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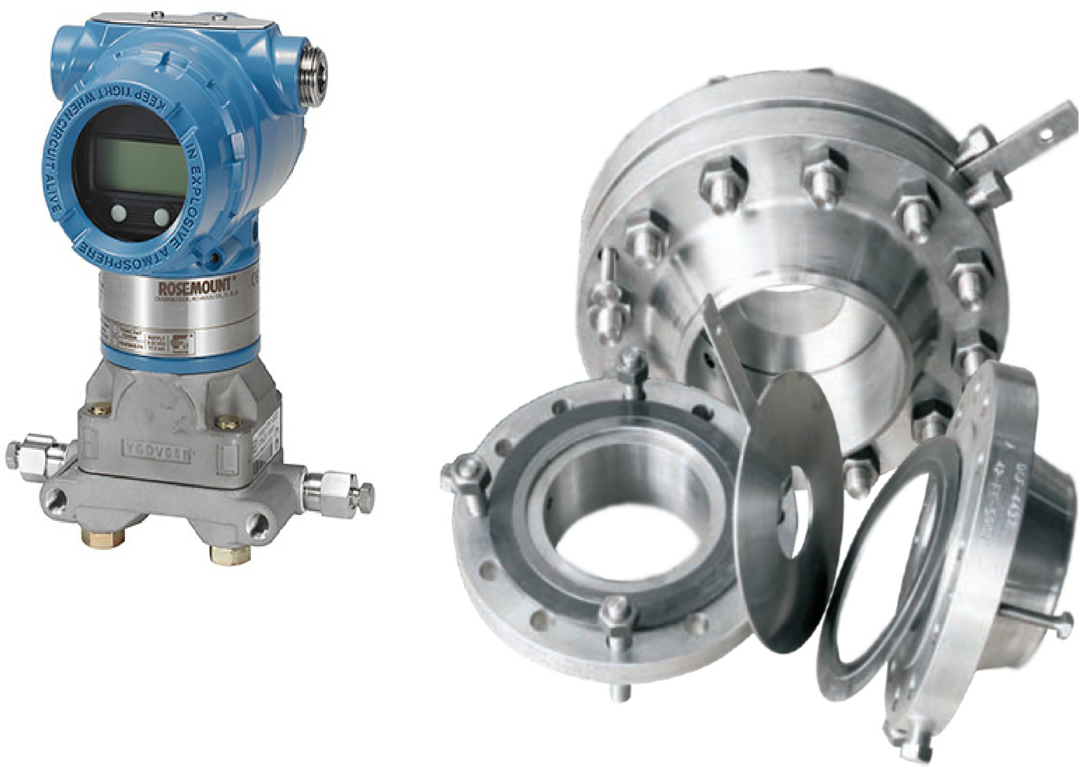
نصب اریفیس ÔúÞõv ½Ā¤Å¹

ORIFICE
INSTALLATION MANUAL



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اساس کارکرد

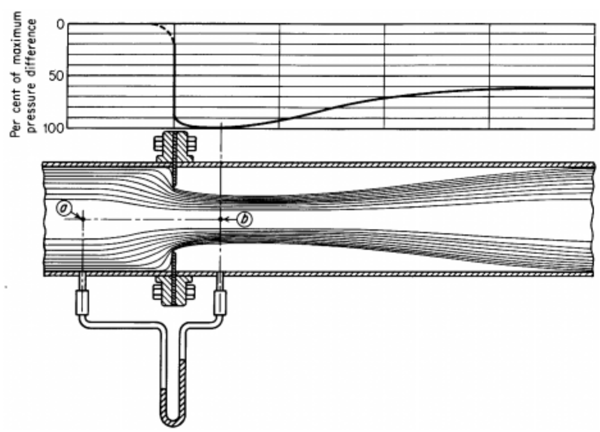
اریفیس جزء قدیمی‌ترین روش‌های اندازه‌گیری دبی است. در این روش، جریان سیال از مجرایی که از سطح مقطع جریان اصلی کوچک‌تر است، عبور داده می‌شود. اختلاف فشار ایجاد شده، توسط یک وسیلهٔ اندازه‌گیری اختلاف فشار، اندازه‌گیری شده و دبی سیال با استفاده از روابط حاکم به‌دست می‌آید. در شکل ۱ شکل ساده شده یک اریفیس نشان داده شده است. با نوشتن روابط هیدرودینامیک می‌توان رابطهٔ بین دبی و اختلاف فشار دو طرف اریفیس را به‌صورت زیر به‌دست آورد:

$$Q = C\varepsilon \frac{\pi}{4} d2 \frac{1}{\sqrt{1-\beta 4}} \sqrt{2\rho \Delta P}$$

در این رابطه، C ضریب تخلیهٔ اریفیس، ε ضریب انبساط گاز (برای مایع برابر ۱ است)، d قطر سوراخ صفحهٔ اریفیس، ρ جرم حجمی سیال و ΔP اختلاف فشار دو طرف اریفیس (نقاط a و b) است.

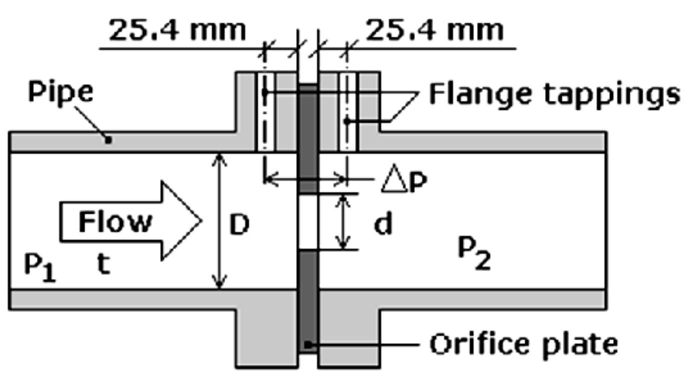
مقدار تقریبی ضریب تخلیه برابر ۰/۶ است، ولی مقدار دقیق آن از رابطهٔ زیر به‌دست می‌آید:

$$C = 0.5959 + 0.0312\beta^{2.1} - 0.184\beta^{8} + \frac{91.71\beta^{2.5}}{R_e^{\ 0.75}}$$

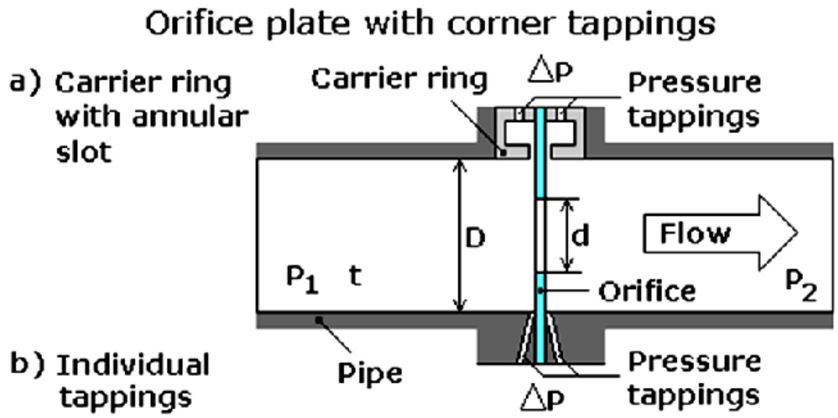


شکل ۱. اساس کار اریفیس.

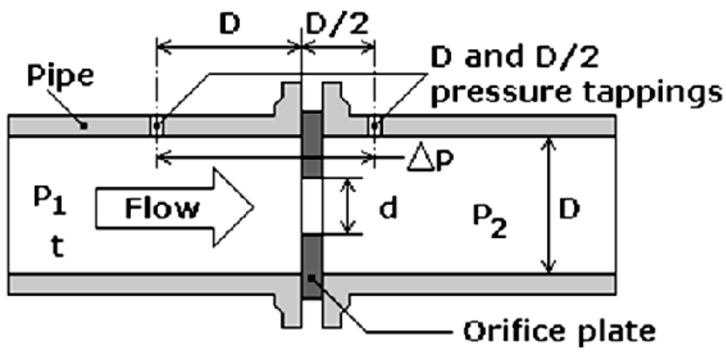
مقدار دقیق ضریب تخلیه و جزئیات دیگر طراحی و ساخت اریفیس در استانداردهای مربوط به‌طور کامل ارائه شده است.



شکل ۲. حالت flange tap.



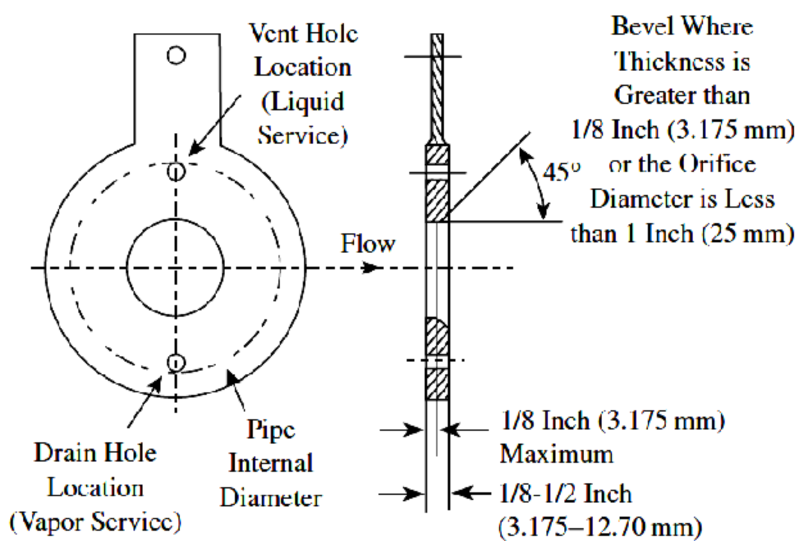
شکل ۳. حالت corner tap.



شکل ۴. حالت radius tap.

یکی از پارامترهای تأثیرگذار بر ضریب تخلیهٔ اریفیس، فاصلهٔ نقاط اندازه‌گیری بالا دست و پایین دست از تیغهٔ (صفحه) اریفیس است. مقادیر ضریب تخلیه برای چند حالت مختلف از جمله مواردی که در شکل های بالا نشان داده شده‌اند، در استانداردها موجود است.

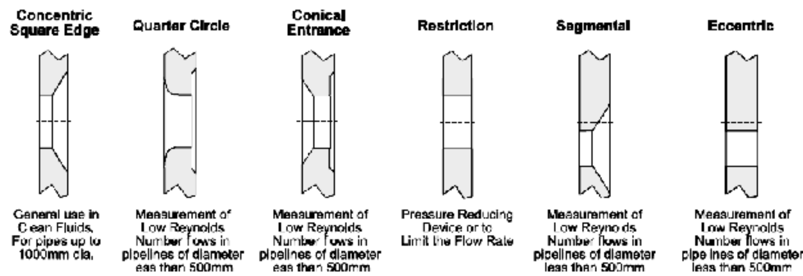
جزئیات صفحهٔ اریفیس از نوع هم مرکز در شکل ۵ نشان داده شده است.



شکل ۵ـ۵. جزئیات صفحه اریفیس.

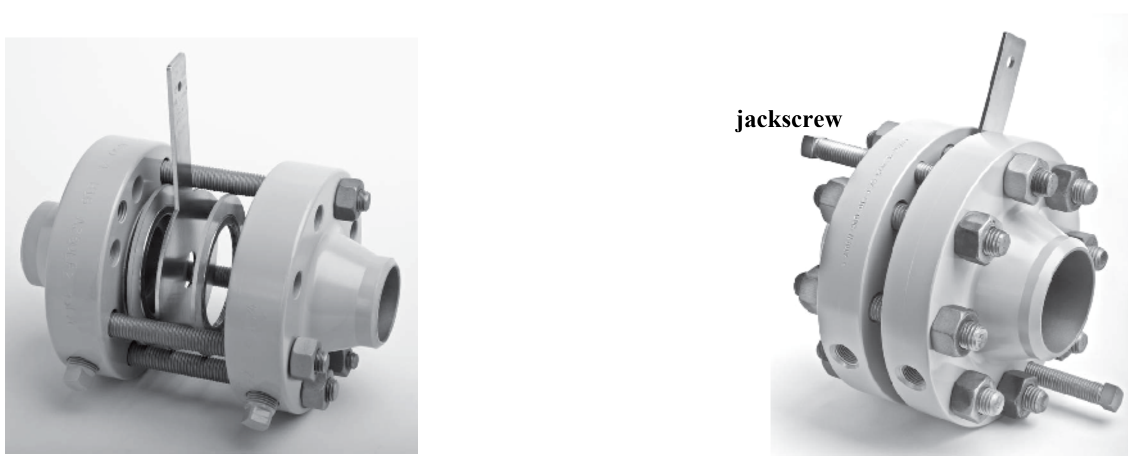
سوراخ vent در شکل فوق برای حالاتی است که جریان مایع حاوی حباب‌های گاز باشد و سوراخ drain برای مواردی است که در جریان گاز، احتمال وجود مایع یا کندانس وجود داشته باشد. در صورت تعبیهٔ این سوراخ‌ها در صفحهٔ اریفیس باید اثر آنها را نیز به حساب آورد.

با آنکه سوراخ هم مرکز اریفیس بیشترین کاربرد را دارد، لیکن در موارد خاص ممکن است مطابق شکل ۶ از صفحات با شکل‌های عبور جریان متفاوت استفاده کرد.



شکل ۶. انواع مجرای عبور سیال در صفحهٔ اریفیس.

در شکل۷ در قسمت سمت راست یک مجموعه اریفیس فلنج بسته شده و در سمت چپ قسمت‌های مختلف یک مجموعه اریفیس شامل فلنج‌ها، واشرها، پیچ‌ها و صفحهٔ اریفیس نشان داده شده است. از jackscrew برای جداکردن فلنج‌ها از هم در هنگام بازکردن مجموعه استفاده می‌شود.



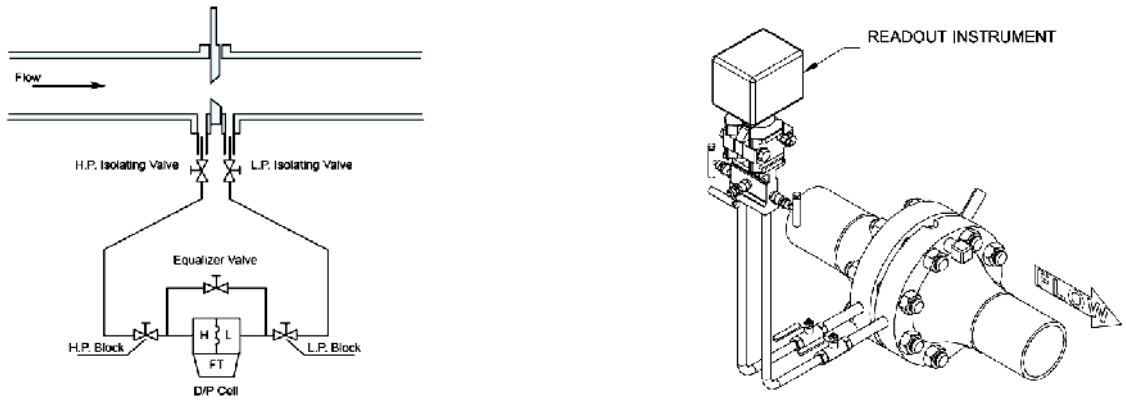
شکل۷. مجموعه اجزای یک اریفیس به‌صورت مونتاژ شده (سمت راست) و جدا شده (سمت چپ).

برای اندازه‌گیری اختلاف فشار دو طرف اریفیس می‌توان از روش‌های مختلفی استفاده کرد. ساده‌ترین روش، مطابق شکل ۱، استفاده از یک مانومتر (از انواعی که در فصل اندازه‌گیری فشار توضیح داده شد)، است. با اندازه‌گیری اختلاف ارتفاع دو ستون مایع و استفاده از روابط ارائه شده، اختلاف فشار دو طرف اریفیس و دبی سیال محاسبه می شود.

روش دوم، استفاده از یک اختلاف فشارسنج عقربه‌ای است.

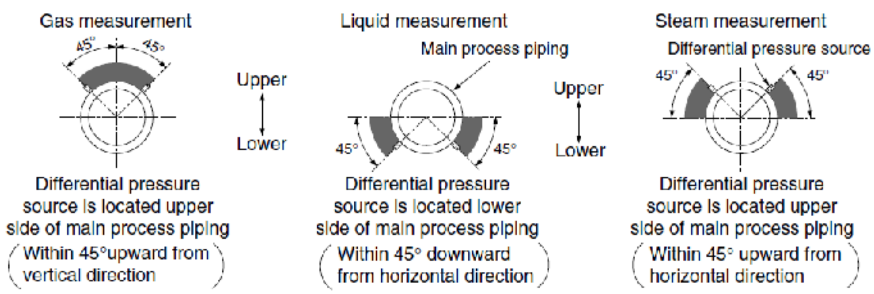
مرسوم‌ترین روشی که در صنعت مورد استفاده قرار می‌گیرد، استفاده از یک ترانسمیتر اختلاف فشار

است. نمونه‌ای از نحوهٔ اتصال یک اریفیس به ترانسمیتر اختلاف فشار در شکل ۸ نشان داده شده است.



شکل ۸. نحوهٔ اتصال اریفیس به ترانسمیتر اختلاف فشار.

دقت کنید که وسیلهٔ اندازه‌گیری اختلاف فشار، با توجه به نوع سیال باید در بالا، پایین یا کنار اریفیس نصب شود. این امر در شکل ۹ نشان داده شده است.



شکل ۹. نحوهٔ اتصال اریفیس به وسیلهٔ اندازه‌گیری اختلاف فشار.

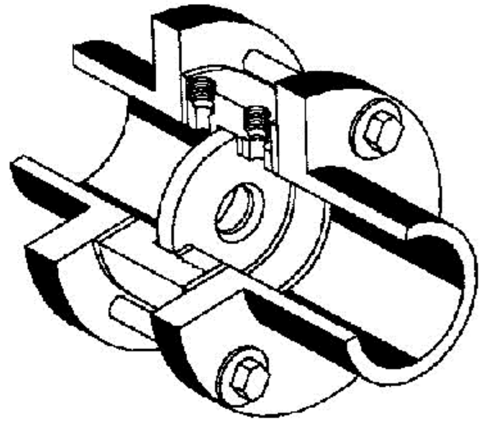
یکی از نکات مهم در استفاده از اریفیس (و سایر روش‌های مبتنی بر اختلاف فشار) آن است که اختلاف فشار دو طرف اریفیس با توان دوم دبی رابطه دارد. این امر باعث می‌شود که معمولاً نسبت حداکثر دبی به حداقل دبی به ۱:۵ محدود باشد.

انواع اریفیس از نظر نوع فلنج

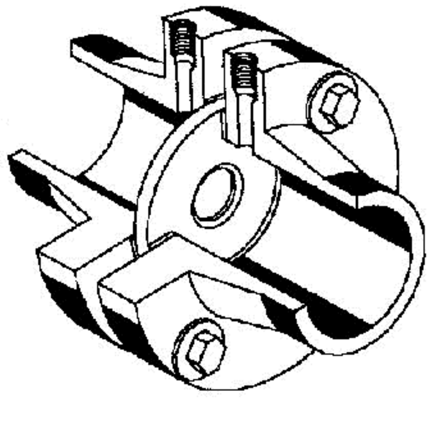
اریفیس های از نظر نوع فلنج به دو شکل کلی تقسیم بندی می شوند .

روش اول که در شکل ۱۰ نشان داده شده است، استفاده از فلنج های نوع Wafer است . در این نوع، هنگام نصب دو عدد فلنج تخت به دو سر لوله ورودی و خروجی نصب شده و سپس با قرار دادن اریفیس نوع Wafer و واشر ها در بین دو فلنج پیچ های فلنج تخت بسته می شود .

روش دوم مطابق شکل ۱۱، استفاده از فلنج های Welding Neck است . مطابق شکل ۱۱ این فلنج ها بایستی به خط لوله ورودی و خروجی جوش داده شوند .



شکل۱۰



شکل ۱۱

<u>طول لوله های ورودی و خروجی</u>

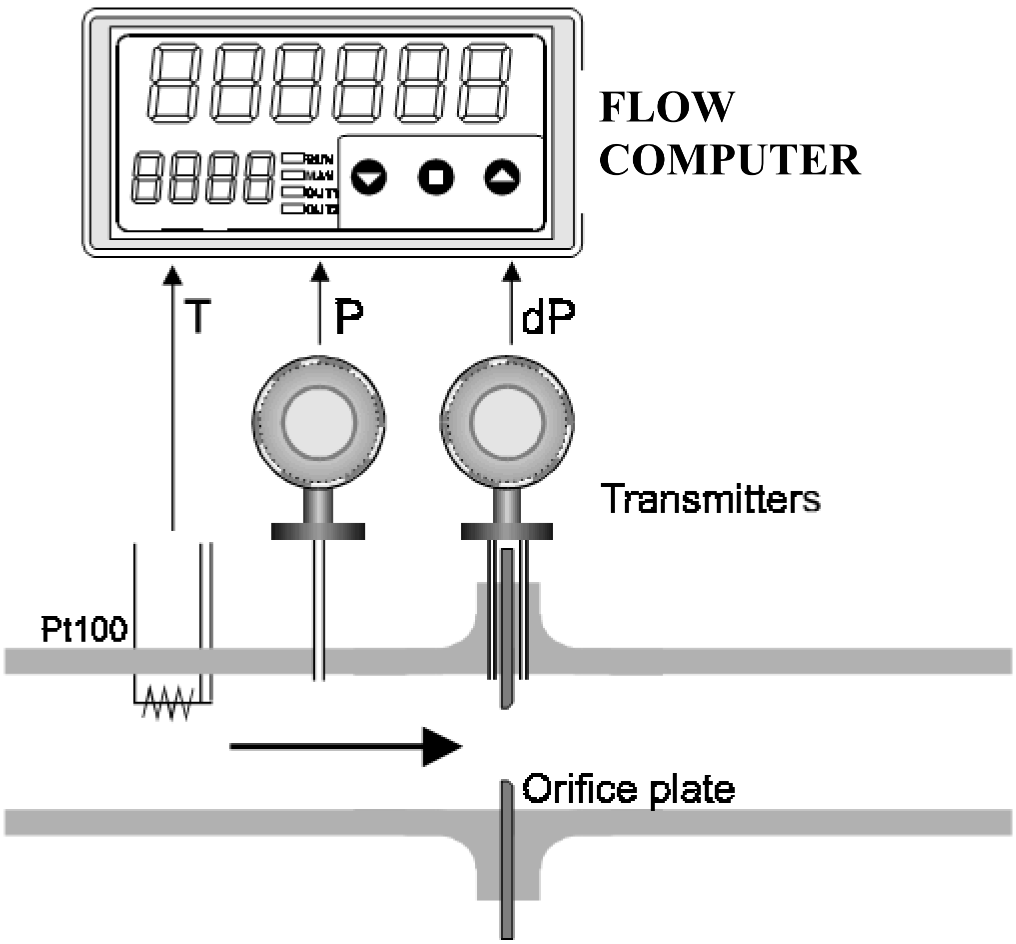
به منظور برطرف کردن اغتشاشات جریان , لازم است در ورودی و خروجی اریفیس طول معینی از لوله با قطر داخلی فلنج اریفیس بصورت مستقیم داده شود .

مقدار این طول به نسبت قطر اریفیس (β) و نوع اتصالات ورودی بستگی دارد . در جداول زیر مقدار تقریبی طول مستقیم ورودی نشان داده شده است ولی برای محاسبات دقیقتر باید به استانداردهای مربوطه که صفحات نمونه ای از آن (مربوط بهISO5167) در انتهای این دستورالعمل آورده شده مراجعه کرد.

Fittings before straight run	Piping Layout	Straightening Vanes	Diameter Ratio (Note 1)				
			Up to .40	.50	.60	.70	.80
			(All values listed below are in pipe diameters)				
Elbow or Tee	A, ORIFICE	none	6	7	8	12	20
		with			8	11	13
2 Ells or bends in the same plane		none	9	10	13	18	25
		with			11	12	13
2 Ells or bends in different planes		none	18	20	24	30	40*
		with	10	10	11	12	13
			*Multiply by 0.7 if long radius bends				
Globe or regulating valve (Note 2)		none	10	11	13	15	21
		with		10	11	12	13
Reducer or Expander		none	9	9	9	12	15

تصحیح اثر تغییرات دما و فشار

در اندازه گیری دبی گازها، در صورت تغییر دما و فشار خط، جرم حجمی گاز نیز تغییر می کند. یکی از روش های تصحیح اثرات این تغییرات، استفاده از فلو کامپیوتر است. در این روش، برای تصحیح اثر این تغییرات، بایستی علاوه بر اندازه گیری اختلاف فشار دو طرف اریفیس توسط ترانسمیتر اختلاف فشار، فشار و دمای خط نیز اندازه گیری شده و سپس توسط دستگاه فلو کامپیوتر، تصحیحات لازم برای تغییرات دما و فشار انجام می شود.



شکل ۱۲. نحوهٔ اتصال اریفیس به flow computer.

6 Installation requirements

6.1 General

General installation requirements for pressure differential devices are given in Clause 7 of ISO 5167-1:— and should be followed in conjunction with the additional specific requirements for orifice plates given in this clause. The general requirements for flow conditions at the primary device are given in 7.3 of ISO 5167-1:—. The requirements for use of a flow conditioner are given in 7.4 of ISO 5167-1:—. For some commonly used fittings, as specified in Table 3, the minimum straight lengths of pipe indicated may be used and detailed requirements are given in 6.2. However, a flow conditioner as specified in 6.3 will permit the use of a shorter upstream pipe length; moreover, a flow conditioner shall be installed upstream of the orifice plate where sufficient straight length to achieve the desired level of uncertainty is not available. Downstream of a header the use of a flow conditioner is strongly recommended. Many of the lengths given in 6.2 and all lengths given in 6.3.2 are based on data included in Reference [8] of the Bibliography. Additional work which contributed to the lengths in 6.2 is given in References [9] and [10].

6.2 Minimum upstream and downstream straight lengths for installation between various fittings and the orifice plate

6.2.1 The minimum straight lengths of pipe required upstream and downstream of the orifice plate for the specified fittings in the installation without flow conditioners are given in Table 3.

6.2.2 When a flow conditioner is not used, the lengths specified in Table 3 shall be regarded as the minimum values. For research and calibration work in particular, it is recommended that the upstream values specified in Table 3 be increased by at least a factor of 2 to minimize the measurement uncertainty.

6.2.3 When the straight lengths used are equal to or longer than the values specified in Columns A of Table 3 for "zero additional uncertainty", it is not necessary to increase the uncertainty in discharge coefficient to take account of the effect of the particular installation.

6.2.4 When the upstream or downstream straight length is shorter than the value corresponding to "zero additional uncertainty" shown in Columns A and either equal to or greater than the "0,5 % additional uncertainty" value shown in Columns B of Table 3 for a given fitting, an additional uncertainty of 0,5 % shall be added arithmetically to the uncertainty in the discharge coefficient.

6.2.5 This part of ISO 5167 cannot be used to predict the value of any additional uncertainty when either

a) straight lengths shorter than the "0,5 % additional uncertainty" values specified in Columns B of Table 3 are used; or

b) both the upstream and downstream straight lengths are shorter than the "zero additional uncertainty" values specified in Columns A of Table 3.

6.2.6 The valve shown in Table 3 shall be set fully open during the flow measurement process. It is recommended that control of the flowrate be achieved by valves located downstream of the orifice plate. Isolating valves located upstream of the orifice plate shall be set fully open, and these valves shall be full bore. The valve should be fitted with stops for alignment of the ball in the open position. The valve shown in Table 3 is one which is of the same nominal diameter as the upstream pipe, but whose bore diameter is such that a diameter step is larger than that permitted in 6.4.3.

6.2.7 In the metering system, upstream valves which are match bored to the adjacent pipework and are designed in such a manner that in the fully opened condition there are no steps greater than those permitted in 6.4.3, can be regarded as part of the metering pipework length and do not need to have added lengths as in Table 3 provided that when flow is being measured they are fully open.

Table 3 — Required straight lengths between orifice plates and fittings without flow conditioners

Values expressed as multiples of internal diameter, D

Diameter ratio β	Upstream (inlet) side of orifice plate																										Downstream (outlet) side of the orifice plate	
	Single 90° bend Two 90° bends in any plane ($S > 30D$) [a]		Two 90° bends in the same plane: S-configuration ($30D \geqslant S > 10D$) [a]		Two 90° bends in the same plane: S-configuration ($10D \geqslant S$) [a]		Two 90° bends in perpendicular planes ($30D \geqslant S \geqslant 5D$) [a]		Two 90° bends in perpendicular planes ($5D > S$) [a, b]		Single 90° tee with or without an extension Mitre 90° bend		Single 45° bend Two 45° bends in the same plane: S-configuration ($S \geqslant 2D$) [a]		Concentric reducer $2D$ to D over a length of $1,5D$ to $3D$		Concentric expander $0,5D$ to D over a length of D to $2D$		Full bore ball valve or gate valve fully open		Abrupt symmetrical reduction		Thermometer pocket or well [c] of diameter $\leqslant 0,03D$ [d]		Fittings (columns 2 to 11) and the densitometer pocket	
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]
$\leqslant$ 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 [h]	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	22	44	20	75	18	44	18	44	18	13	8	36	18	24	12	30	15	5	3	8	4

NOTE 1 The minimum straight lengths required are the lengths between various fittings located upstream or downstream of the orifice plate and the orifice plate itself. Straight lengths shall be measured from the downstream end of the curved portion of the nearest (or only) bend or of the tee or the downstream end of the curved or conical portion of the reducer or the expander.

NOTE 2 Most of the bends on which the lengths in this table are based had a radius of curvature equal to $1,5D$.

a S is the separation between the two bends measured from the downstream end of the curved portion of the upstream bend to the upstream end of the curved portion of the downstream bend.

b This is not a good upstream installation; a flow conditioner should be used where possible.

c The installation of thermometer pockets or wells will not alter the required minimum upstream straight lengths for the other fittings.

d A thermometer pocket or well of diameter between $0,03D$ and $0,13D$ may be installed provided that the values in Columns A and B are increased to 20 and 10 respectively. Such an installation is not, however, recommended.

e Column A for each fitting gives lengths corresponding to "zero additional uncertainty" values (see 6.2.3).

f Column B for each fitting gives lengths corresponding to "0,5 % additional uncertainty" values (see 6.2.4).

g The straight length in Column A gives zero additional uncertainty; data are not available for shorter straight lengths which could be used to give the required straight lengths for Column B.

h $95D$ is required for $Re_D > 2 \times 10^6$ if $S < 2D$.

6.2.8 The values given in Table 3 were determined experimentally with a very long straight length of pipe upstream of the fitting in question so that the flow immediately upstream of the fitting was considered as fully developed and swirl-free. Since in practice such conditions are difficult to achieve, the following information may be used as a guide for normal installation practice.

a) If several fittings of the type covered by Table 3, treating the combinations of 90° bends already covered by these tables as a single fitting, are placed in series upstream of the orifice plate the following shall be applied.

   1) Between the fitting immediately upstream of the orifice plate, fitting 1, and the orifice plate itself there shall be a straight length at least equal to the minimum length given in Table 3 appropriate for the specific orifice plate diameter ratio in conjunction with fitting 1.

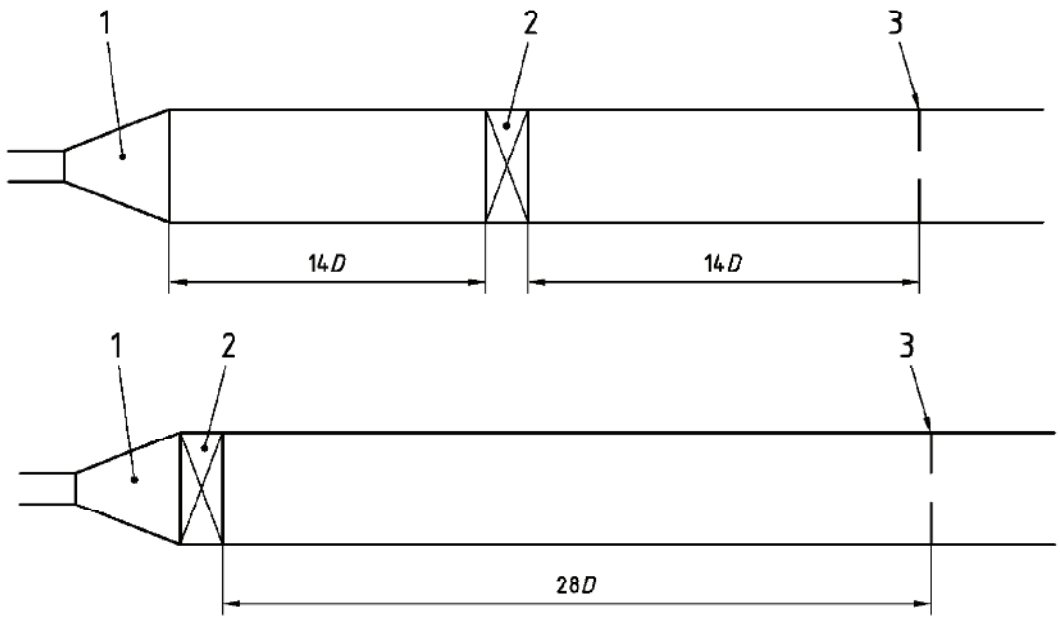
   2) In addition, between fitting 1 and the next fitting further from the orifice plate (fitting 2), a straight length at least equal to half the product of the diameter of the pipe between fitting 1 and fitting 2 and the number of diameters given in Table 3 for an orifice plate of diameter ratio 0,67 used in conjunction with fitting 2 shall be included between fittings 1 and 2 irrespective of the actual β for the orifice plate used. If either of the minimum straight lengths is selected from Column B (i.e. prior to taking the half value from fitting 1 to 2 of Table 3, a 0,5 % additional uncertainty shall be added arithmetically to the discharge coefficient uncertainty.

   3) If the upstream metering section has a full bore valve (as in Table 3) preceded by another fitting, e.g. an expander, then the valve can be installed at the outlet of the 2nd fitting from the orifice plate. The required length between the valve and the 2nd fitting according to 2) should be added to the length between the orifice plate and the 1st fitting specified in Table 3; see Figure 6. It should be noted that 6.2.8 b) shall also be satisfied (as it is in Figure 6).

b) In addition to the rule in a) any fitting, treating any two consecutive 90° bends as a single fitting, shall be located at a distance from the orifice plate at least as great as the distance given by the product of the pipe diameter at the orifice and the number of diameters required between that fitting and an orifice plate of the same diameter ratio in Table 3, regardless of the number of fittings between that fitting and the orifice plate. The distance between the orifice plate and the fitting shall be measured along the pipe axis. If, for any upstream fitting, the distance meets this requirement using the number of diameters in Column B but not that in Column A then a 0,5 % additional uncertainty shall be added arithmetically to the discharge coefficient uncertainty, but this additional uncertainty shall not be added more than once under the provisions of a) and b).

c) It is strongly recommended that a flow conditioner (see 7.4 of ISO 5167-1:2003) should be installed downstream of a metering system header (e.g. one whose cross-section area is approximately equal to 1,5 times the cross sectional area of the operating flow meter tubes) since there will always be distortion of the flow profile and a high probability of swirl.

d) When the second (or more distant) fitting from the orifice is a combination of bends, then in applying Table 3 the separation between the bends is calculated as a multiple of the diameter of the bends themselves.



Key

1 expander

2 full bore ball valve or gate valve fully open

3 orifice plate

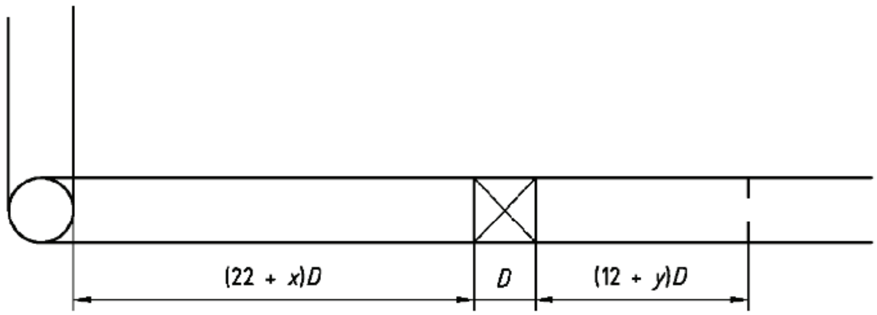
Figure 6 — Layout including a full bore valve for β = 0,6

6.2.9 By way of example, three cases of the application of 6.2.8 a) and b) are considered. In each case, the second fitting from the orifice plate is two bends in perpendicular planes (the separation between the bends is 10 times the diameter of the bends) and the orifice plate has diameter ratio 0,4.

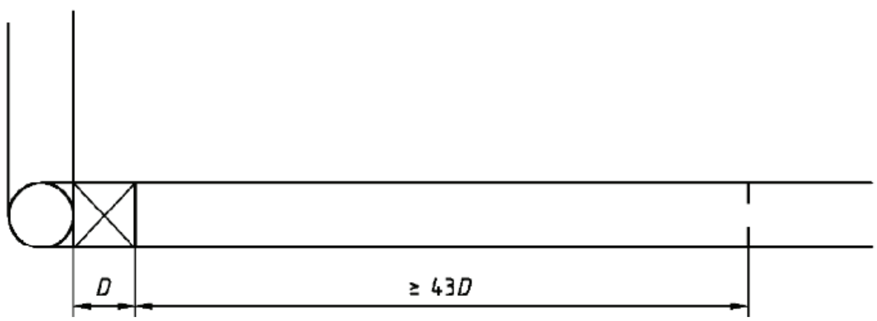
6.2.9.1 If the first fitting is a full bore ball valve fully open [see Figure 7 a)], the distance between the valve and the orifice plate shall be at least 12*D* (from Table 3) and that between the two bends in perpendicular planes and the valve shall be at least 22*D* [from 6.2.8 a)]; the distance between the two bends in perpendicular planes and the orifice plate shall be at least 44*D* [from 6.2.8 b)]. If the valve has length 1*D* an additional total length of 9*D* is required which may be either upstream or downstream of the valve or partly upstream and partly downstream of it. 6.2.8 a) 3) could also be used to move the valve to be adjacent to the two bends in perpendicular planes provided that there is at least 44*D* from the two bends in perpendicular planes to the orifice plate [see Figure 7 b)].

6.2.9.2 If the first fitting is a reducer from 2*D* to *D* over a length of 2*D* [see Figure 7 c)], the distance between the reducer and the orifice plate shall be at least 5*D* (from Table 3) and that between the two bends in perpendicular planes and the reducer shall be at least 22 × 2*D* [from 6.2.8 a)]; the distance between the two bends in perpendicular planes and the orifice plate shall be at least 44*D* [from 6.2.8 b)]. So no additional length is required because of 6.2.8 b).

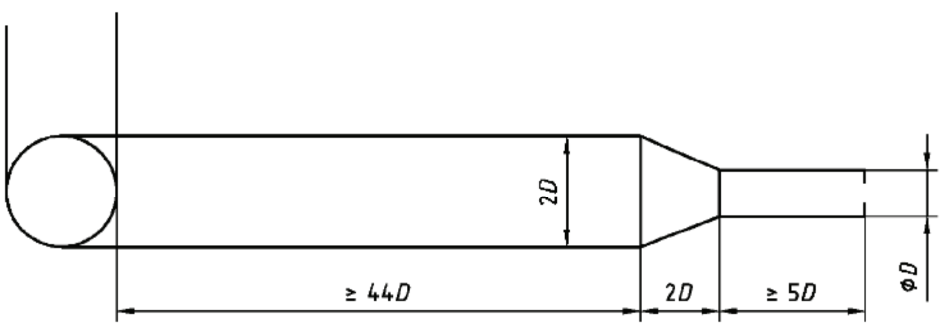
6.2.9.3 If the first fitting is an expander from 0,5*D* to *D* over a length of 2*D* [see Figure 7 d)], the distance between the expander and the orifice plate shall be at least 12*D* (from Table 3) and that between the two bends in perpendicular planes and the expander shall be at least 22 × 0,5*D* [from 6.2.8 a)]; the distance between the two bends in perpendicular planes and the orifice plate shall be at least 44*D* [from 6.2.8 b)]. So an additional total length of 19*D* is required which may be either upstream or downstream of the expander or partly upstream and partly downstream of it.



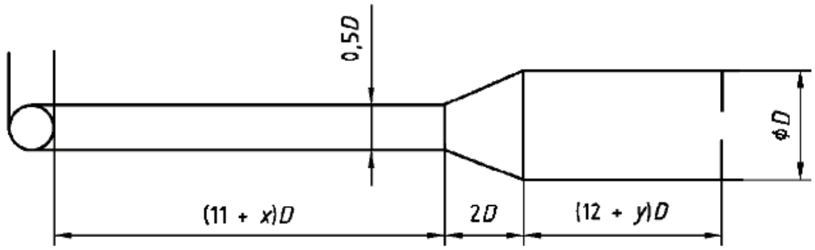
a) $x \geqslant 0, y \geqslant 0, x + y \geqslant 9$



b)



c)



d) $x \geqslant 0, y \geqslant 0, x + y \geqslant 19$

Figure 7 — Examples of acceptable installations (see 6.2.9)