depending on probe strength
Lower limit of measurement	Depending on minimum differential pressure requirement for measurement
Sensor material	304 stainless steel, 316L stainless steel, alloy steel or special media, etc.
Range ratio	Greater than 10:1
Applicable pipe diameter	200 mm~6,000 mm, a diameter greater than 200 mm is preferred for round and square pipes
Applicable media	Single-phase gases and liquids with a viscosity not more than 10 centipoises, which are filled in the pipes and flow unidirectionally
Medium flow velocity requirements	Greater than or equal to 4.5 m/s for gases; greater than or equal to 0.6 m/s for liquids

5. Structure type







5.1 Structural characteristics of bullet-shape SDB

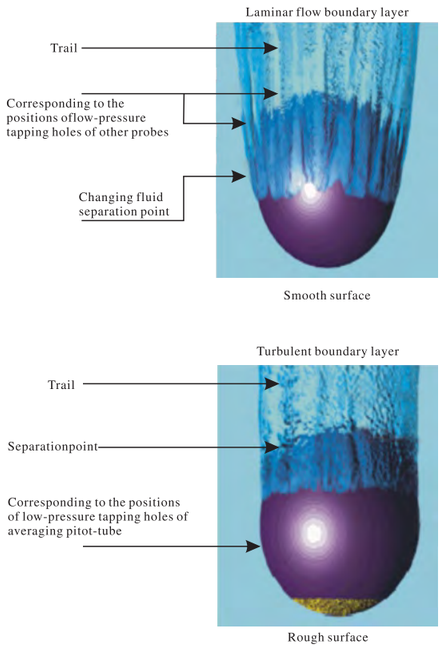
• The streamlined probe design minimizes the traction force and fixes the separation point between the fluid and the probe to ensure the most stable differential pressure signal.

• The high-strength probe has an integrated dual-cavity structure to avoid intermittent leakage, ensure long-term accuracy and improve upper range limit of the probe.

• Multiple groups of pressure tapping holes truly reflect the average flow rate of fluid, and make the signal more accurate.

• The unique position of low-pressure tapping hole not only prevents the hole from being blocked effectively, but also prevents the hole from being affected by vortex, making the low-pressure signal more stable and accurate.

• The probe surface is roughened, and the boundary layer of fluid on the probe surface is in a turbulent state, so that the probe can still obtain stable and accurate signals at low flow rates.



5.2 Structural characteristics of diamond-shape SDB

(1) Enlarged sensor. The differential pressure value generated at the same flow rate is slightly higher than that of bullet-shape sensor, and it is suitable for the flow measurement of low static pressure and low differential pressure fluids.

(2) Static pressure holes are located on both sides of the backflow surface to avoid the direct influence of vortex. The number of static pressure hole is increased from 1 to 6~8 on each side, and the hole diameter is increased from φ3~4 to φ10, which reduces the probability of blockage greatly.

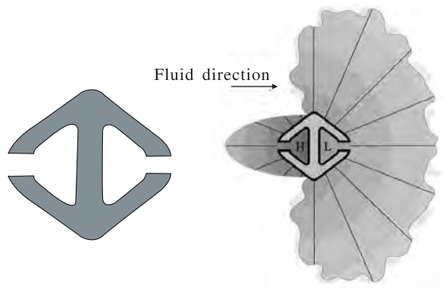
It can be widely used in the measurement of gases with high dust content (such as blast furnace gas, coke oven gas, converter gas, sintering flue gas, dust removal gas and flue gas).

(3) High-temperature averaging pitot-tube flow sensor.

It is suitable for measuring the flow of high-temperature liquid, gas, water steam and other media.

(4) High-strength averaging pitot-tube sensor.

Compared with the traditional averaging pitot-tube sensor, the high-strength averaging pitot-tube flow sensor is characterized by a larger detection rod whose diameter is increased from φ28 to φ60, larger pressure tapping hole whose diameter is increased from φ4 to φ10, greater number of 8~16, greater differential pressure (increased by 30%~40%), more stable measurement, higher accuracy (up to Grade 0.5), wider range ratio (usually 1:12, and up to 1:15), and longer period of blockage in dirty gas.



6. Product type

6.1 The bullet-shape SDB averaging pitot-tube flowmeter is divided into the following four types according to the connection mode:

Bullet-shape SD flowmeter				
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

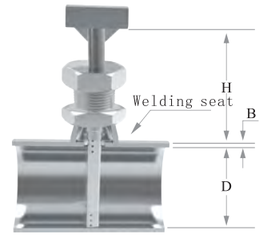
6.2 Product type

Diamond-shape SDB flowmeter			
Name	High-strength type	High-temperature type	Anti-blocking type
Sealing	Flange sealing	Flange sealing	Flange sealing
Connection method	Flange connection	Flange connection	Flange connection

7. Overall Dimensions of Bullet-shape Sensor

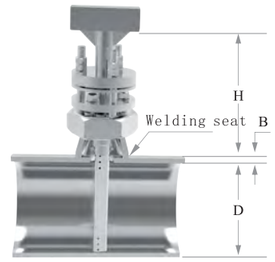
Ferrule type/ferrule type with double-sided supporting (SDB-R/SDB-RS)

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



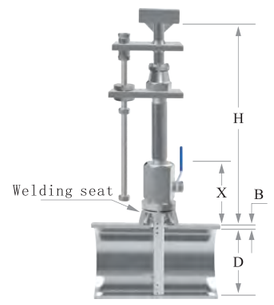
Threaded connection and spring-locked type (SDB-SS)

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



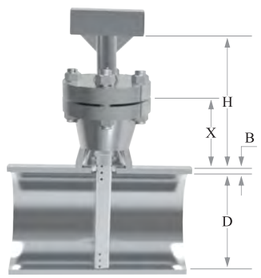
Threaded connection and online type (SDB-HS)

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



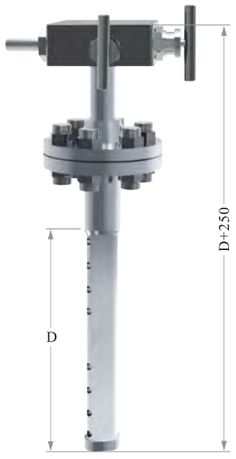
Flange connection type/flange connection type with double-sided supporting (SDB-F/SDH-FS)

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

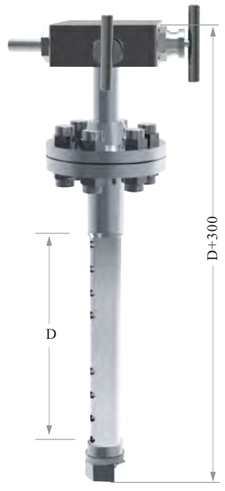


Note: D refers to pipe inner diameter

8. Overall Dimensions of Diamond-shape Sensor



Flange installation



Note: D refers to pipe inner diameter

9. Installation requirements

9.1 Installation environment

The installation environment is divided into shutdown installation and online installation according to the structure of SDB products.

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

9.2 Requirements for straight pipe section

SDB averaging pitot-tube flowmeter is a plug-in flowmeter. The flow in the tube shall be in a nearly fully developed turbulent state in order to make sure that the total pressure measured in several inspection holes in diameter direction of averaging pitot-tube can fully reflect the velocity distribution in the tube.

Therefore, when there is no rectifier, the length of front and rear straight pipe sections shall not be less than 7D and shall be 3D respectively. Such requirements are proposed mainly to ensure a higher measurement accuracy. If the requirements are not met, the accuracy of the averaging pitot-tube will be reduced and the tube should not be used for direct measurement and trade accounting.

However, the measurement accuracy of SDB averaging pitot-tube is ±5% when the current straight pipe section is 2D long. Satisfactory results can still be achieved when it is used for industrial control systems.

9.3 Installation position

The interference of pipe layout to flow can affect the measurement accuracy, so it is important to install the SDB averaging pitot-tube flowmeter properly. 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. When installing an instrument, the user shall make sure that the flow direction arrow on the sensor is consistent with the field process flow direction.

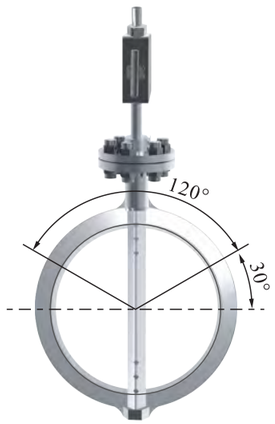
9.3.1 Influence of installation position on accuracy

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.

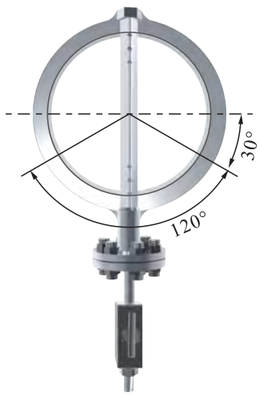
The flow direction arrow marked on the SDB averaging pitot-tube flowmeter sensor is a forward flow direction specified by the manufacturer, which shall be consistent with the fluid direction in the field pipeline during the installation of instrument. The included angle of the axis direction of the pipe is within ±3°.



Installation of horizontal pipe

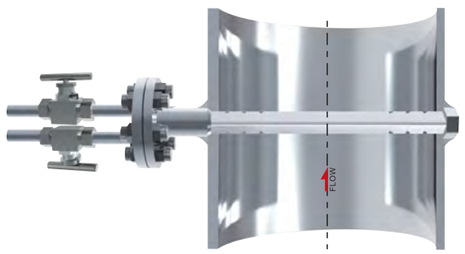


Installation for gas

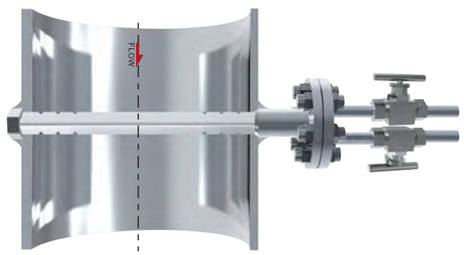


Installation for liquid/steam

Installation of vertical pipe



Installation for liquid/steam



Installation for gas

(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.



Horizontal pipe



Vertical pipe

9.3.2 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.

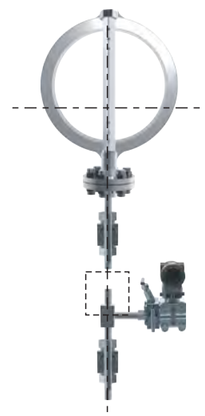
■ Please read the transmitter manufacturer's instructions carefully to install the transmitter.



Installation for gas
(transmitter above the root valve)



Installation for liquid
(transmitter below the root valve)



Installation for steam
(transmitter below the root valve)

10. Impulse Pipe

The requirements for the impulse pipe between SDB averaging pitot-tube flow sensor and differential pressure transmitter are the same as those for differential pressure flow instruments (orifice, nozzle, etc.), which are briefly described here.

10.1 Installation requirements for impulse pipe

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(in 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

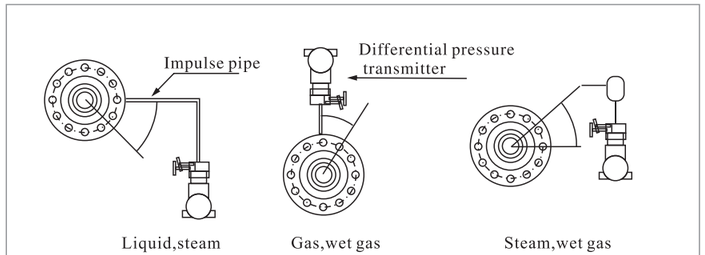
(2) The impulse pipe shall be installed vertically or obliquely with an inclination of not less than 1:12, so that the gas (for measuring the liquid medium) or condensate (for measuring the gas medium) can be exhausted in time. For viscous fluids, the inclination must be increased.

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.

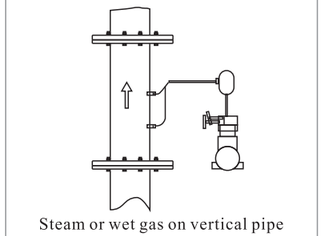
(3) In order to avoid transmission distortion of differential pressure signal, positive- and negative-pressure impulse pipes shall be laid as close as possible, and anti-freezing measures shall be taken for impulse pipes in severe cold areas.

10.2 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 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 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.

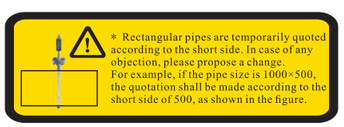
b. Gas as the measured medium: The pipe is installed vertically. The high- and low-pressure impulse pipes shall be connected to the differential pressure transmitters after they are led upward and parallel.

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

11. Model Selection of SDB Averaging Pitot-tube Flowmeter

Model	Description
DFB	
Diameter (DN200~DN6000)	
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 2: Ferrule type (with double-sided support) SDB-RS 3: Threaded connection and spring-locked type SDB-SS 4: Threaded connection and online type SDB-HS 5: Flange connection type SDB-F 6: Flange connection type (with double-sided support) SDB-FS
Nominal pressure	
X	Applicable scope: (0.25~10) MPa 1: 1.6 MPa 2: 4.0 MPa 4:2.5MPa 5: 1.0 MPa 6: 0.6 MPa 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
Operating environment	
X	1: Medium temperature: -196°C~120°C 2: Medium temperature: -196°C~300°C 3: Medium temperature: -196°C~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
Structure type	
X	1: Split type 2: Integrated
Accuracy grade	
X	C: Grade 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.

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.



DFF Air Volume Measuring Device

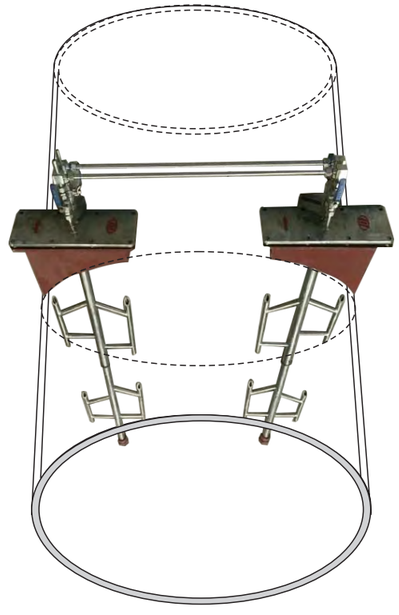
Product Introduction

The combustion conditions of a power plant, power station and boiler highly affect the economy and safety of boiler and overall power plant operation. Proper adjustment of combustion conditions, i.e. sufficient fuel combustion, uniform distribution of furnace temperature field and heat load, is necessary condition for ensuring safe, stable and economical operation of boiler. While the accuracy of air volume measurement of boiler directly affects normal operation of boiler operating conditions by operators. With higher automation degree of power plants and power stations, engineers have higher requirements for the stability of air volume measurement.

The existing air volume measuring devices for boilers of power plants and power stations in the market mainly include the flow meters with two principles: 1. thermal mass type, 2. differential pressure type. Differential pressure type has the most mature and popular application, and the air volume measuring device produced by us is also based on differential pressure principle. However, its revolutionary design makes application principle completely different from the existing differential-pressure flow meters, our air volume measuring device can fundamentally settle the existing bottleneck of the existing measuring devices, and replace the existing air volume measuring devices to become the first choice for air volume measurement of power plants.



Single-group Multi-point Air Volume

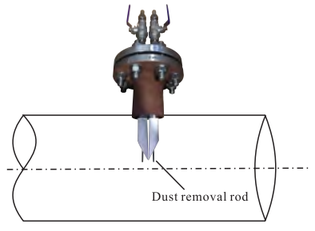


Multi-point Air Volume of Double-group Circular Pipe

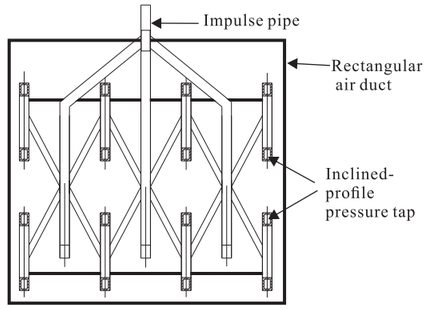
Measurement Principles

DFF air volume measuring device is based on the pitot tube measurement principle: The measuring device is installed on a pipe, with probe inserted into the pipe; in case of air flow in the pipe, the windward side will be impacted by the air flow to convert kinetic energy of the air flow into pressure energy, thus the pipe at windward side has higher pressure which is called "full pressure"; the leeward side is free of air flow impact, and its pressure in the pipe is static pressure in the air pipe, which is called "static pressure"; the difference between full pressure and static pressure is differential pressure which is in direct proportion to the air flow rate (volume) in the pipe; thus the air volume in the pipe can be measured correctly by measuring differential pressure and find out the correspondence of differential pressure and air flow rate (volume).

Due to the large cross section of the air duct of primary and secondary air volume and pulverizing ventilation volume, only one measuring point is insufficient to measure the air volume of the large air duct. In order to measure the accurate primary and secondary air volume and pulverizing ventilation volume of the boiler, we adopt the method of multi-point measurement with uniform cross section on the cross section of the large air duct. We determine the number of measuring points according to the above measurement principle, as well as factors such as the size of each measuring section and the length of straight pipe section; assemble many measuring points with the same cross section, connect one positive pressure side with another and one negative pressure side with another; lead one main pressure pipe from the positive pressure side and negative pressure side respectively and connect them with positive and negative ends of the differential pressure transmitter respectively; obtain average velocity of the section, and calculate the air volume. It has been proved by practice that the device can be put in long-term reliable service as a maintenance-free product.



▲ Schematic Diagram of Single-point Measuring Device



▲ Uniform-section Multi-point Diagram of Measuring Device

Q= K*A*f(△P, T) (m^3/h)

K - total coefficient of arithmetical operation model for air volume calculation

A - the area of installation place of air volume measuring device

T - the air temperature corresponding to air flow rate (volume), in ℃

△P - output differential pressure of air volume measuring device, in Pa

Performance Characteristics of DFF Air Volume Measuring Device

• DFF air volume measuring device completely settles the problem of signal jamming of air volume measuring devices for dusty air flow; the air volume measuring device has the function of automatic dust removal and anti-blocking by using fluid kinetic energy without any additional compressed air for purging, thus realizing completely long-term maintenance-free operation regardless of dust concentration in the air.

• DFF air volume measuring device has stable performance and good adjustment linearity.

• DFF air volume measuring device has very low requirements for the straight pipe section, and only requires a position for installing throttling parts, thus the device applies to the installation on complicated pipes.

• Due to the high measurement accuracy, DFF air volume measuring device can ensure long-term measurement accuracy of within ±1%.

Anti-blocking measure analysis

Firstly, an automatic dust removal rod is hung in each pressure tapping pipe, which swings irregularly for automatic dust removal under the impact of air flow in the pipe. The dead weight and thickness of the rod are determined by experiments before leaving the factory according to the range experiment of the design air speed (quantity) in the primary and secondary air pipes or the pulverizing ventilation pipe on the test bench, and underweight rods or rods which are too thick or too thin are disqualified. Secondly, the air volume measuring device has the function of self-cleaning and anti-blocking by using fluid kinetic energy, and it is absolutely unnecessary to add any compressed gas for purging. Long-term maintenance-free operation can be achieved regardless of the dust concentration in gas.

Feasibility analysis

1. Since the installation conditions of straight section of primary and secondary main air pipes of station boiler are not met in many occasions, and because of large air duct section and uneven flow rate distribution on the section, we can lay out the air volume measuring probes at multiple points with the same section, connect positive pressure/negative pressure ends of measuring devices with positive/negative pressure ends respectively, and finally lead a signal group to transmitter, so as to ensure the measurement accuracy, in addition, such combined air volume measuring devices do not have too many requirements for straight section of the air duct.

2. The device completely settles the problem of signal jamming of air volume measuring devices for dusty air flow; the air volume measuring device has the function of automatic dust removal and anti-blocking by using fluid kinetic energy without any additional compressed air for purging, thus realizing completely long-term maintenance-free operation regardless of dust concentration in the air.

3. The air volume measuring device has stable performance and good adjustment linearity.

4. Inserted layout is adopted. For the entire large air duct, screen area of combined air volume measuring device can be ignored, indicating that the pressure loss of the entire air duct fluid is almost zero, the energy conservation effect is significant, and it is convenient to be installed.

Economic benefit analysis

With the automatic dust removal and anti-blocking function, DFF multi-point primary and secondary air volume measuring device ensures long-term measurement accuracy, improves automatic input rate of boiler greatly, and reflects the air volume in air pipes in time to adjust boiler operation at any time, and keep boiler in operation in economical conditions; to be specific, the device has the functions as below:

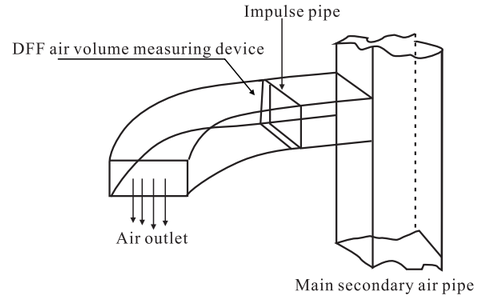
1. The device realizes reasonable air distribution of boiler and stable combustion, reduces smoke exhaust temperature, carbon content in fly ash and heat loss of pulverized coal caused by imcomplete mechanical and chemical combustion effectively, and improves the boiler efficiency.

2. The device ensures long-term measurement accuracy, and improves automatic input rate of boiler significantly. Boiler operators can make correct judgment according to the change in air volume to facilitate safe and economical operation of boiler.

3. The device can control combustion flame center of boiler effectively to prevent local coking of boiler and prevent flame deviation, and mitigate the deviation of smoke temperature at both sides of furnace outlet. It also prevents pipe burst of water wall and superheater.

4. The device can adjust air-coal proportion of coal mill in a reasonable way. The intake air volume of coal mill indirectly reflects coal volume.

5. Inserted layout is adopted. For the entire large air duct, screen area of combined air speed measuring device can be ignored, indicating that the pressure loss of the entire air duct fluid is almost zero, the energy conservation effect is significant, and it is convenient to be installed.



Selection plan

DFF multi-point cross-section measuring device is adopted. Special working conditions such as short straight pipe section and close distance from fan cone on site lead to instable flow field in the pipe, and the possibility of backflow or vortex flow. Measurement accuracy and stability cannot be ensured. In regard of the above complicated working conditions, DFF multi-point cross-section measuring device is adopted, and 16 measuring points are set to ensure accurate detection of pipe flow signal.

Operation result

Many years' operation test shows that DFF multi-point cross-section measuring device has stable performance, good adjustment linearity and stable signal, and realizes long-term maintenance-free operation.

Selection of DFF Air Volume Measuring Device

Model	Description	
DFF		
Caliber		
XXX		
Product type		
X	1. Air volume measuring device	2. Air speed measuring device
Installation method		
X	1. Inserted type	2. Pipe type
Automatic dust removal device		
X	0. Not equipped	1. Equipped with automatic dust removal device
Wear-resistant ceramic device		
X	0. Not equipped	1. Equipped with wear-resistant ceramic device
Number of measuring points		
X		
Accuracy grade		
X	Class C.1	
Pipe direction		
X	H. Horizontal	V. Vertical
Pipe direction		
X/X	Outer diameter/wall thickness(unit: mm)	

Annular Orifice Plate

1. Product Overview

1.1 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.



1.2 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 is installed coaxially in the center of the pipe. When the fluid flows in the pipe and through the annular gap formed by outer edge of the annular orifice plate and 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 △P 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:

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

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

Where:

qm - mass flow (kg/s)

qv - volume flow under working conditions (m^3/s)

△p - differential pressure (Pa)

ρ1 - working condition density (kg/m^3)

ε - expandability coefficient

C - discharge coefficient

D - pipe inner diameter (m)

1.3 Product features

The special structure of this product determines its many characteristics in application, which are not only well-founded theoretically, but also have been proved by field application. What is more prominent is:

(1) The measurement range is wide. It is not only suitable for the flow measurement of general fluid medium, but also for the measurement of fluid flow containing various impurities (such as dust, suspended solid, sedimentation, etc.), including various gases, hot air, flue gas, natural gas, cooling circulating water, etc.

(2) It has firm structure, stable performance and reliable operation.

(3) The equipment is provided with a measuring

pipe with a straight section. During installation on site, the installation error (such as eccentricity and sealing washer extending into the pipe) has little impact on the instrument measurement. Therefore, the accuracy of this instrument is higher than that of the standard orifice.

(4)When measuring saturated steam and superheated steam, it can avoid the accumulation of condensate caused by steam failure, and can start accurate metering in a short time when steam is supplied again.

(5) The "grading ring" structure is adopted, and accurate measurement is ensured when the straight pipe section is not long enough. For example: the straight pipe section ahead of the flowmeter downstream of a 90° elbow is 2D; the straight pipe section ahead of the flowmeter downstream of an elbow is 0.5D.

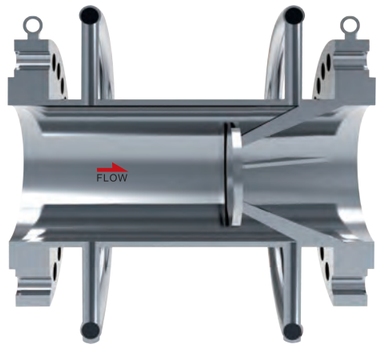
(6) The "welding method" is adopted for connection, which is suitable for high-temperature and high-pressure fluids (such as superheated steam), with low cost, reliable operation and stable performance.

1.4 Product structure

The product is divided into the following types according to the connection mode between the annular orifice plate flow sensor and the process pipeline:

(1) Flange connection type

(2) Direct welding connection type



Flange connection type

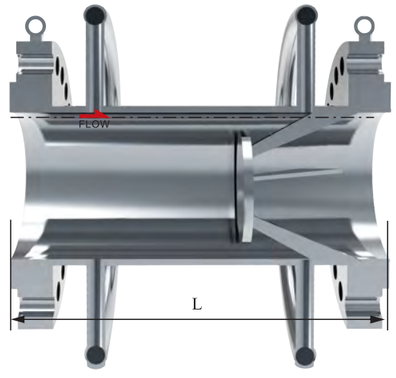


Direct welding connection type

2. Main technical parameters

Type	Annular orifice plate sensor
Basic error (sensor)	±1.0%
Diameter (mm)	DN50~DN2000
Pressure grade (MPa)	0.6 MPa~40 MPa (0.6 MPa, 1.0 MPa, 1.6 MPa, 2.5 MPa, 4.0 MPa, 6.4 MPa, etc.)
Pressure tapping mode	D-D/2 pressure tapping (radius pressure tapping)
Medium temperature	≤350℃
Repeatability	≤0.33%
Material of annular orifice plate	304 stainless steel/special requirements
Flange	Various flange standards, carbon steel/stainless steel
Applicable media	Gas, liquid, steam (flow measurement of general fluid medium, as well as the flow measurement of fluid containing various impurities)
Note: The annular orifice plate shall be calibrated according to the user's demand.	

3. Sensor Connection Size



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

Diameter	Pressure Grade ≤ 10MPa or ≤ CL300
	L
DN80 (3")	400
DN100 (4")	500
DN125 (5")	500
DN150 (6")	600
DN200 (8")	700
DN250 (10")	900
DN300 (12")	1000
DN350 (14")	1100
DN400 (16")	1200
DN450 (18")	1200
DN500 (20")	1200
DN600 (24")	1200
DN700 (28")	1400

4. Sensor Selection

4.1 Selection of sensor diameter

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

4.2 Selection of diameter code

The diameter code of annular orifice plate flow sensor is expressed in three digits, i.e. the first and second digits of DN and the number of zeros following the first two digits (unit: mm).

For example, code 500 indicates a diameter of 50 mm; code 501 indicates a diameter of 500 mm.

4.3 Selection of flanges

In addition to the standards of Machinery Department, national standards or standards of the Power Department and Petroleum Department, foreign standards of the United States, Japan and Germany can also be followed to design and manufacture flanges and to meet the needs of various users.

If companion mounting flanges are required, please specify them at the time of ordering.

4.4 Working environment

Requirements of flowmeter for external environment:

There must be sufficient installation space around the flowmeter in order to facilitate installation and maintenance.

* Refer to Page P03 for the type spectrum

5. 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.

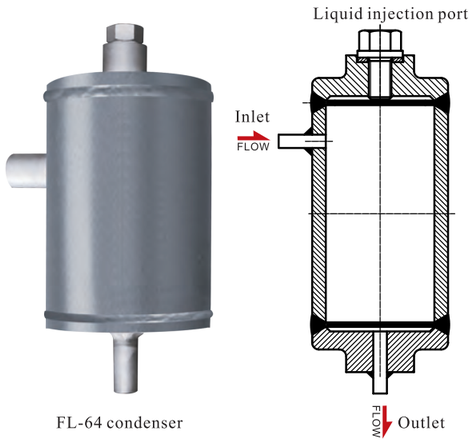
(2) Install the settlers or isolators when measuring the flow of fluids containing suspended solids or dust. Pay attention to reasonably selecting the inlet, outlet and drain outlet of the impulse fluid for drainage. It is recommended to select "dirty fluid type" sensor and "differential pressure transmitter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

Accessories of Throttling Device

1. Condenser

1.1 Purpose of condenser

FL-64 condenser is an accessory for measuring steam flow. It is filled with condensate and installed between the flowmeter and the throttling device to prevent steam entering the meter directly.



Standard interface φ14×3, φ22×4
Non-standard interfaces shall be indicated separately at the time of ordering

1.2 Technical data of condenser

1. Working pressure: 6.4 MPa (64 kgf/cm^2)
2. Specification:

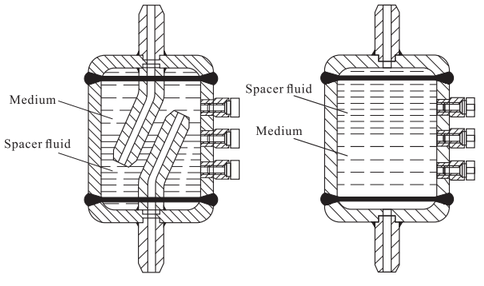
Name	Model	Specifications
Condenser	FL-64	Sectional area: 100 cm^2

2. Isolator

2.1 Purpose of isolator

FG isolator is an accessory for measuring the flow of corrosive liquid or gas. FG-64A isolator is used when specific gravity of the measured medium is less than that of the spacer liquid, and FG-64B isolator is used when specific gravity of the measured medium is greater than that of the spacer liquid. The isolator device is located between the instrument and the throttling element, and protective liquid is injected into the isolator and the impulse pipe behind it, so that the instrument will not be corroded by the measured liquid or gas.)



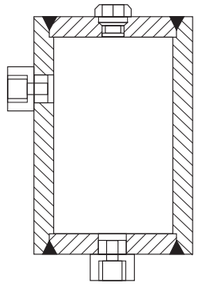


FG-64A FG-64B

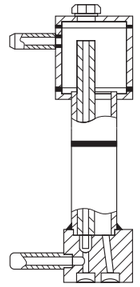
2.2 Technical data of isolator

1. Working pressure: 6.4 MPa (64 kgf/cm^2)
2. Specification:

Product Name	Isolator	
Model	FG-64A	FG-64B
Specifications	The specific gravity of the measured medium is less than that of the spacer fluid	The specific gravity of the measured medium is greater than that of the spacer fluid



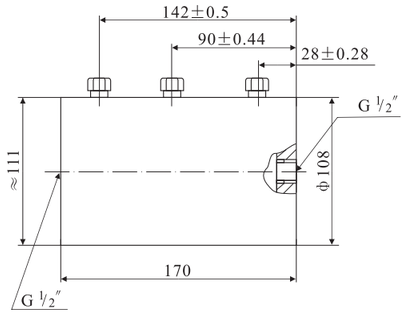
FP-64A



FP-64B

2.3 Installation dimension of isolator

Diagram for installation dimension of FG-64 isolator (as follows)



3. Balance

3.1 Purpose of balancer

FP-64A and FP-64B balancers are accessories for measuring liquid levels. The FP-64A single-layer balancer is used for measuring the liquid level of open or low pressure vessel.

The FP-64B double-layer balancer is adopted for measuring the water level of boiler water drum.

3.2 Technical data of balancer

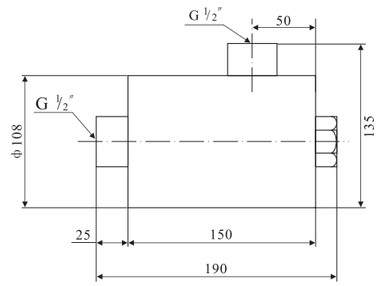
1. Working pressure: 6.4 MPa (64 kgf/cm^2)
2. Measuring range:

Determined by the differential pressure measuring range of the differential pressure gauge for the FP-64A type

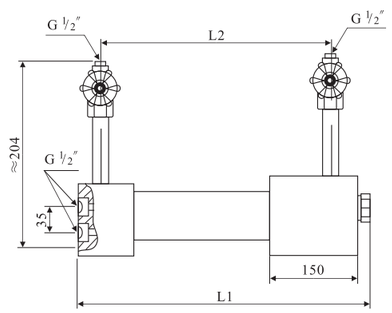
±1.8 kpa~±5 kpa for the FP-64B type

3.3 Installation dimension of balancer

Diagram for installation dimension of FP-64 balancer (as follows)



FP-64A

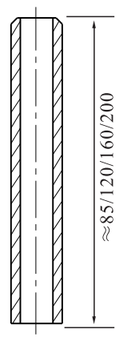


FP-64B

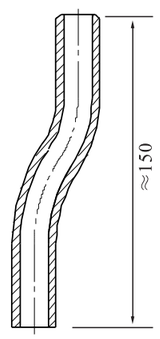
FP-64B		Measurement range	
		±3.2kpa (±320mmH$_2$O)	±5kpa (±500mmH$_2$O)
Dimension (mm)	L1	730	1090
	L2	640	1000
	L3	274	454

4. Pressure tapping pipe and pipe fittings

The standard valve diameters of throttling devices are mainly DN6 and DN15, and the corresponding outer diameter and wall thickness of the pressure tapping pipe are φ14×3 and φ22×4. Common pressure tapping pipes include straight pressure tapping pipes and S-shaped pressure tapping pipes, and the outline is roughly as follows:



Straight Pressure Tapping Pipe



S-shaped Pressure Tapping Pipe





5. Three-valve Manifold and Five-valve Manifold

When the integrated throttling device needs to be equipped with a three-valve manifold (or five-valve manifold), different mounting bolts shall be provided for installing differential pressure transmitters of different brands.
If the differential pressure transmitter is not purchased by us, please provide the brand of differential pressure transmitter to help select the corresponding valve group mounting bolts.

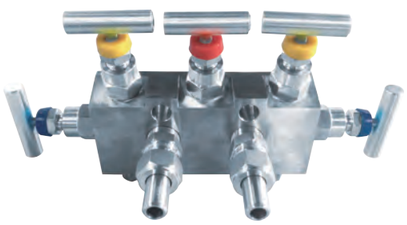
Precautions for the selection of three-valve manifold (or five-valve manifold):

1. There are two common spacings for valve groups, which are 35 mm and 54 mm respectively depending on different installation spacings, and shall not be exchanged.
2. Check the valve group for proper pressure during selection.
3. Pay attention to the applicability of gaskets according to different applicable media of the valve group.
4. The manufacturer of valve group shall have the TS special equipment production license due to the requirements for product safety.

High risk of safety accidents



Three-valve Manifold



Five-valve Manifold

Schedule I Data Correction after Real Flow Calibration

During the real flow calibration of differential pressure flowmeter, the coefficient detection method is generally adopted to measure the discharge coefficient or flow coefficient of differential pressure devices. The basic flow formula of differential pressure flowmeter is as follows:

Mass flow $q_m = \frac{C}{\sqrt{1-\beta^4}} \cdot \varepsilon \cdot \frac{\pi}{4} \cdot d^2 \cdot \sqrt{2\Delta P \cdot \rho}$

Or

$$q_m = \alpha \cdot \varepsilon \cdot \frac{\pi}{4} \cdot d^2 \cdot \sqrt{2\Delta P \cdot \rho}$$

Volume flow $q_V = \frac{C}{\sqrt{1-\beta^4}} \cdot \varepsilon \cdot \frac{\pi}{4} \cdot d^2 \cdot \sqrt{2\Delta P / \rho}$

Or

$$q_V = \alpha \cdot \varepsilon \cdot \frac{\pi}{4} \cdot d^2 \cdot \sqrt{2\Delta P / \rho}$$

C - discharge coefficient

α - flow coefficient $\alpha = \frac{C}{\sqrt{1-\beta^4}}$

The product of discharge coefficient in the above formula multiplied by the flow coefficient α is the theoretical value in the design calculation, which can also be obtained after real flow calibration and recorded as C1 or α1. Substituting C1 or α1 into the above formula or the formula in the design calculation for recalculation can correct the theoretical value and improve the accuracy. Generally, two methods, i.e. flow value correction or range change of differential pressure transmitter, are adopted, as follows:

Flow correction: $q_{m1} = q_m \cdot \frac{C_1}{C}$ Or $q_{V1} = q_V \cdot \frac{C_1}{C}$

Range change of transmitter: $\triangle P_1 = \triangle P \cdot (C/C_1)^2$

C - theoretical discharge coefficient

α - theoretical flow coefficient

C_1 - actual discharge coefficient

α_1 - actual flow coefficient

q_m - theoretical mass flow

q_{m1} - actual mass flow

q_v - theoretical volume flow

q_{v1} - actual volume flow

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Schedule II 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 in State
Working temperature		℃	Fluid viscosity	Pa.s
Regional atmospheric pressure		Pa	Relative humidity	% in 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:

①The 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;

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

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

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

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

