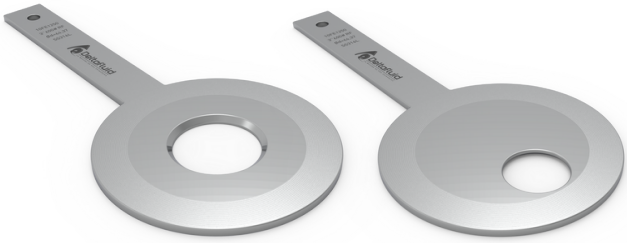
Datasheet

ORIFICE PLATE - overview

FLOW MEASUREMENT

KEY FEATURES

- Different types of orifice plates: sharp-edge, conical entrance, quarter circle, eccentric, segmental, conditioning
- Orifice plate design according to ISO5167-1 & ISO5167-2 or ISO/TR 15377 or ASME.MFC.3M or AGA3 / API MPMS 14.3 standards
- Recommended for gas, liquid or steam
- Internal pipe diameter : from 25 mm to 1 000 mm
- Reynolds number : from 5.000 to 10^8
- Accuracy : from 0,5% of the max flowrate
- Repeatability of measurement : 0,1%



Conical orifice plate Eccentric orifice plate

BENEFITS

- Cost-effective measurement system : low installation cost and maintenance-free
- Very long life-time product, no drift over time
- Standardized principle : reliability and accuracy of measurement, no need of calibration
- Easy and quick installation and commissioning
- Suitable for a large range of fluids and process conditions
- Use for custody transfer metering

Deltafluid
MEASURING UP TO YOUR EXPECTATIONS

Orifice plates or diaphragms are the primary elements most used for differential pressure flow measurement. Inserted within a circular pipe, they create a restriction, increase the speed of the fluid and generate a pressure difference between upstream and downstream of the restriction.

This differential pressure measurement is translated into a flow rate value.

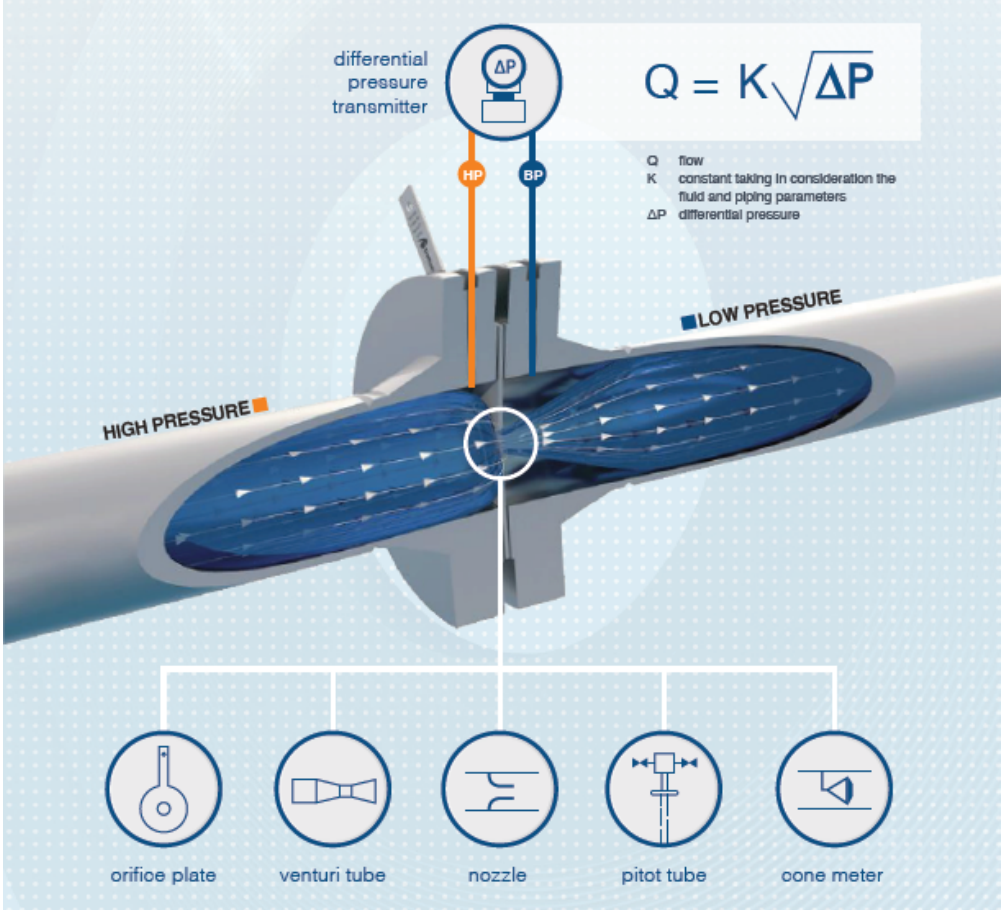


Diagram differential pressure flow measurement

The orifice plate is used for many types of applications and fluids covering wide operating ranges. Its main characteristics are a high measurement accuracy, low piece and maintenance costs and a long life span without wear failure. This standardized element does not require any on-site calibration allowing quick and simple installation.

STANDARDIZED	COST-SAVING	ROBUST
UNNECESSARY CALIBRATION	QUICK AND EASY INSTALLATION	NO MOVING PARTS
GUARANTEED PRECISION	MAINTENANCE FREE	LONG LIFE TIME

Deltafluid design office sizes and designs different types of orifice plates as well as complete measurement systems to meet all customer needs & applications. Deltafluid production workshop is equipped to manufacture and test these elements according to current standards

APPLICATIONS

- Types of fluids :

✓✓ recommanded

✓ suitable

		GAS		LIQUID				STEAM
		clean	dirty	clean	dirty	viscous	agressive	
ORIFICE PLATE	Sharp edge	✓✓		✓✓	✓		✓	✓
	Conical entrance			✓✓	✓	✓✓	✓	✓
	Quarter circle			✓✓	✓	✓✓	✓	✓
	Eccentric	✓	✓✓	✓	✓✓		✓	✓
	Segmental	✓	✓✓	✓	✓✓		✓	✓
	Conditioning	✓✓		✓✓	✓		✓	✓

- This table is valid for orifice plates as well as for all assemblies including these orifices (flange tap flowmeter, annular chamber, monoblock, compact, meter run...)
- Industries : Oil & gas, Chemical & petrochemicals, Energy including Nuclear, Iron & steel, Paper mill, Water treatment,...

  This list of industries in which differential pressure flow measurement elements can be used is not exhaustive. Orifice plates are suitable for all types of fluids whatever the application.

STANDARDS

- ISO 5167-1 & ISO 5167-2
- ISO/TR 15377
- ASME MFC-3M
- AGA3 / API MPMS 14.3

MATERIALS

- Materials (1) : carbon steel, stainless steel, monel, hastelloy, inconel, duplex, super duplex, titanium, tantalum, PVC, PTFE...

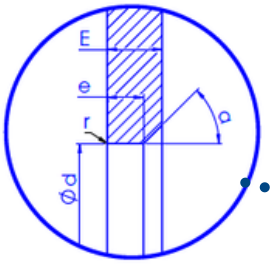
(1) For an aggressive fluid, possibility of a resistant coating applied on the edge in contact with the fluid to increase the lifespan of the product (stellite deposit, ceramic projection, etc.)

DIFFERENTS TYPES OF ORIFICE PLATES

Concentric orifice plate

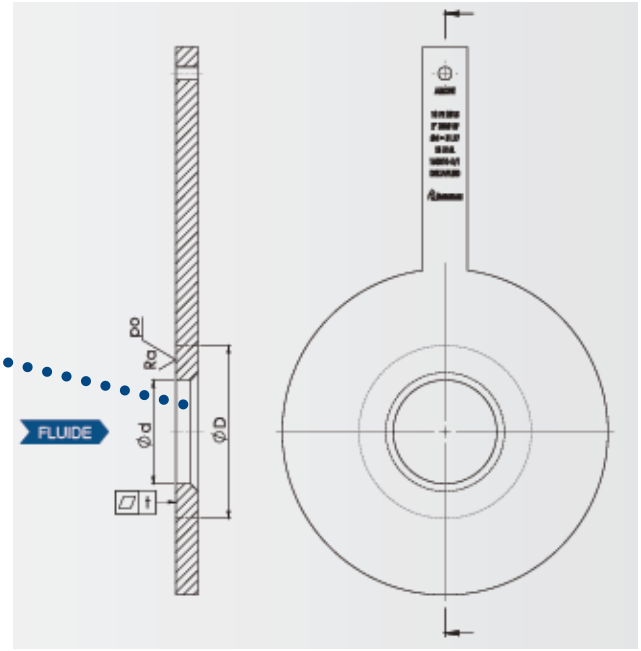
Concentric orifice plates are the most used. The hole drilling is positioned exactly in the center of the plate.

- Sharp-edge orifice plate



Sharp-edge zoom

Ød, orifice diameter
r, sharp edge radius
e, orifice thickness
E, plate thickness
α, angle of the downstream bevel
ØD, inside pipe diameter



Section of a sharp-edge orifice plate

Pressure taps

ΔP 0/0 | ΔP 25/25 | ΔP D-D/2

Specificity

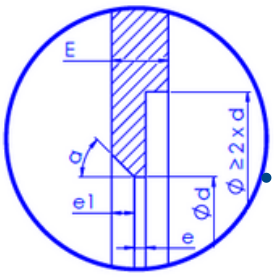
Economical and reliable system, high precision, easy installation and maintenance - most used plate

Technical characteristics

		ISO/TR 15377	ISO 5167-1&2	ASME MFC-3M
ReD	Reynolds number in the pipe	5.000 ≤ ReD ≤ 10^8		
D	Inside pipe diameter	25 mm(2) ≤ D ≤ 50 mm	50 mm ≤ D ≤ 1 000 mm	
d	Orifice diameter	d ≥ 12,5 mm		
β	d/D	0,5 ≤ β ≤ 0,7	0,1 ≤ β ≤ 0,75	
Ra	Upstream face roughness	Ra < 10^4.d		
r	Sharp edge radius	r < 0,000 4.d		
e	Orifice thickness	0,005.D ≤ e ≤ 0,02.D		
E	Plate thickness	e ≤ E ≤ 0,05.D		
α	Angle of the downstream bevel	α = 45° ± 15°		
t	Flatness tolerance	t < 0,005.(D-d)/2		

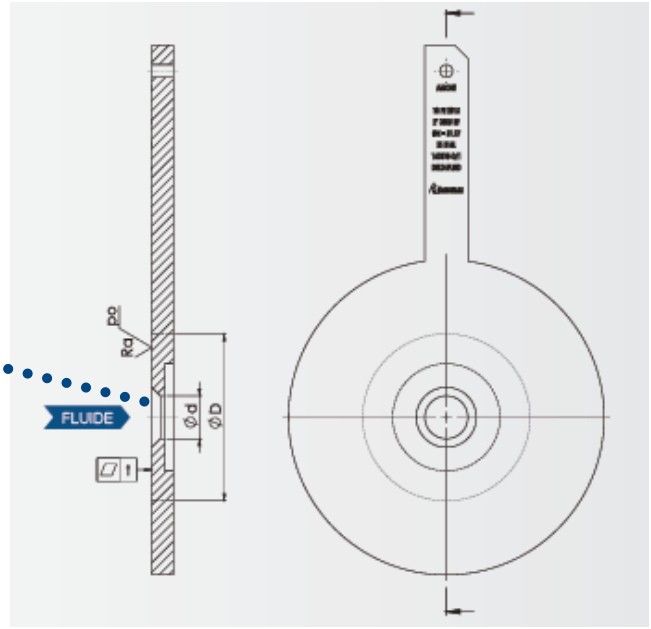
(2) Possibility of inside diameter below 25 mm according to ASME MFC-14M standard. Consult us.

Conical orifice plate



Conical entrance zoom

Ød, orifice diameter
e, thickness of the orifice cylindrical part
e1, thickness of the orifice conical part
E, plate thickness
α, angle of the upstream bevel
ØD, inside pipe diameter



Section of a conical entrance orifice plate

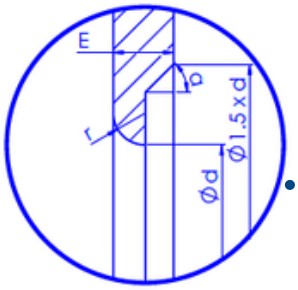
Pressure taps [3]

Specificity: System recommended for low flow rates and/or viscous fluids

Technical characteristics		ISO/TR 15377
ReD	Reynolds number in the pipe	80 ≤ ReD ≤ 6.10 ^{4}
D	Inside pipe diameter	25 mm ≤ D ≤ 500 mm
d	Orifice diameter	d > 6 mm
β	d/D	0,1 ≤ β ≤ 0,316
Ra	Upstream face roughness	Ra ≤ 10^4.d
e1	Thickness of the orifice conical part	e1 = 0,084.d ± 0,003.d
e	Thickness of the orifice cylindrical part	e = 0,021.d ± 0,003.d
E	Plate thickness	E ≤ 0,1.D
α	Angle of the upstream bevel	α = 45° ± 1°
t	Flatness tolerance	t < 0,005.(D-d-2.e1)/2

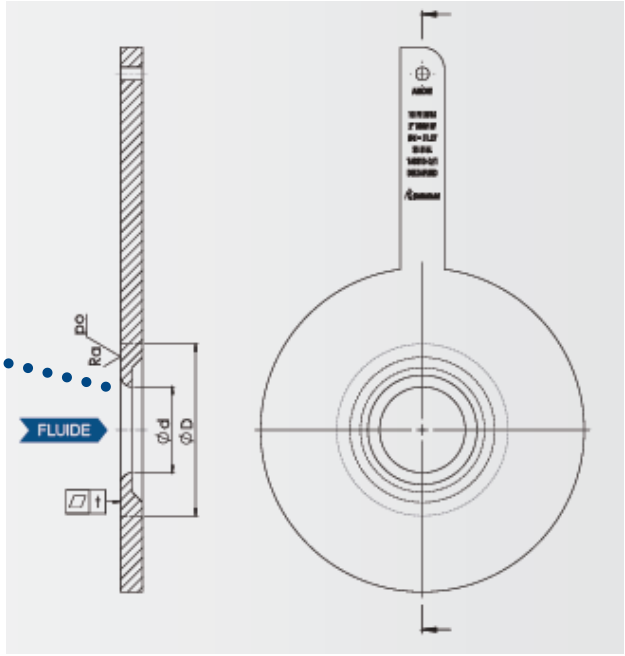
(3) Orifice flanges with conical entrance orifice plate do not comply with the standard. Either a 0/0 monoblock or annular chambers should be used.

Quarter circle orifice plate



Quarter circle zoom

Ød, orifice diameter
r, quarter circle radius
e, quarter circle orifice thickness
E, plate thickness
α, angle of the downstream bevel
ØD, inside pipe diameter



Section of a quarter circle orifice plate

Pressure taps

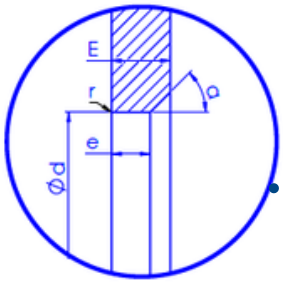
Specificity: System recommended for viscous fluids

Technical characteristics		ISO/TR 15377
ReD	Reynolds number in the pipe	250 ≤ ReD ≤ 6.10^4
D	Inside pipe diameter	25 mm ≤ D ≤ 500 mm
d	Orifice diameter	d ≥ 15 mm
β	d/D	0,245 ≤ β ≤ 0,6
Ra	Upstream face roughness	Ra ≤ 10^4.d
r	Quarter circle radius	0,100.d ≤ r ≤ 0,207.d
e	Quarter circle orifice thickness	2,5 mm ≤ e ≤ 0,1.D
E	Plate thickness	E ≥ r
α	Angle of the downstream bevel	α = 45°
t	Flatness tolerance	Consult us

Non-concentric orifice plate

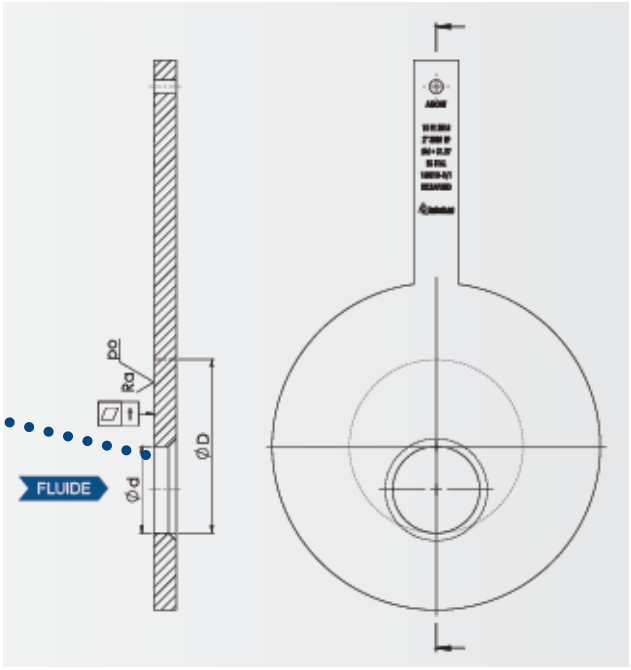
A concentric orifice plate is not suitable for fluids loaded with particles which could accumulate against the upstream plate and cause blockage and a significant loss of precision. Non-concentric orifice plates are designed so that particles can pass through them.

- Eccentric orifice plate



Eccentric zoom

Ød, orifice diameter
r, upstream sharp edge radius
e, eccentric orifice thickness
E, plate thickness
α, angle of the downstream bevel
ØD, inside pipe diameter



Section of an eccentric orifice plate

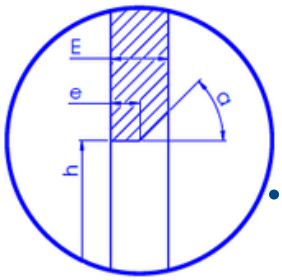
Pressure taps (4)

Specificity: System recommended for dirty or particle-laden fluids

Technical characteristics		ISO/TR 15377
ReD	Reynolds number in the pipe	42 000 ≤ ReD ≤ $8{,}4.10^5$
D	Inside pipe diameter	100 mm ≤ D ≤ 1 000 mm
d	Orifice diameter	d ≥ 50 mm
β	d/D	0,46 ≤ β ≤ 0,84
Ra	Upstream face roughness	Ra ≤ 10^4.d
r	Upstream sharp edge radius	r < 0,000 4.d
e	Eccentric orifice thickness	0,005.D ≤ e ≤ 0,02.D
E	Plate thickness	e ≤ E ≤ 0,05.D
α	Angle of the downstream bevel	α = 45° ± 15°
t	Flatness tolerance	t < 0,005.(D-d)/2

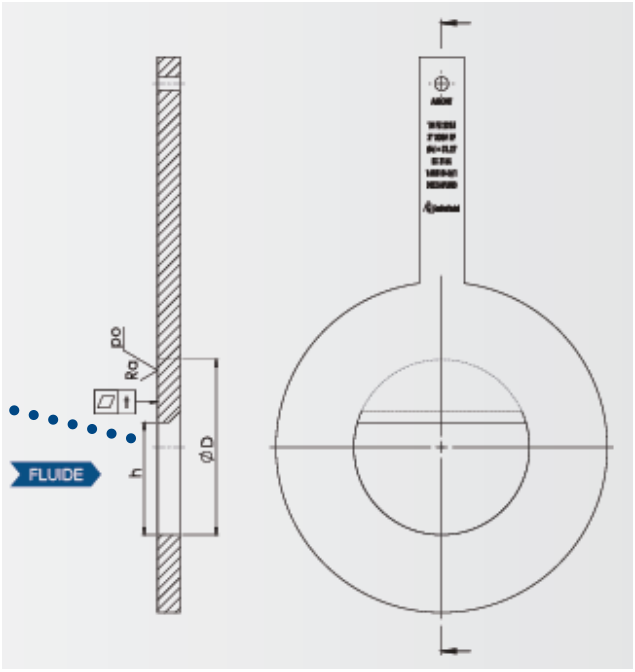
(4) Orifice flanges with eccentric orifice plate do not comply with the standard. Either a 0/0 monoblock or annular chambers should be used.

Segmental orifice plate



Segmental zoom

h, orifice height
e, orifice thickness
E, plate thickness
α, angle of the downstream bevel
ØD, inside pipe diameter



Section of a segmental orifice plate

Pressure taps

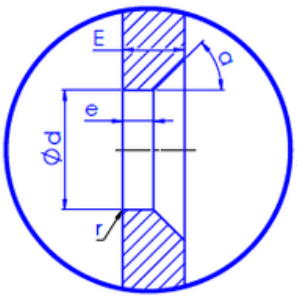
ΔP 0/0 | ΔP 25/25

Specificity

System recommended for dirty or particle-laden fluids

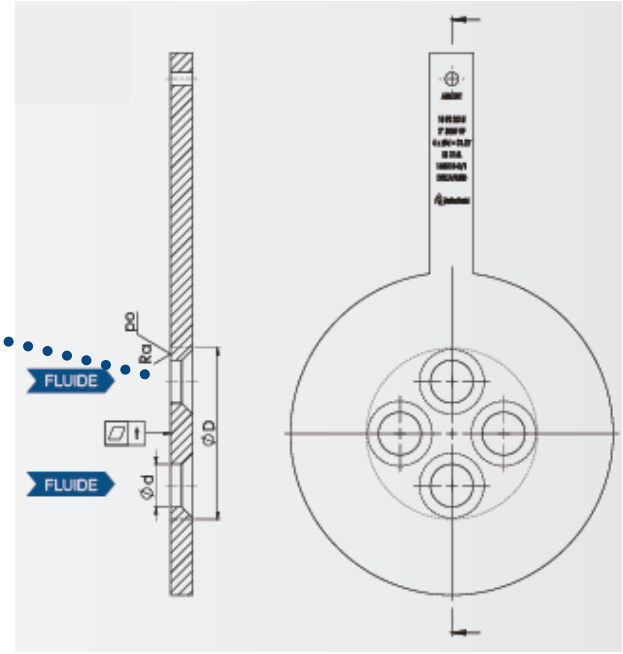
Technical characteristics		DIN VDI/VDE 2041
ReD	Reynolds number in the pipe	$10^4 \leq ReD \leq 10^6$
D	Inside pipe diameter	50 mm ≤ D ≤ 500 mm
h	Orifice height	h ≥ 12,5 mm
β	h/D	0,316 ≤ β ≤ 0,707
Ra	Upstream face roughness	Ra ≤ 10^4.h
e	Orifice thickness	0,005.D ≤ e ≤ 0,02.D
E	Plate thickness	e ≤ E ≤ 0,05.D
α	Angle of the downstream bevel	α = 45° ± 15°
t	Flatness tolerance	t < 0,005.(D-h)/2

Conditioning orifice plate



Conditioning zoom

Ød, diameter of an orifice
r, upstream sharp edge radius
e, sharp edge orifice thickness
E, plate thickness
α, angle of the downstream bevel
ØD, inside pipe diameter



Section of a conditioning orifice plate

Pressure taps

ΔP 0/0 | ΔP 25/25 | ΔP D-D/2

Specificity

Cost-saving solution allowing to reduce the upstream and downstream straight lengths

Technical characteristics

ReD	Reynolds number in the pipe	5 000 ≤ ReD ≤ 10^8
D	Inside pipe diameter	25 mm ≤ D ≤ 1 000 mm (5)
d	Orifice diameter	d ≥ 6 mm
β	d/D	0,2 ≤ β ≤ 0,65
Ra	Upstream face roughness	Ra ≤ 10^4.d
r	Sharp edge radius	r < 0,000 4.d
e	Sharp edge orifice radius	0,005.D ≤ e ≤ 0,02.D
E	Plate thickness	e ≤ E ≤ 0,05.D
α	Angle of the downstream bevel	α = 45° ± 15°
t	Flatness tolerance	t < 0,005.(D-d)/2

(5) Possibility of internal diameter beyond 1000 mm. Consult us.

Comparison of all plates

Maximum amplitudes according to the characteristics and standards cited in the previous pages (summary table):

	D (mm)	ReD	β
Sharp-edge orifice plate	25 ≤ D ≤ 1 000	5 000 ≤ ReD ≤ 10^8	0,1 ≤ β ≤ 0,75
Conical entrance orifice plate	25 ≤ D ≤ 500	80 ≤ ReD ≤ 6.10^4	0,1 ≤ β ≤ 0,316
Quarter circle orifice plate	25 ≤ D ≤ 500	250 ≤ ReD ≤ 6.10^4	0,245 ≤ β ≤ 0,6
Eccentric orifice plate	100 ≤ D ≤ 1 000	42 000 ≤ ReD ≤ $8,4.10^5$	0,46 ≤ β ≤ 0,84
Segmental orifice plate	50 ≤ D ≤ 500	10^4 ≤ ReD ≤ 10^6	0,316 ≤ β ≤ 0,707
Conditioning orifice plate	25 ≤ D ≤ 1 000	5 000 ≤ ReD ≤ 10^8	0,2 ≤ β ≤ 0,65

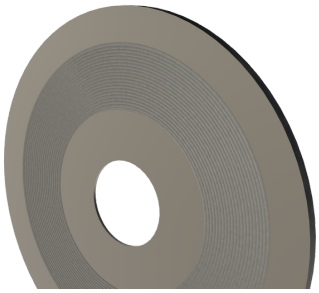
D, inside pipe diameter in mm
ReD, Reynolds number
β, equals the d/D ratio (d, orifice diameter) - used for all orifice plates except segmental for which β = h/d (h, orifice height)

MOUNTING

- An orifice plate can be mounted between flanges, inserted between 2 annular slots (see page 12) or inserted between 2 carrier rings. The orifice can also be mounted as a welded spool or a monoblock.
- Flange types : ISO PN 2,5 to PN 420, ASME 150# to 2500#, API flanges
- Piping connection between straight sections according to the standard:
  Variable upstream and downstream straight lengths according to β (β=d/D) and according to upstream fittings
  See upstream straight lengths table on page 13
  These lengths can be reduced with an additional uncertainty of 0.5% on the discharge coefficient - see page 13, right column in table
- Gasket types : flat gasket (spiral wound, graphite, PTFE) or RTJ (soft iron, inox, monel…)

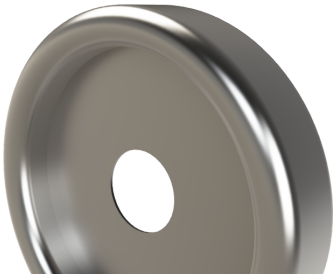
GASKET FACES

- RF / flat gasket

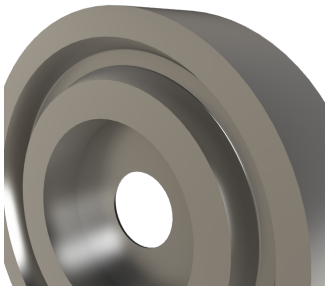


Possibility of Stock Finish gasket seat

- RTJ-M gasket



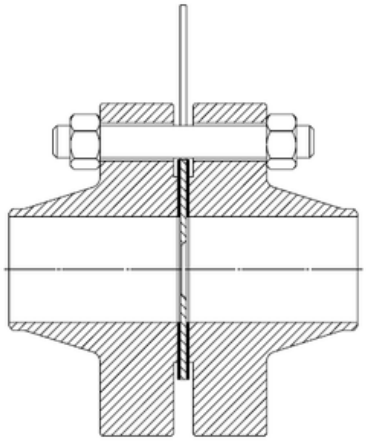
- RTJ-F gasket



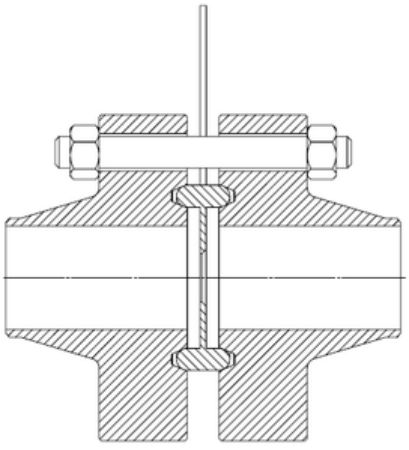
- RF orifice plate requires flat or spiral gaskets to be mounted between flanges on the pipe.

- RTJ orifice plate acts as a gasket and must be mounted between RTJ flanges to ensure a perfect tightness. The orifice plate can also be mounted on an RTJ orifice holder; in this case, the orifice holder is made of a softer material than the plate so that the RTJ gasket squeezes slightly into the flange notch to further improve the sealing.

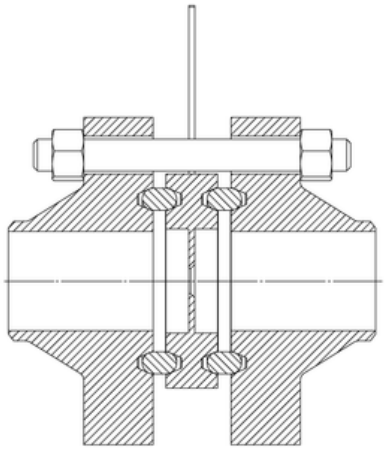
- Mounting between RF and RTJ flanges



RF orifice plate between flanges



RTJ-M orifice plate between flanges



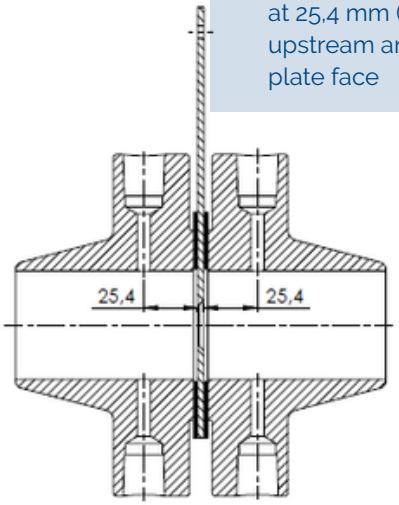
RTJ-F orifice plate between flanges

PRESSURE TAPS TYPES

- flange tap (or 1''/1'') with orifice flanges

  ASME standard only from 300#

➤ The measurement is executed at 25,4 mm (1 inch) from the upstream and downstream plate face

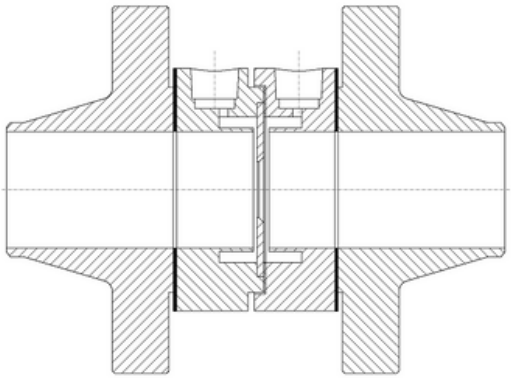


Orifice plate between orifice flanges

- Easily interchangeable measuring element
- Plate / flange materials can be different

- corner tap (or 0/0) with annular slots

➤ The measurement is executed at the upstream and downstream plate edge

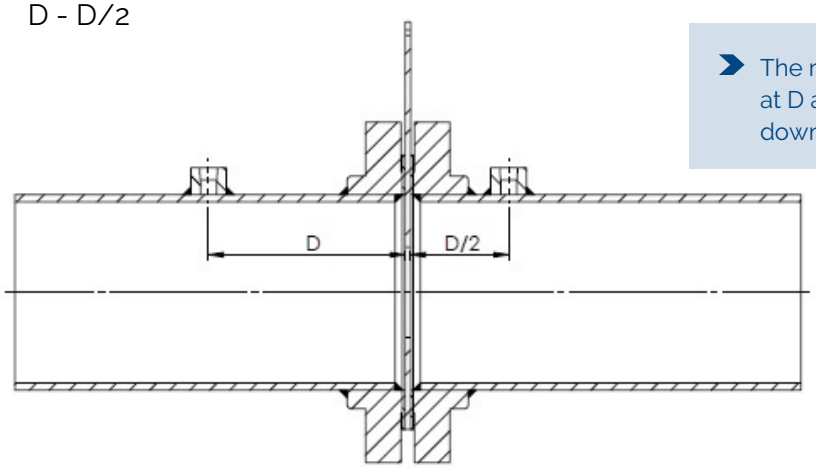


Orifice plate between annular slots

- Assembly used for better accuracy : averaged upstream and downstream pressure taps
- Mounting between simple flanges (welding neck, slip-on...)
- Flange / annular slots materials can be different

- D - D/2

➤ The measurement is executed respectively at D and D/2 from the upstream and downstream plate face



Orifice plate between simple flanges

- Mounting of the orifice plate between simple flanges (welding neck, slip-on...)
- Assembly used for diameters > DN150
- Pressure taps welded to the pipe

- illustrations with a RF orifice plate - the same types of pressure taps also exist in RTJ
- Carrier rings, mounting as a welded spool or a monoblock (individual pressure taps) are not shown here.

STRAIGHT LENGTHS

- Required straight lengths between **conditioning orifice plate** (or orifices in the compact monoblock) and fittings - 2D upstream / 2D downstream

- Required straight lengths between single hole orifice plate (or single orifice in the compact monoblock) and fittings - without flow conditioner

Values expressed as multiple of pipe internal diameter, D

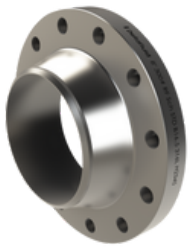
	UPSTREAM SIDE OF ORIFICE PLATE													Downstream side of orifice plate	
d/D	Single 90° bend or two 90° bends in any plane S>30S		Two 90° bends in the same plane 30D≥S≥10D		Two 90° bends in the same plane 10D≥S		Two 90° bends in perpendicular planes 30D≥S≥5D		Two 90° bends in perpendicular planes 5D>S		Single 90° tee with or without extension		Single 45° bend or two 45° bends in the same plane S≥22D		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 symmetric reduction		Thermometer pocket or well of diameter ≤ 0,03D		Fittings (columns 2 to 11) and densitometer pocket	
1	2		3		4		5		6		7		8		9		10		11		12		13			
<0,2	6	3	10		10		19	18	34	17	3		7		5		6		12	6	30	15	5	3	4	2
0,40	16	3	10		10		44	18	50	25	9	3	30	9	5		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	22	44	20	75	18	44	18	44	18	13	8	36	18	24	12	30	15	5	3	8	4

Nota :
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 / conical portion of the nearest bend or tee or reducer or expander to the upstream face of the orifice plate.
In the columns, left values give lengths corresponding to zero additional uncertainty (see ISO 5167-1 standard)
Right values give lengths corresponding to 0,5% additional uncertainty (see ISO 5167-1 standard). Empty cells when no available data.
S is the distance between two fittings..

ACCESSORIES

For flow measurement, we offer a full range of accessories for assembly with orifice plates.

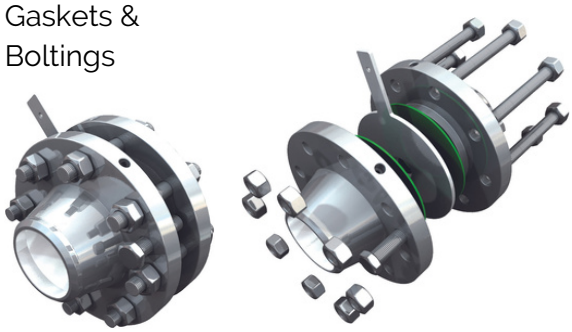
- Flanges



Flanges with flat gasket face, raised face, large male/female face, tongue/groove face, RTJ-F face

For a complete assembly with orifice flanges, see flange tap flowmeter datasheet

- Gaskets & Boltings



Example of boltings with orifice flanges

- Transmitter

Differential pressure transmitter, multivariable transmitter

- Manifold

2-way / 3-way / 5-way manifold with or without direct mounting

- Condensation pot

- Valve

- Siphon

- Fittings

- Flow straightener or conditioner

FURTHER INFORMATION

All information on the mounting of orifice plates (and their accessories) such as :

- pressure taps orientation
- mounting of the differential pressure transmitter
- flange tightening

can be found on the IOM notice "User guide - Installation, operation and maintenance manual" supplied on request upon delivery of the components.

ITEM CODES

- Orifice plate : DPLO-DN-PN-Face type-Material

  Depending on the type of orifice plate:

  DPLO for sharp-edge orifice plate
  DPLOS-EC for conical entrance orifice plate
  DPLOS-QC for quarter circle orifie plate
  DPLOS-EX for eccentric orifice plate
  DPLOS-SEG for segmental orifice plate
  DPLO4T for conditioning orifice plate

DPLO	ND	NP	Face type	Material
Nominal diameter - ASME	1/2'' to 24''	150# to 2500#	RF RTJ SEM (6) SEF (6) DEM (6) DEF (6)	304L 316L Others
OU				
Nominal diameter - ISO	DN15 to 600	PN2,5 to 400		

- Examples orifice plate codes:

  - DPLO-2-300-RF-316
  - DPLOS-QC-DN100-PN64-RF-304
  - DPLO4T-12-900-RTJM-316

(6) Specify large or small male/female face if flanges according to ASME B16-5 standard.

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MEASURING UP TO YOUR EXPECTATIONS

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