节　流　装　置

安 装 使 用 说 明 书

目　　录

概述

节流装置与差压计或差压变送器配套构成的差压式流量计，最广泛地被应用于单相条件下的液体、气体和水蒸汽流量的测量、控制和调节。因它具有结构简单、维护方便、使用可靠、价格低廉、准确度高等优点。

我公司是制造节流装置的专业企业，生产符合我国节流装置国家标准规定和 ISO5167-91 国际建议规范规定的各种节流装置。同时，还生产目前应用普遍的特殊节流装置。如：1/4 圆喷嘴、双重孔板、圆缺孔板等。

本公司提供的整套环室取压、法兰取压和 D-D/2 径距取压孔板，ISA1932 喷嘴、长径喷嘴和文丘利管，其技术条件符合中华人民共和国国家标准 GB/T2624-93 和国际标准 ISO5167-91 的规定，不需个别标定。除上述整套节流装置以外的特殊节流装置，在准确度要求较高时应进行个别标定。

我公司除向用户提供成套节流装置外，还可根据用户需要单独提供各种节流件和取压装置。

原理、结构和使用范围

2.1 原理

在管道内部装上孔板或喷嘴等节流件，流体流经节流件时，其上下游侧之间就会产生静压力差，该静压力差与流量之间有确定的数值关系，所以通过测量差压以及在已知流过流体的性质和其他有关环境条件下，即可根据通用的国际标准计算流量。

2.2 取压方式

2.2.1 环室取压法：

用于孔板及 ISA1932 喷嘴。环室取压的取压方法有单独钻孔取压和环室取压。对孔板，节流件上下游侧取压孔和节流件前后端面平齐。见图1，对ISA1932 喷嘴，见图2。

2.2.2 法兰取压法：

用于孔板，也称 1″取压法，节流件上下游侧取压孔轴心线分别位于距节流件前后端面25.4+0.8mm 的位置上。见图3。

2.2.3 D-D/2 径距取压法：

用于孔板、长径喷嘴，节流件上下游侧取压孔中心线分别位于距进口端面 1D 和 1/2D 处。见图4 和图5。

2.3 结构及使用范围

根据中华人民共和国国家标准GB/T2624-93 和国际标准ISO5167-91 规定，

节流装置适用的流量量程比为 3（即最大与最小适用流量之比），在个别情况下允许量程比为4，如果量程比大于上述值，则在使用同一台差压计时在小流量时的测量误差很大。

2.3.1　环室取压标准孔板：

适用直径比β为0.2~0.75，雷诺数为R_{eD}≥$5\times10^{3\sim7}$管道通径为50~600mm。

β=d/D，d—孔板开孔直径；D—管道实际内径

2.3.2　法兰取压孔板及D-D/2 取压孔板

适用的直径比β为 0.2~0.75，雷诺数为 R_{eD}≥$5\times10^{3\sim7}$，适用管道通径为400~3000mm，其几何结构与环室取压孔板相同，只多一个手柄。

2.3.3　ISA1932 喷嘴和长径喷嘴

适用的直径比β对ISA1932 喷嘴为0.3~0.8，雷诺数为$R_{eD}=10^{4\sim7}$，适用管道通径为50~600mm，对长径喷嘴为 0.2~0.75，雷诺数为 $R_{eD}=5\times10^{3\sim7}$，适用管道通径为50~600mm，且压力损失较孔板小。见图2 和图5。

2.3.4　1/4 圆喷嘴

适用雷诺数较低，一般在$R_{eD}=500\sim2.5\times10^{5}$，管道通径为15~150mm，其结构如图6。

2.3.5　双重孔板

由相互按一定距离安装在直管段中的两块孔板组成，适用雷诺数较低，一般在$R_{eD}=3\times10^{3\sim5}$，其结构如图7。

2.3.6　圆缺孔板

适用于测量脏污介质，（如高炉煤气、泥浆等），其结构如图8。

2.3.7　文丘利管

适用的直径比β为 0.3~0.75，雷诺数范围为 $R_{eD}=2\times10^{5\sim6}$，管径范围为200~2000mm，其压力损失比孔板、喷嘴小。结构见图9。

规格

3.1　节流件及其附件，见下表1

表

节流件	型号	取压方式	规格和参数		直径比 β	采用标准
			公称管径 Dg(mm)	公称压力 Pn(Mpa)		
标准孔板	HLGBH	环室取压	50~600	≤6.4	0.2-0.75	GB/T2624-93 ISO5167-91
	HLGBZ	钻孔取压	400~3000	≤2.5		
	HLGBF	法兰取压	50~700	≤2.5		
	HLGBJ	D-D/2 取压	50~700	≤2.5		
圆缺孔板	HLGQH	环室取压	400~1000	≤1.6	0.2-0.75	VDI/VDE2041
	HLGQZ	钻孔取压				
	HLGQF	法兰取压				
1/4 圆喷嘴	HLGEH	环室取压	50~150	≤1.6	0.2-0.62	VDI/VDE2041
	HLGEZ	钻孔取压	15~50			
双重孔板	HLGYH	环室取压	25~400	≤2.5	0.2-0.75	本厂标准
ISA1932 喷嘴	HLGPH	环室取压	50~600	≤6.4	0.3-0.8	GB/T2624-93 ISO5167-91
	HLGPZ	钻孔取压	400~600	≤2.5		
长径喷嘴	HLGCJ	D-D/2 取压	50~630	≤20	0.2-0.75	GB/T2624-93 ISO5167-91
文丘利管 (特殊取压)	HLGTT	机加工式	50~250	≤1.6	0.4-0.7	GB/T2624-93 ISO5167-91
	HLGWT	粗焊铁板式	200~2000			
小孔板	HLGMH	环室取压	10~50	≤10.0	0.2-0.75	GB2624-81
	HLGMZ	钻孔取压				
	HLGMF	法兰取压				
笛形均速管（阿牛巴）	HLGZT	特殊取压	80~5000	≤6.4	0.3~0.75	本厂标准
双重文丘利	HLGST	特殊取压	250~4000	≤2.5	0.3~0.75	本厂标准
机翼测风装置	HLGJT	特殊取压	≥150	≤1.6	0.3~0.65	本厂标准

备注：对于环室取压、法兰取压、径距取压管径 Dg≤400mm 时，节流装置成套包括：节流件（如孔板、喷嘴、1/4 圆喷嘴、圆缺孔板等）、取压装置、节流件前 10 和后 5D 测量管，工艺管道上一对连接法兰、密封垫、导压管及引压短管、二只截止阀、所有紧固件及有关附件（如冷凝器等）。

安装要求

为了保证测量准确度，有必要规定如下主要安装要求。

4.1　对节流件或一次元件

4.1.1 节流件必须这样安装，即令流体从节流件上游面流向下游面(见管道上的箭头)。

4.1.2　节流件必须与管道同轴安装，其不同心度应在±1°以内。

4.1.3　节流件与管道必须同心（或者在环室内对好中心），其偏心距离 CX（节流件中心线与上下游管道中心线之间的距离）应不大于 0.0025D/(0.1+2.3β)或0.015D(1/β-1)。

4.2　对管道

4.2.1 节流件应嵌装在两段直的等截面的管段之间，建议应随节流件配套供应上游 10D 和下游5D 长的镗制直管段。

4.2.2 安装时在节流件上下游必须的直管长度与上游管件的形式和β值有关，其最小长度应按GB/T2624-93 或 ISO5167-91 考虑。

4.2.3 节流件应在管道清洗或吹扫后安装。

装置运行时，测量段管路内的流体必须充满。

4.2.4 若必须装调节阀，则建议把调节阀装在下游5D 直管段之后。

4.2.5 若必须在节流件上游装设隔离阀，则该阀应为闸阀形式且必须全开。

4.2.6 垫片或密封圈应这样制造和安装，即在任何地点，它不得突入管道内腔或挡住取压孔、取压槽。

4.2.7 在节流件或环室之间若有垫片，则垫片应尽量薄且不得突入环室内腔。

4.3　对差压讯号管路

4.3.1 差压引出口原则上可在相对于节流件的任何位置上，但对水平管道，其位置应这样安排，即令差压讯号管道有可能自动疏水（被测介质为气体时）和排气（被测价质为液体时），其安装位置见图10。

4.3.2 通向节流件两侧取压口的取压管应先接一段直的短管，然后接以闸阀，如果取压口靠得很紧，则短管可以有不同的长度以适应装拆阀门。

4.3.3 取压口引出的短管应在一致的水平面上。在蒸汽垂直管道上或对气体或液体管路有必要安装隔离容器时，在阀门和T 形接头(用于安装冷凝器或隔离容器)之间的短管可以向上弯使之准确地位于同一水平面上，其具体安装方式见图11~ 15。

4.3.4 与差压计连接的差压信号管路的长度一般应小于 16m，长度大，其内径也应相应增大，其内径和长度的关系参见表2。

表 2

内径(mm) 信号管路长度(m) 被测流体	≤16	16~45	45~90
水、水蒸汽、干气体	7~10	10	13
湿气体	13	13	13
低中粘度油脂	13	19	25
脏的液体或气体	25	25	38

4.3.5 差压讯号管路应垂直或以不小于1：12 的倾斜度连续倾斜敷设（即使长度很小时也应如此）。

4.3.6 在差压讯号管线上不得有可能积留液体或气体的袋形空间，如不能避免时，应装设集气器和沉降器。

4.3.7 在讯号管线很长时（超过30 m），则应分段倾斜并在各段装设集气器和沉降器。

4.3.8 如管线（垂直段）相当长，应避免由于温差导致的虚假压差，此时建议把两根差压管线靠近敷设并一起包在保温层内，在严寒地区还应防冻。

4.3.9 差压管线应有支架，以避免差压计受到振动或外部作用力。

使用与维护

5.1 实际工作中工艺条件有时会有所改变，会给测量结果带来误差，因此有时要做必要的修正。

当压力与温度发生变化时，将影响到介质的变化。须采用下列公式予以修正：

$$G_2 = G_1 * \sqrt{\frac{r_2}{r_1}} \qquad \text{或} \quad Q_2 = Q_1 * \sqrt{\frac{r_1}{r_2}}$$

式中：G_1—读数流量　G_2—实际流量　（kg/h）

Q_1—读数流量　Q_2—实际流量　（m^3/h）

r_1—被测介质设计密度

r_2—被测介质实际密度

5.2 维护

节流装置和导压系统及前后管道，每年至少应检查一次，清除污垢，更换报废元件，保证其正常运行。

The differential pressure flowmeter that consists of the throttling device and differential pressure gauge or differential pressure transmitter is most widely used for the measurement, control and regulation of liquid, gas and steam flows under single-phase conditions, as it features a simple structure, easy maintenance, reliable use, low cost, high accuracy, etc.

Ours is a specialized manufacturer of throttling devices and we manufacture various types of throttling devices that meet the GB/T2624-93 national standard and ISO5167-91 international standard as well as special ones being widely used at present, for example, the 1/4 round nozzle, two-tier orifice plate, segmental orifice plate, etc.

The technical conditions of the complete sets of corner, flange and D—D/2 tappings orifice plate, ISA1932 nozzle, long radius nozzle and venturi tube provided by our company meet the stipulations of the P.R.C. standard GB/T2624-93 and international standard ISO5167-91 , do not need to be calibrated individually. Special throttling devices other than the above complete sets of throttling devices should undergo individual calibration when there is a high demand for accuracy.

Besides providing complete sets of throttling devices for the users, we can also separately supply various independent throttling devices and pressure-tapping devices based on the users' needs.

2.1 Principle

Mount a throttling device — an orifice plate or a nozzle inside the pipe and when the fluid flows through it, a static pressure difference between the upstream side and the downstream side will occur. There is a definite relationship in the numerical value between the static pressure difference and flow, so by measuring the differential pressure and under the conditions of knowing the nature of the fluid passing through and under other relevant environmental conditions, the flow can be measured based on the general international and national standards.

2.2 Pressure-tappings

2.2.1 The corner tappings:

Used for orifice plates and ISA1932 nozzles. The methods of corner tapping fall into two kinds: separate bore tapping and ring chamber tapping. For an orifice plate, the pressure-tapping holes on the upstream and downstream sides must be in alignment with the front and rear end faces as shown in Diagram 1. See Diagram 2 in the case of an ISA1932 nozzle.

2.2.2 The flange tappings:

Used for orifice plates, also called the l inch pressure-tapping method. The center line of the pressure-tapping holes on the upstream and downstream sides are located 25.4±0.8mm away from the front and rear end faces respectively as shown in Diagram 3.

2.2.3 The D—D/2 tappings

Used for orifice plates and long radius nozzles. The center lines of the pressure-tapping holes on

the upstream and downstream sides are located 1D and D/2 away from the inlet end faces respectively as shown in Diagrams 4 and 5.

2.3 Structure and scope of application

According to the stipulations of National Standard GB2624-81 of the People's Republic of China, the flow measurement range ratio applicable to the throttling device is 3 (viz., the ratio between the maximum and minimum applicable flows). In certain cases, the allowable measurement range ratio is 4. If the measurement range ratio is greater than the above value, the measurement error is apt to be very great with the same differential pressure gauge at a low flow.

2.3.1 The corner tapping standard orifice plate

Applicable diameter ratio β is 0.2~0.75. Reynolds number is 5×10^3~10^7. The pipe is 50~600mm.

β = d/D d: orifice diameter (mm) .

D: actual ID of the pipe (mm)

2.3.2 The orifice plate with flange and D—D/2 tappings

Applicable diameter ratio β is 0.2~0.75. Reynolds number is 5×10^3~10^7. The pipe is 400~3000mm. The geometrical structure is the same as that of the corner one, except it has a handle.

2.3.3 The ISA1932 nozzle and long radius nozzle

Applicable diameter ratio is 0.3~0.8 and Reynolds number is 2×10^4~10^7 for the ISA1932 nozzle , for the long radius nozzle applicable diameter ratio is 0.2~0.75. Reynolds number is 5×10^3~10^7 .Applicable pipe is 50~600mm for the together and the pressure loss is less than the orifice plate. See Diagrams 2 and 5.

2.3.4 The 1/4 round nozzle

The applicable Reynolds number is low, generally 500~ 2.5×10^5. The pipe ID is 15~150mm. The structure is as shown in Diagram 6.

2.3.5 The two-tier orifice plate

Consisting of two orifice plates being arranged with definite spacing in the straight pipe line. The available Reynolds number is lower, normally 3×10^3~10^5. The structure is as shown in Diagram 7.

2.3.6 The segmental orifice plate

Fit for measuring dirty media (such as blast furnace gas and slurry). The structure is as shown in Diagram 8.

2.3.7 The venturi tube

The applicable diameter ratio β is 0.3~0.75. Reynolds number is 2×10^5 to 2×10^6. The pipe diameter ranges from 200 to 2000mm. The pressure loss is less than with an orifice plate or a nozzle. See Diagram 9 for its structure.

3.1 Throttling devices and the accessories (See Table 1)

Table 1

Throttling device	Model	Pressure tapping type	Specifications and parameters		Diameter Ratio β	Standard adopted
			Pipe diameter Dg(mm)	Nor. Press. Pn (Mpa)		
Standard orifice plate	HLGBH	Ring chamber tapping	50~600	≤6.4	0.2-0.75	GB/T2624-93 ISO5167-91
	HLGBZ	Bore tapping	400~3000	≤2.5		
	HLGBF	Flange tapping	50~700	≤2.5		
	HLGBJ	D-D/2 tapping	50~700	≤2.5		
Segmental orifice plate	HLGQH	Ring chamber tapping	400~1000	≤1.6	0.2-0.75	VDI/VDE2041
	HLGQZ	Bore tapping				
	HLGQF	Flange tapping				
1/4 round nozzle	HLGEH	Ring chamber tapping	50~150	≤1.6	0.2-0.62	VDI/VDE2041
	HLGEZ	Bore tapping	15~50			
Two-tier orifice plate	HLGYH	Ring chamber tapping	25~400	≤2.5	0.2-0.75	Company standard
ISA1932 nozzle	HLGPH	Ring chamber tapping	50~600	≤6.4	0.3-0.8	GB/T2624-93 ISO5167-91
	HLGPZ	Bore tapping	400~600	≤2.5		
Long radius nozzle	HLGCJ	D-D/2 tapping	50~630	≤20	0.2-0.75	GB/T2624-93 ISO5167-91
Venturi tube (Special tapping)	HLGTT	Mechanical processed	50~250	≤1.6	0.4-0.7	GB/T2624-93 ISO5167-91
	HLGWT	Rough welding lron plate	200~2000			
Small orifice plate	HLGMH	Ring chamber tapping	10~50	≤10.0	0.2-0.75	GB/T2624-81
	HLGMZ	Bore tapping				
	HLGMF	Flange tapping				
ANB flowmeter	HLGZT	Special tapping	80~5000	≤6.4	0.3~0.75	Company standard
Two-tier venturi flowmeter	HLGST	Special tapping	250~4000	≤2.5	0.3~0.75	Company standard
Airfoil type volume measuring device	HLGJT	Special tapping	≥150	≤1.6	0.3~0.65	Company standard

* When Dg≤400mm in the case of corner, flange or D—D/2 tapping, complete sets of throttling devices include: throttling devices (for example: orifice plate, nozzle, 1/4 round nozzle, segmental nozzle, etc.), pressure-tapping devices, 10D and 5D measurement pipe sections for the front and back of the throttling device respectively, a pair of connecting flanges on the process pipe, seal pads, pressure-diverting tubes, two valves, all fasteners and the relevant accessories (condensers, for example).

In order to ensure the measurement accuracy, it is necessary to stipulate the following main mounting requirements:

4.1 For throttling devices and primary elements

4.1.1 The throttling device must be mounted in such a way that it will make the fluid flow from the

upstream side to the downstream side. (See the arrow on the pipe.)

4.1.2 The throttling device shall be coaxial with the center line of the pipe to within ±1°.

4.1.3 The throttling device and the pipe must be concentric or center-aligned in the ring chamber. The eccentricity or offsetting distance ex (the distance between the centre line of the throttling device and that of the upstream and downstream pipe sections) should not be greater than 0.0025D/(0.1+2.3β) or 0.015D(1/β-1).

4.2 For the pipe

4.2.1 The throttling device should be inserted between two straight pipe sections with uniform cross-sections. It is suggested that bored straight pipe sections (10D upstream and 5D downstream) be supplied with the throttling device.

4.2.2 The necessary lengths of the upstream and downstream straight pipes are related to the form of the upstream pipe and the β value. The minimum length should be taken into consideration in accordance with GB/T2624-93 or ISO5167-91.

4.2.3 Only after the pipe is purged can the throttling device be mounted.

4.2.4 In the section for measurement, the fluid must fully fill the pipe during the operation.

4.2.5 If an adjustable valve must be mounted, it is suggested that it be mounted after the 5D straight pipe section downstream.

4.2.6 If a section valve must be mounted at the downstream section of the throttling device, the valve must take the form of a sluice valve and must be fully open.

4.2.7 The gasket or seal ring should be made and mounted in such a way that it should at no point stick into the bore of the pipe or hamper the pressure-tapping hole or groove.

4.2.8 If there is a gasket between the throttling device and ring chamber, the gasket should be as thin as possible and must not stick into the bore of the chamber.

4.3 For the differential pressure signal pipe

4.3.1 The differential pressure signal pipe lead-out hole or opening may be at any corresponding location on the throttling device in principle, but with a horizontal pipe, the location should be arranged in such a way that it will make it possible for the differential pressure signal pipe to automatically discharge water (when the medium being measured is a gas) or gas (when the medium being measured is a liquid). See Diagram 10 for the mounting location.

4.3.2 The pressure-tapping tubes leading to the pressure-tapping holes on both sides of the throttling device should be equipped, at the base, with short straight tube sections to which sluice valves are to be connected. If the pressure-tapping holes are close by, the length of the short pipe sections may vary to be fit for valve mounting or removal.

4.3.3 The short pipes leading from the pressure-tapping holes should be on a uniform level. On a perpendicular steam pipe or when it is necessary to mount an isolator or a gas or liquid pipe, the short pipes between the valve and the T joint (for mounting a condenser or an isolator) may bend upward to make them exactly on the same level. See Diagrams 11-15 for the mounting details.

4.3.4 The differential pressure signal pipe connected with the differential pressure gauge should normally be less than 16m long. The longer pipe, the greater ID. Refer to Table 2 for the relationship between the ID and length.

ID of tube (mm) / Length of tube (m) / Fluid	≤16	16~45	45~90
Water, steam or dry gas	7~10	10	13
Wet gas	13	13	13
Medium- or low-viscosity grease	13	19	25
Dirty liquid or dusty gas	25	25	38

4.3.5 The differential pressure signal pipe should be laid perpendicularly or with a tilt of not less than 1:12 featuring a continuous tilt (even if the length is very small).

4.3.6 There must not be a bag-shaped space where liquids or gases may accumulate on the differential pressure signal pipe line. If it is unavoidable, a gas collector and a precipitator should be mounted.

4.3.7 If the signal pipe line is very long (longer than 30m), it should be tilted by sections and each section should be equipped with a gas collector and a precipitator.

4.3.8 If the pipe line (the perpendicular section) is quite long, false differential pressure caused by temperature difference should be avoided. In this case, it is suggested that the two differential pressure pipe lines be laid close to each other and wrapped in the thermal insulation layer together. And measures should be taken to avoid freezing in cold areas.

4.3.9 The differential pressure pipe line should have a support to avoid action of vibration or load on the differential pressure gauge.

5.1 In actual work, technological conditions may change, bringing errors to the measurement result, so it is sometimes necessary to make amendments.

A change in the pressure or temperature will cause a change in the medium. The following formula should be adopted for amendment.

$$G_2 = G_1 * \sqrt{\frac{r_2}{r_1}} \qquad 或\ Q_2 = Q_1 * \sqrt{\frac{r_1}{r_2}}$$

In which: G_1 — indicated flow G_2 — actual flow (kg/h)

Q_1 — indicated flow Q_2 — actual flow (m^3/h)

r_1 — design density of the medium measured

r_2 — actual density of the medium measured

5.2 Maintenance

The throttling device and the pressure-diverting system as well as the front and rear pipes should be examined at least once a year. Dirt should be removed and scrapped elements changed to ensure normal operation.

附图

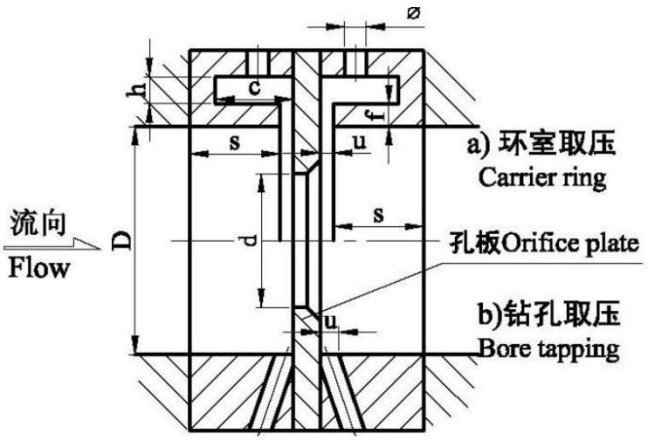

图1 角接取压孔板
Fig1 Orifice plate with Corner tappings

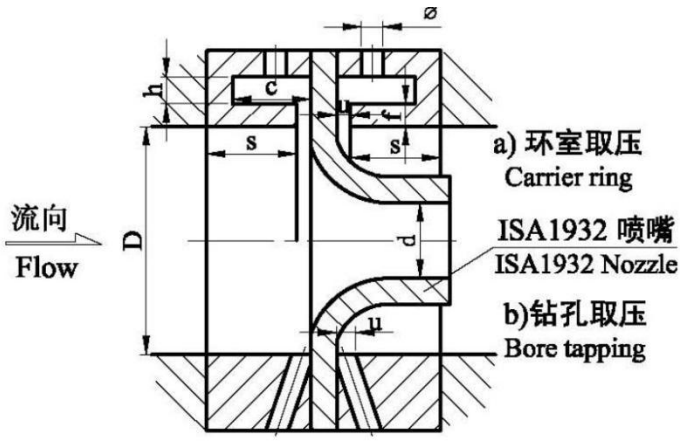

图2 ISA1932 喷嘴
Fig2 ISA1932 Nozzle with Corner tappings

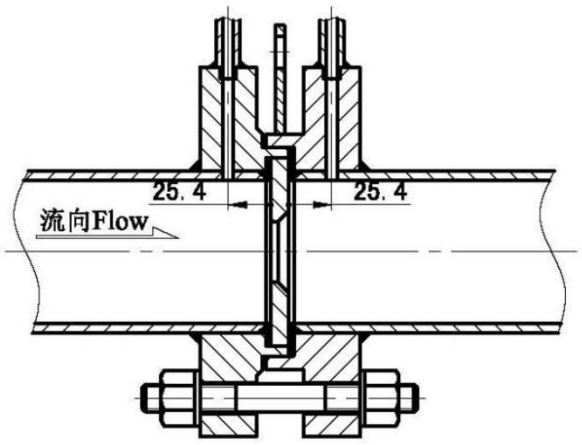

图3 法兰取压孔板
Fig3 Orifice plate with Flange tappings

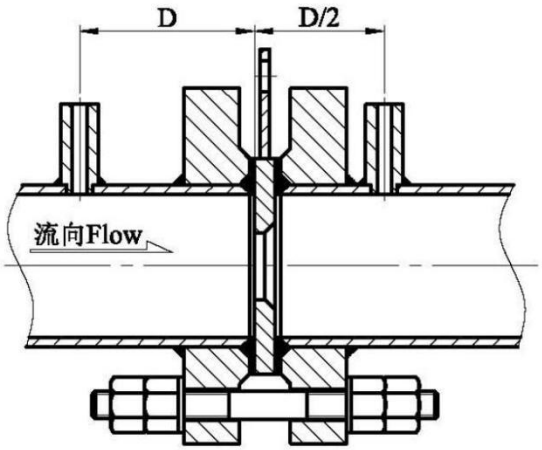

图4 D-D/2 取压孔板
Fig4 D-D/2 Pressure tappings

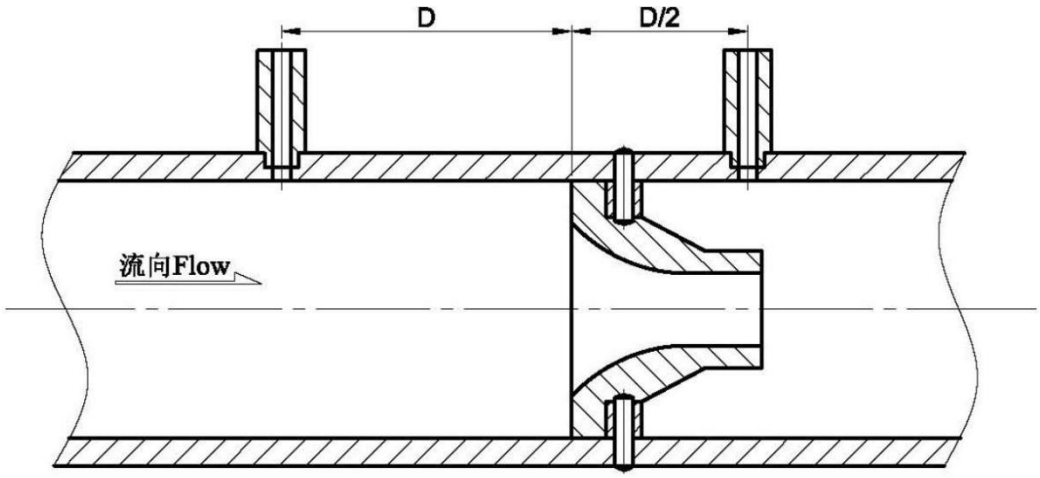

图5 D-D/2 长径喷嘴

Fig5 D-D/2 Long Radius Nozzle

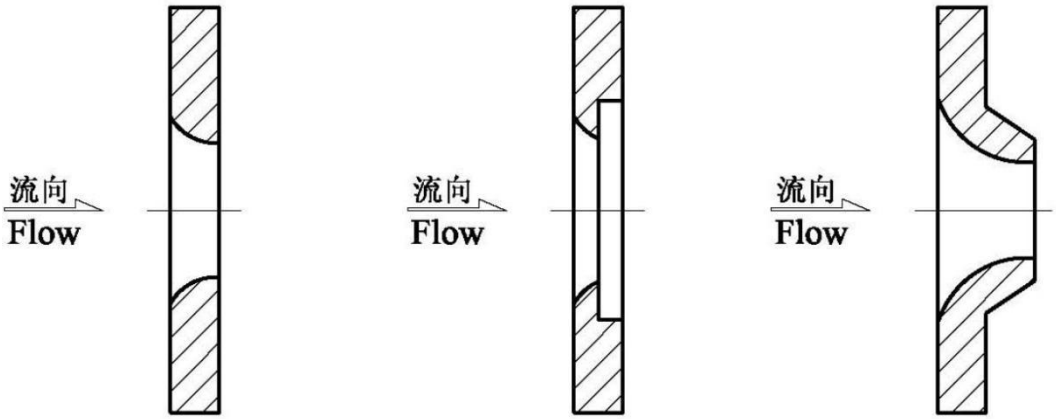

图6 四分之一圆喷嘴

Fig6 1/4-round Nozzle

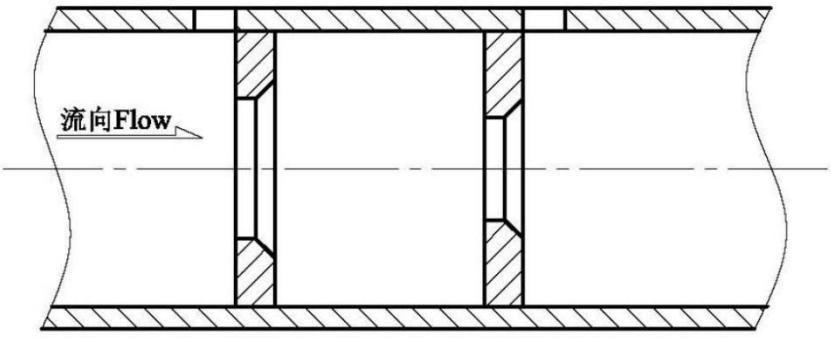

图7 双重孔板

Fig7 Dual orifice plates

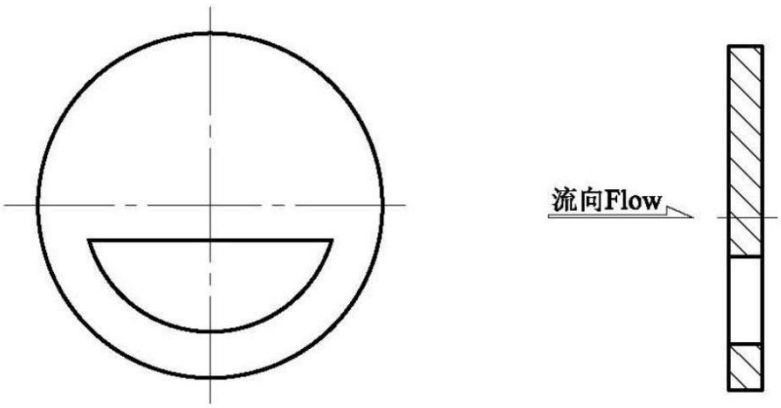

图8 圆缺孔板
Fig8 Segmental orifice plate

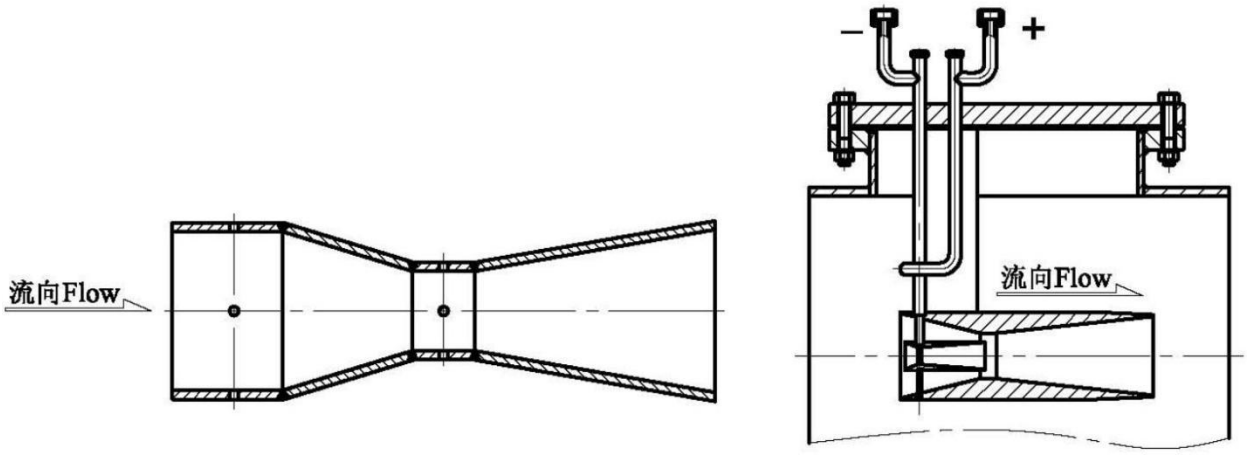

图9 文丘利管
Fig9 Venturi Tube

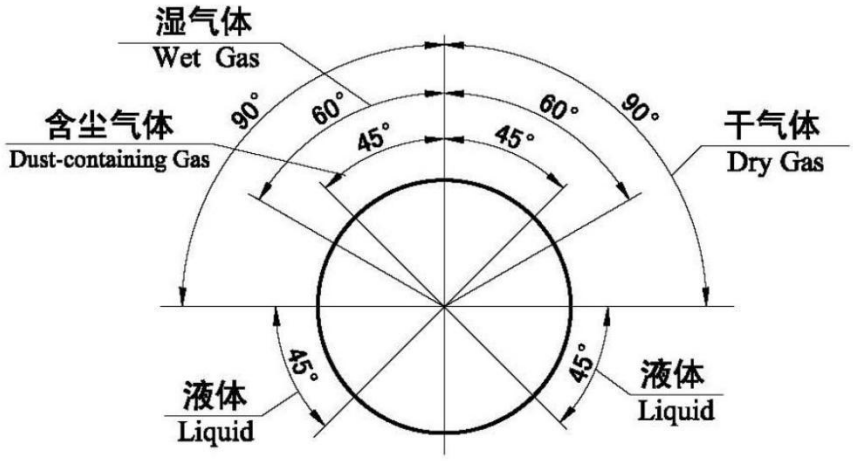

图10 取压孔位置
Fig10 Position of tapping Holes

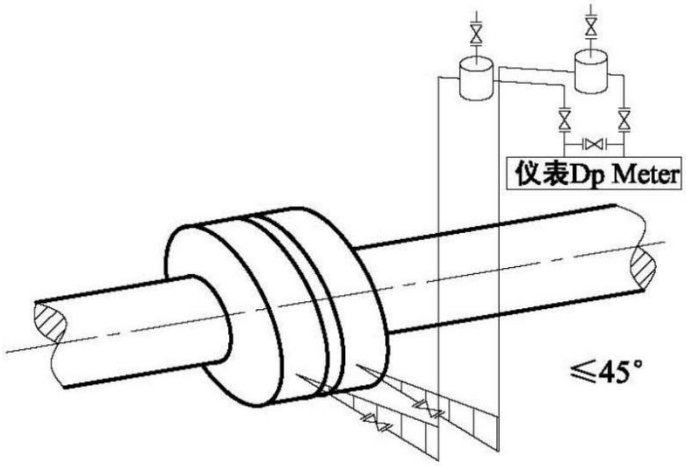

图11
Fig11

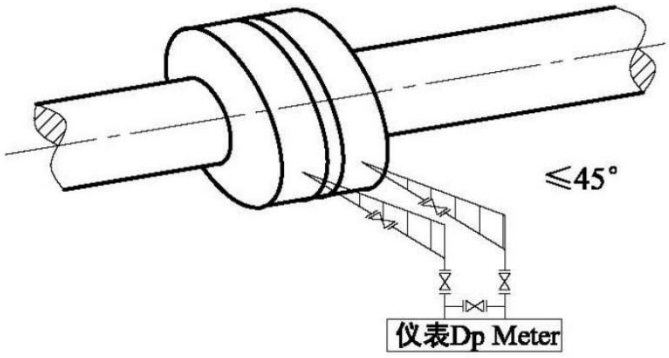

图12
Fig12

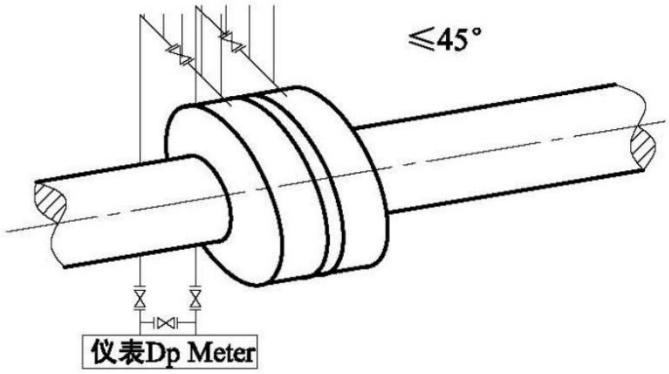

图13
Fig13

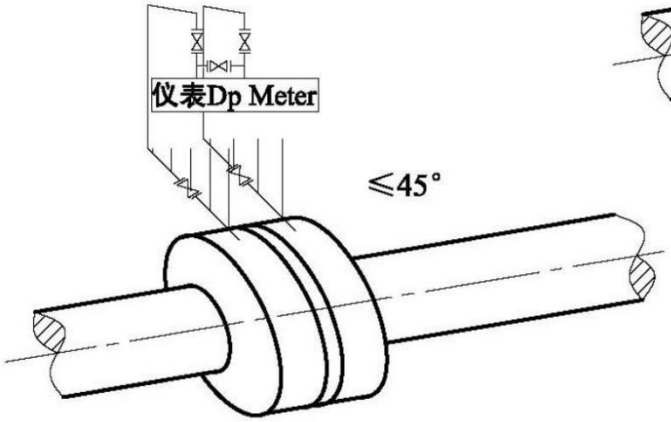

图14
Fig14

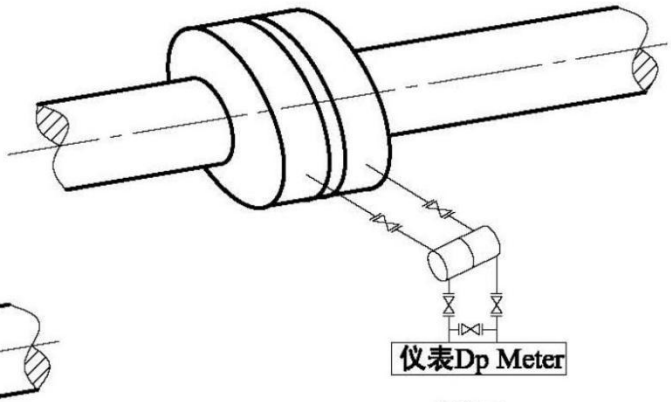

图15
Fig15

图 11~15 仪表连接安装示意图

Fig 11~15 Installation of Dp connecting Tubes