9/1/2024

Fluid Measurement

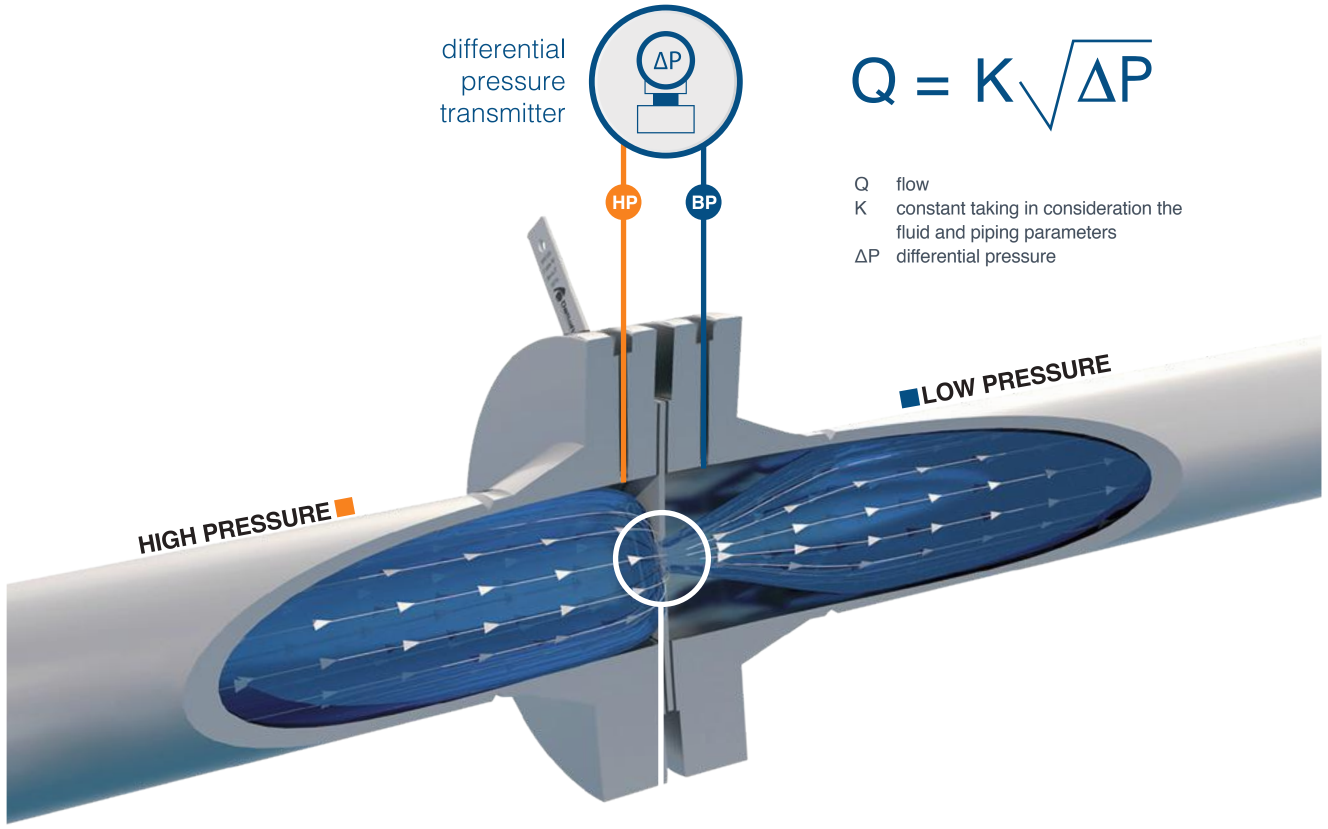
Q2024103

AVA ESPIKOO SANAT

DIFFERENTIAL PRESSURE FLOW MEASUREMENT

applicable for all types of fluids and mixtures
in **liquid, gas or steam** form

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



$$Q = K\sqrt{\Delta P}$$

- Q flow
- K constant taking in consideration the fluid and piping parameters
- ΔP differential pressure

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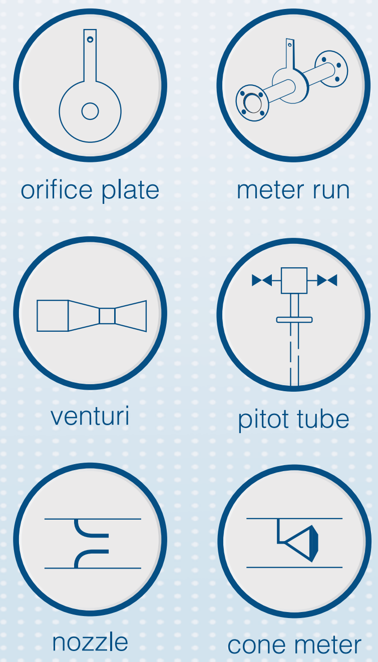
A TURNKEY SOLUTION

Flow measuring elements supplied

Flow measuring elements



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PRIMARY ELEMENT
SELECTION GUIDE

Primary elements allow to cover a very wide range of applications.
The below table will help you select the most suitable solution for your installation.

✓✓ *recommended*
✓ *adapted*

		GAS		LIQUID				STEAM
		CLEAN	DIRTY	CLEAN	DIRTY	VISCOUS	AGRESSIVE	
ORIFICE PLATE	CONCENTRIC[1]	✓✓		✓✓			✓ [2]	✓✓ [2]
	CONICAL ENTRANCE[1]	✓				✓✓	✓ [2]	✓✓ [2]
	QUARTER CIRCLE[1]	✓	✓	✓	✓	✓✓	✓ [2]	✓✓ [2]
	ECCENTRIC[1]		✓✓		✓✓		✓ [2]	✓ [2]
	SEGMENTAL[1]		✓✓		✓✓		✓ [2]	✓ [2]
	CONDITIONING[1] SHORT STRAIGHT LENGTH	✓✓		✓✓			✓ [2]	✓✓ [2]
	VENTURI TUBE SHORT STRAIGHT LENGTH	✓✓	✓	✓✓	✓		✓	✓
	NOZZLE	✓✓	✓	✓✓	✓	✓	✓✓ [2]	✓✓ [2]
	VENTURI-NOZZLE	✓✓	✓	✓✓	✓	✓	✓✓	✓✓
	METER RUN[3]	✓✓		✓✓	✓	✓	✓	✓✓
	PITOT TUBE	✓✓		✓✓		✓		
	CONE METER SHORT STRAIGHT LENGTH	✓✓	✓	✓✓	✓		✓	✓
	WEDGE METER		✓✓		✓✓	✓✓	✓✓	✓

(1) All of these primary elements can be integrated in a compact flowmeter version.
(2) For a very corrosive / abrasive fluid, provide a resistant material .
(3) The meter run is a complete solution including the primary element, gaskets, flanges, pressure taps, upstream and downstream straight lengths.
Special meter run :
- Integrated orifice for diameters up to 40 mm .
- High precision measurement tube with differential pressure transmitter and temperature sensor if needed for the most accurate measure of the market .

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REYNOLDS
NUMBER Re_D

$$Re_D = \frac{V_1 D}{\nu_1} = \frac{4\,q_m}{\pi\,\mu_1\,D}$$

V_1 fluid velocity in m/s
D pipe internal diameter in m
ν_1 kinematic fluid viscosity in m²/s
q_m mass flow rate in kg/s
μ_1 dynamic fluid viscosity in Pa.s

The Reynolds number (Re_D) is a dimensionless parameter which expresses the relationship between the inertia and viscosity forces in a pipe. It qualifies the type of flow (laminar, transient or turbulent).

The below table provides the Reynolds number limitations and the recommended pipe diameter as per the standards. It is possible to extend these values by performing a calibration of the device concerned.

STANDARDIZED VALUES ACCORDING ISO 5167 & ISO/TR 15377: - Reynolds number Re_D - Internal diameter of the pipe D, in mm				MAIN ADVANTAGE
5 000	25 ≤ D ≤ 1 000	10^8		Economical and reliable
80	25 ≤ D ≤ 500	6.10^4		Low flowrate and/or viscous fluid
250	25 ≤ D ≤ 500	6.10^4		Viscous fluid
42 000	100 ≤ D ≤ 1 000	$8.4.10^5$		Dirty, charged or two-phase fluid
10^4	50 ≤ D ≤ 500	10^6	(4)	Dirty, charged or two-phase fluid
5 000	25 ≤ D ≤ 1 000	10^8	(5)	Short straight length (2D/2D)
2.10^5	50 ≤ D ≤ 1 200	2.10^6		Short straight length and low permanent pressure drop
10^4	50 ≤ D ≤ 630	10^7		Large flowrate
$1.5.10^5$	65 ≤ D ≤ 500	2.10^6		Large flowrate and low permanent pressure drop
80	6 ≤ D ≤ 300	10^8	(6)	High accuracy
$1.2.10^4$	100 ≤ D ≤ 5 000	10^8	(7)	Wide pipe and very low pressure drop
8.10^4	50 ≤ D ≤ 500	$1.2.10^7$		Short straight length
10^4	50 ≤ D ≤ 600	9.10^6		Fluid charged with impurities

10 10^2 10^3 10^4 10^5 10^6 10^7 10^8 Re_D

(4) Standardized element according to DIN VDI/VDE 2014
(5) Non standardized element, recommended Re_D and D ranges
(6) From 6 to 40 mm, standardized element according to ASME MFC-14M
(7) Standardized element according to ASME MFC-12M

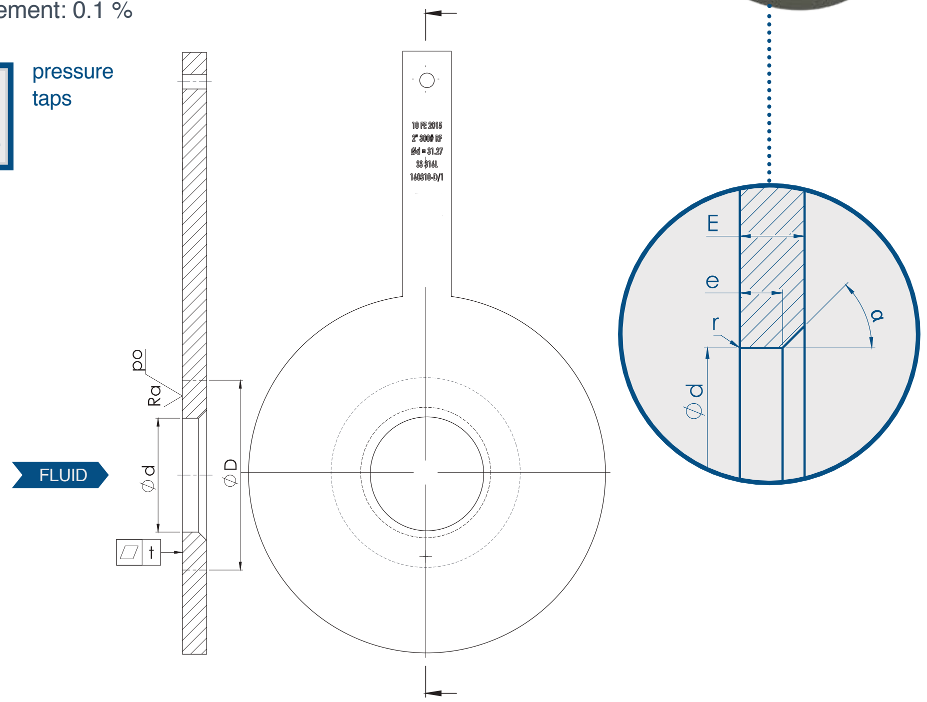
CONCENTRIC ORIFICE PLATE

Cost-saving and reliable solution

GENERAL DATA

- Standards: ISO 5167-1&2, ASME MFC-3M, ISO/TR 15377
- Flange mounting :
  - o ISO PN 2.5 to PN 420
  - o ASME 150# to 2500#
  - o Others: upon request
- Material:
  - o Standard: stainless steel 304L / 316L
  - o Others : according to your datasheet
- Fluid: liquid, gas, steam
- Pipes from ϕ 25 to 1 000 mm
- Accuracy: 0.5 % of the max flow rate
- Repeatability of measurement: 0.1 %

ΔP 0/0 | ΔP 25/25 | ΔP D-D/2 — pressure taps



TECHNICAL CHARACTERISTICS

		ISO/TR 15377	ISO 5167-1&2	ASME MFC-3M
Re_D	Reynolds number in the pipe	$5\,000 \le Re_D \le 10^8$		
D	Inside pipe diameter	25 mm ≤ D < 50 mm	50 mm ≤ D ≤ 1 000 mm	
d	Orifice diameter	d ≥ 12.5 mm		
ß	d/D	0.5 ≤ ß ≤ 0.7	0.1 ≤ ß ≤ 0.75	
Rα	Upstream face roughness	$R\alpha < 10^{-4}.d$		
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		

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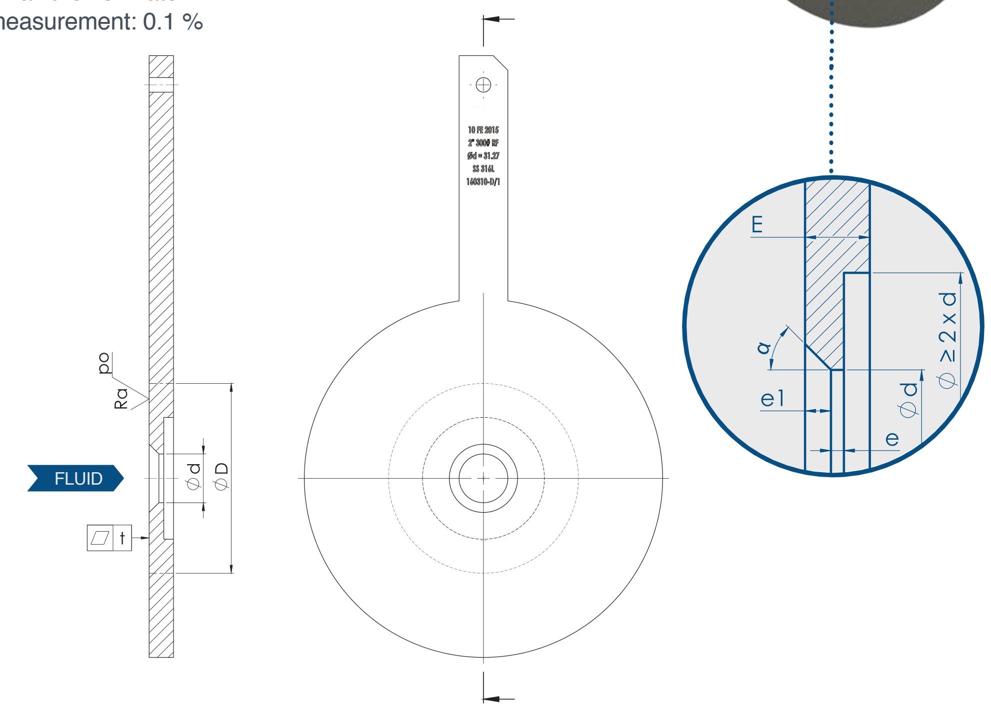
ORIFICE PLATE WITH CONICAL ENTRANCE

Recommended for small flow rates and/or viscous fluids

GENERAL DATA

- Standard: ISO/TR 15377
- Flange mounting :
  - o ISO PN 2.5 to PN 420
  - o ASME 150# to 2500#
  - o Others: upon request
- Material:
  - o Standard: stainless steel 304L / 316L
  - o Others : according to your datasheet
- Fluid: liquid, gas, steam
- Pipes from ϕ 25 to 1 000 mm
- Accuracy: 2 % of max the flow rate
- Repeatability of measurement: 0.1 %

ΔP 0/0 — pressure tap



TECHNICAL CHARACTERISTICS

		ISO/TR 15377
Re_D	Reynolds number in the pipe	$80 \le Re_D \le 6.10^4$
D	Inside pipe diameter	25 mm ≤ D ≤ 500 mm
d	Orifice diameter	d > 6 mm
ß	d/D	0.1 ≤ ß ≤ 0.316
Rα	Upstream face roughness	$R\alpha \le 10^{-4}.d$
e_1	Thickness of the conical entrance	$e_1 = 0.084.d \pm 0.003.d$
e	Cylindrical part thickness	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	$t < 0.005.(D - d - 2.e_1)/2$

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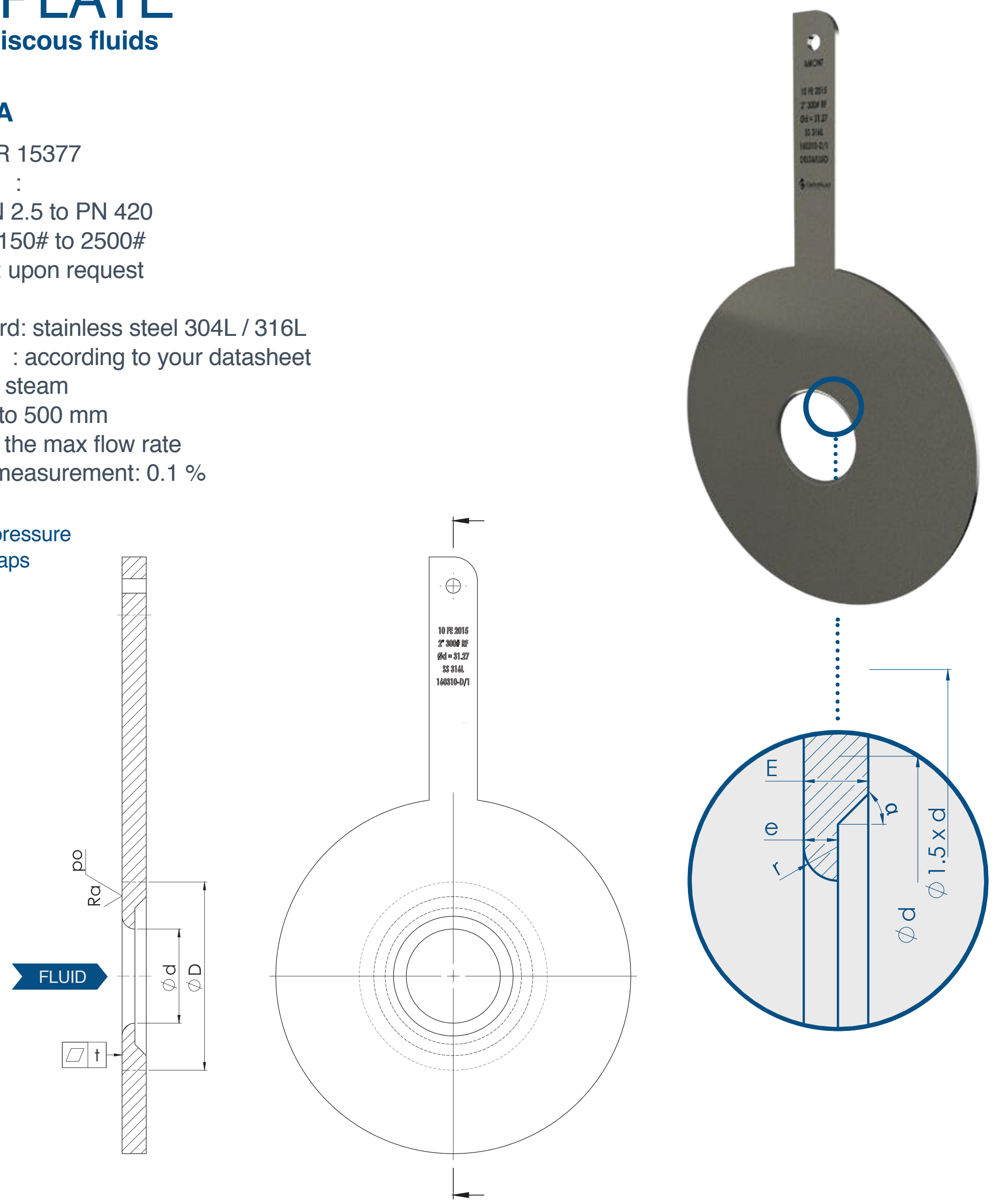
QUARTER CIRCLE
ORIFICE PLATE

Recommended for viscous fluids

GENERAL DATA

- Standard: ISO/TR 15377
- Flange mounting :
    - o ISO PN 2.5 to PN 420
    - o ASME 150# to 2500#
    - o Others: upon request
- Material:
    - o Standard: stainless steel 304L / 316L
    - o Others : according to your datasheet
- Fluid: liquid, gas, steam
- Pipes from ϕ 25 to 500 mm
- Accuracy: 2 % of the max flow rate
- Repeatability of measurement: 0.1 %

ΔP 0/0 | ΔP 25/25 pressure taps



TECHNICAL CHARACTERISTICS

		ISO/TR 15377
Re_D	Reynolds number in the pipe	$250 \leq Re_D \leq 6.10^4$
D	Inside pipe diameter	25 mm ≤ D ≤ 500 mm
d	Orifice diameter	d ≥ 15 mm
ß	d/D	0.245 ≤ ß ≤ 0.6
Ra	Upstream face roughness	$Ra \leq 10^{-4}.d$
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 if needed	α = 45°
t	Flatness tolerance	Contact us

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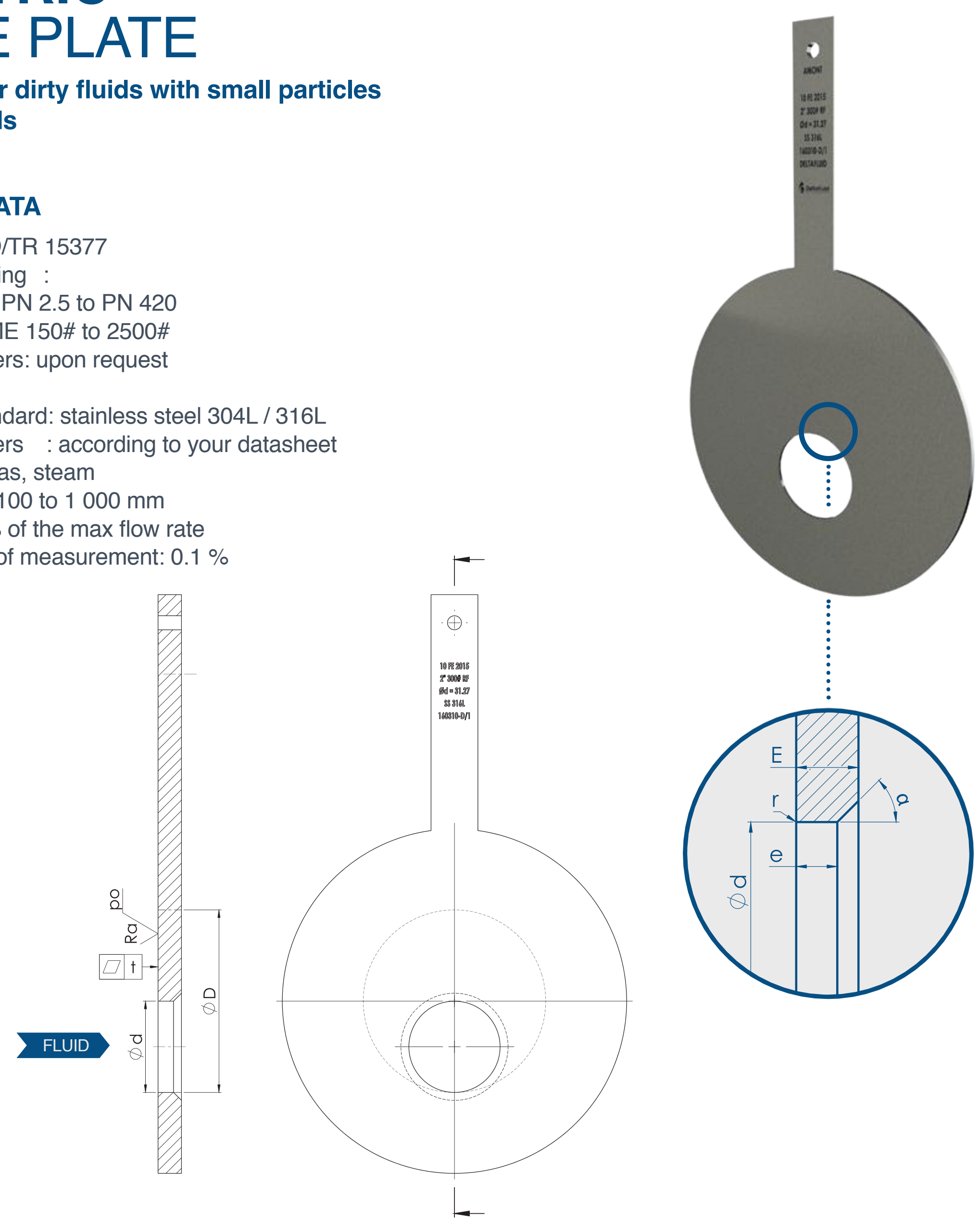
ECCENTRIC
ORIFICE PLATE

Recommended for dirty fluids with small particles or two-phase fluids

GENERAL DATA

- Standard: ISO/TR 15377
- Flange mounting :
    - o ISO PN 2.5 to PN 420
    - o ASME 150# to 2500#
    - o Others: upon request
- Material:
    - o Standard: stainless steel 304L / 316L
    - o Others : according to your datasheet
- Fluid: liquid, gas, steam
- Pipes from ϕ 100 to 1 000 mm
- Accuracy: 1 % of the max flow rate
- Repeatability of measurement: 0.1 %

ΔP 0/0 pressure tap



TECHNICAL CHARACTERISTICS

		ISO/TR 15377
Re_D	Reynolds number in the pipe	$42\,000 \leq Re_D \leq 8.4.10^5$
D	Inside pipe diameter	100 mm ≤ D ≤ 1 000 mm
d	Orifice diameter	d ≥ 50 mm
ß	d/D	0.46 ≤ ß ≤ 0.84
Ra	Upstream face roughness	$Ra \leq 10^{-4}.d$
r	Radius of the upstream sharp edge	r < 0.000 4.d
e	Cylindrical orifice thickness	0.005.D ≤ e ≤ 0.02.D
E	Plate thickness	e ≤ E ≤ 0.05.D
α	Angle of the downstream bevel if needed	α = 45° ± 15°
t	Flatness tolerance	t < 0.005.(D - d)/2

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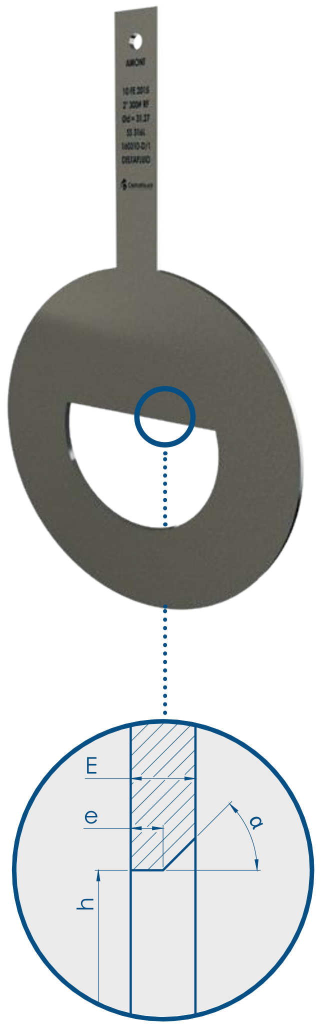
SEGMENTAL
ORIFICE PLATE

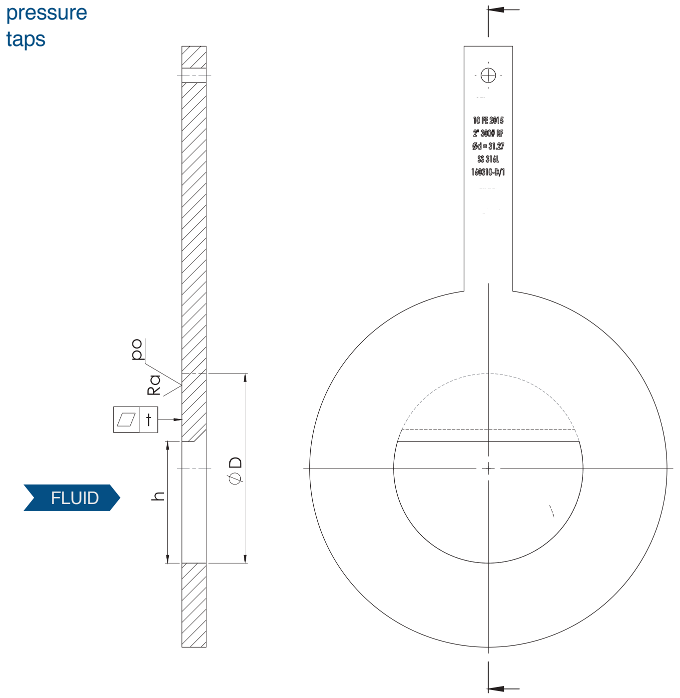
Recommended for dirty fluids with small particles or two-phase fluids

GENERAL DATA

- Standard: DIN VDI/VDE 2041
- Flange mounting :
  - o ISO PN 2.5 to PN 420
  - o ASME 150# to 2500#
  - o Others: upon request
- Material:
  - o Standard: stainless steel 304L / 316L
  - o Others : according to your data sheet
- Fluid: liquid, gas, steam
- Pipes from ϕ 100 to 350 mm
- Accuracy: 1.2 % of the max flow rate
- Repeatability of measurement: 0.1 %



ΔP 0/0 | ΔP 25/25 | pressure taps



TECHNICAL CHARACTERISTICS

		DIN VDI/VDE 2041
Re_D	Reynolds number in the pipe	$10^4 \leq Re_D \leq 10^6$
D	Inside pipe diameter	50 mm ≤ D ≤ 500 mm
h	Orifice height	h ≥ 12.5 mm
ß	h/D	0.316 ≤ ß ≤ 0.707
Ra	Upstream face roughness	$Ra \leq 10^{-4}.h$
e	Orifice thickness	0.005.D ≤ e ≤ 0.02.D
E	Plate thickness	e ≤ E ≤ 0.05.D
α	Angle of the downstream bevel if needed	α = 45° ± 15°
t	Flatness tolerance	t < 0.005.(D - h)/2

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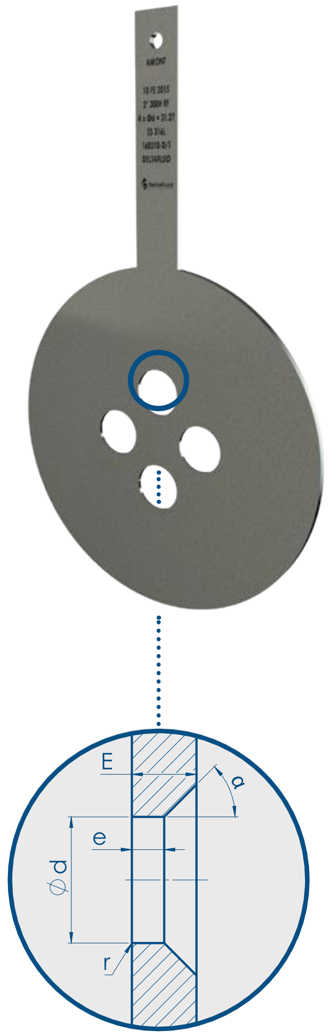
CONDITIONING
ORIFICE PLATE

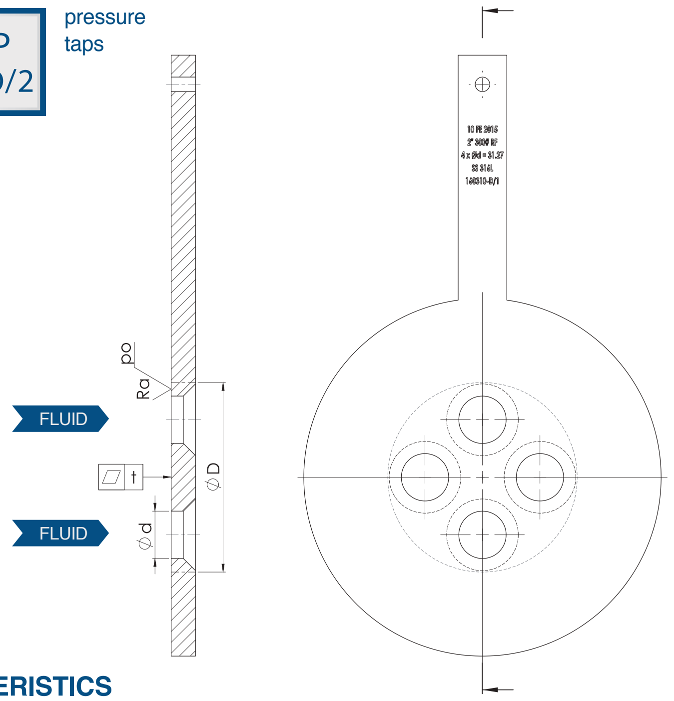
Cost-saving solution thanks to reduced upstream and downstream straight lengths

GENERAL DATA

- Design based on ISO 5167-1&2 or ASME MFC-3M standards
- Flange mounting :
  - o ISO PN 2.5 to PN 420
  - o ASME 150# to 2500#
  - o Others: upon request
- Material:
  - o Standard: stainless steel 304L / 316L
  - o Others : according to your data sheet
- Fluid: liquid, gas, steam
- Pipes from ϕ 25 to 1 000 mm
- Accuracy: 0.5 % of the max flow rate
- Repeatability of measurement: 0.1 %



ΔP 0/0 | ΔP 25/25 | ΔP D-D/2 | pressure taps



TECHNICAL CHARACTERISTICS

Re_D	Reynolds number in the pipe	$5\ 000 \leq Re_D \leq 10^8$
D	Inside pipe diameter	25 mm ≤ D ≤ 1 000 mm
d	Orifice diameter	d ≥ 6 mm
ß	d/D	0.2 ≤ ß ≤ 0.65
Ra	Upstream face roughness	$Ra \leq 10^{-4}.d$
r	Shard edge radius	r < 0.000 4.d
e	Sharp edge orifice thickness	0.005.D ≤ e ≤ 0.02.D
E	Plate thickness	e ≤ E ≤ 0.05.D
α	Angle of the downstream bevel if needed	α = 45° ± 15°
t	Flatness tolerance	t < 0.005.(D - d)/2

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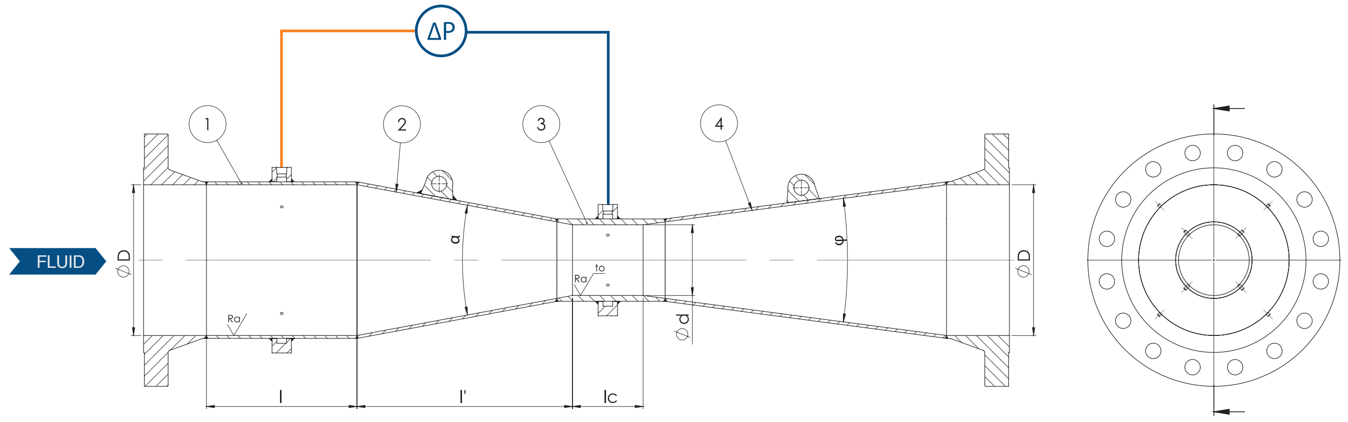
ROLLED WELDED
VENTURI TUBE

Suitable for large diameters and/or low permanent pressure drop

GENERAL DATA

- Standards: ISO 5167-1&4 or ASME MFC-3M
- Weld-end (BW) or flanged connection
- Material:
    - o Standard: carbon steel, stainless steel
    - o Others : according to your data sheet
- Fluid: liquid, gas, steam
- Pipes from ϕ 100 to 1 200 mm
- Accuracy: 1.5 % of the max flow rate
- Repeatability of measurement: 0.1 %

MARK	DESIGNATION
1	Entrance cylinder
2	Convergent
3	Throat
4	Divergent



Upstream and throat pressure taps: annular chambers or four tappings with a «triple-T» arrangement

TECHNICAL CHARACTERISTICS

		ISO 5167-1&4	ASME MFC-3M
Re_D	Reynolds number in the pipe	$2.10^5 \leq Re_D \leq 2.10^6$	$2.10^5 \leq Re_D \leq 6.10^6$
D	Inside pipe diameter	200 mm ≤ D ≤ 1 200 mm	100 mm ≤ D ≤ 1 200 mm
ß	d/D	0.40 ≤ ß ≤ 0.70	0.30 ≤ ß ≤ 0.75
Ra	Throat roughness	$Ra \leq 10^{-4}.d$	
	Entrance cylinder and convergent roughness	$Ra \leq 5.10^{-4}.D$	
l	Entrance cylinder minimal length	l = D	
l'	Entrance convergent length	l' = 2.7.(D - d)	
α	Entrance convergent angle	α = 21° ± 1°	
lc	Throat length	lc = d ± 0.03.d	
φ	Exit divergent angle	7° ≤ φ ≤ 15°	

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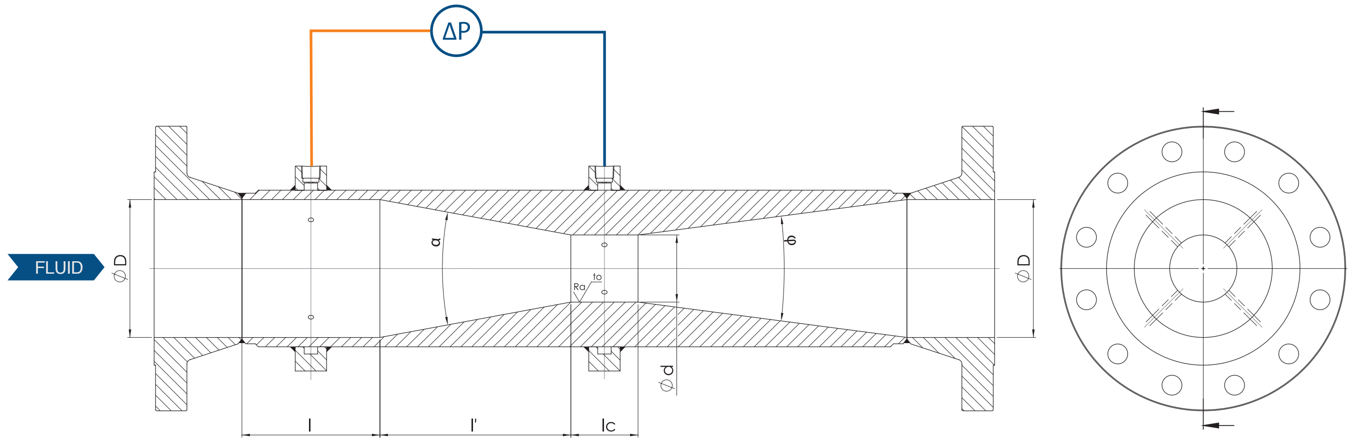
MACHINED
VENTURI TUBE

Suitable for small diameters and/or low permanent pressure drop

GENERAL DATA

- Standards: ISO 5167-1&4 or ASME MFC-3M
- Weld-end (BW) or flanged connection
- Material:
    - o Standard: carbon steel, stainless steel
    - o Others : according to your data sheet
- Fluid: liquid, gas, steam
- Pipes from ϕ 50 to 250 mm
- Accuracy: 1 % of the max flow rate
- Repeatability of measurement: 0.1 %



Upstream and throat pressure taps: annular chambers or four tappings with a «triple-T» arrangement

TECHNICAL CHARACTERISTICS

		ISO 5167-1&4	ASME MFC-3M
Re_D	Reynolds number in the pipe	$2.10^5 \leq Re_D \leq 10^6$	$2.10^5 \leq Re_D \leq 6.10^6$
D	Inside pipe diameter	50 mm ≤ D ≤ 250 mm	
ß	d/D	0.40 ≤ ß ≤ 0.75	0.30 ≤ ß ≤ 0.75
Ra	Throat roughness	$Ra \leq 10^{-4}.d$	
	Entrance cylinder and convergent roughness	$Ra \leq 10^{-4}.d$	
l	Entrance cylinder minimal length	l = D	
l'	Entrance convergent length	l' = 2.7.(D - d)	
α	Entrance convergent angle	α = 21° ± 1°	
lc	Throat length	lc = d ± 0.03.d	
φ	Exit divergent angle	7° ≤ φ ≤ 15°	

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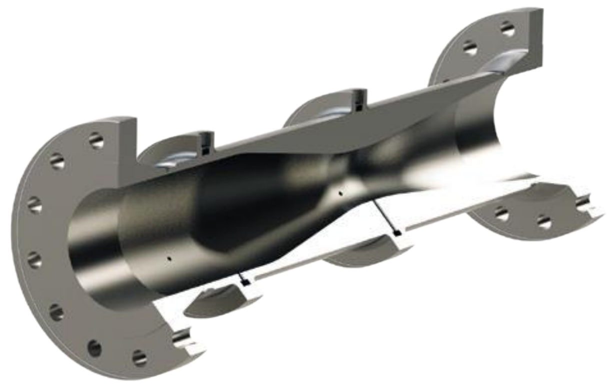
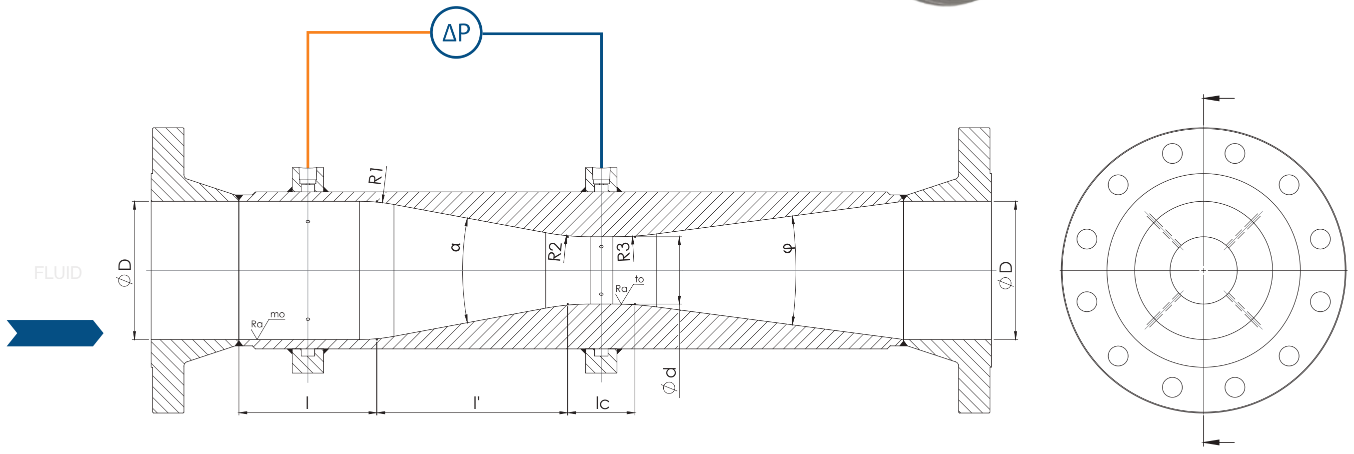
AS CAST
VENTURI TUBE

For a better accuracy

GENERAL DATA

- Standards: ISO 5167-1&4 or ASME MFC-3M
- Weld-end (BW) or flanged connection
- Material:
  - o Standard: carbon steel, stainless steel
  - o Others : according to your application
- Fluid: liquid, gas, steam
- Pipes from ϕ 100 to 1 200 mm
- Accuracy: 0.7 % of the max flow rate
- Repeatability of measurement: 0.1 %





Upstream and throat pressure taps: annular chambers or four tappings with a «triple-T» arrangement

TECHNICAL CHARACTERISTICS

		ISO 5167-1&4	ASME MFC-3M
Re_D	Reynolds number in the pipe	$2.10^5 \leq Re_D \leq 2.10^6$	$2.10^5 \leq Re_D \leq 6.10^6$
D	Inside pipe diameter	100 mm ≤ D ≤ 800 mm	100 mm ≤ D ≤ 1 200 mm
ß	d/D	0.30 ≤ ß ≤ 0.75	
Ra	Throat roughness	$Ra \leq 10^{-4}.d$	
	Entrance cylinder and convergent roughness	$Ra \leq 10^{-4}.D$	
l	Entrance cylinder minimal length	l = D ou (0.25.D + 250 mm)	
l'	Entrance convergent length	l' = 2.7.(D - d)	
α	Entrance convergent angle	α = 21° ± 1°	
lc	Throat length	lc = d ± 0.03.d (minimum value = d/3)	
R_1	Radius of curvature 1 between the entrance cylinder and the convergent section	$R_1 = 1.375.D \pm 0.275.D$	
R_2	Radius of curvature 2 between the convergent section and the throat	$R_2 = 3.625.d \pm 0.125.d$	
R_3	Radius of curvature 3 between the throat and the divergent section	$5.d < R_3 < 15.d$	
φ	Exit divergent angle	7° ≤ φ ≤ 15°	

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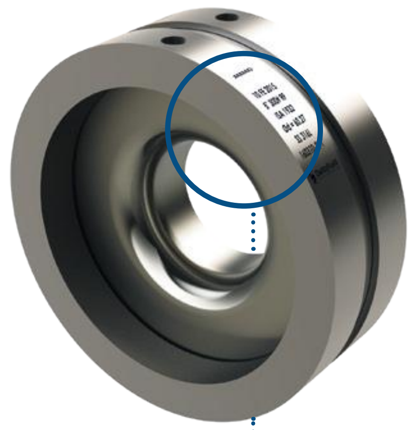
ISA 1932
NOZZLE

Suitable for large flow rates with high speeds

GENERAL DATA

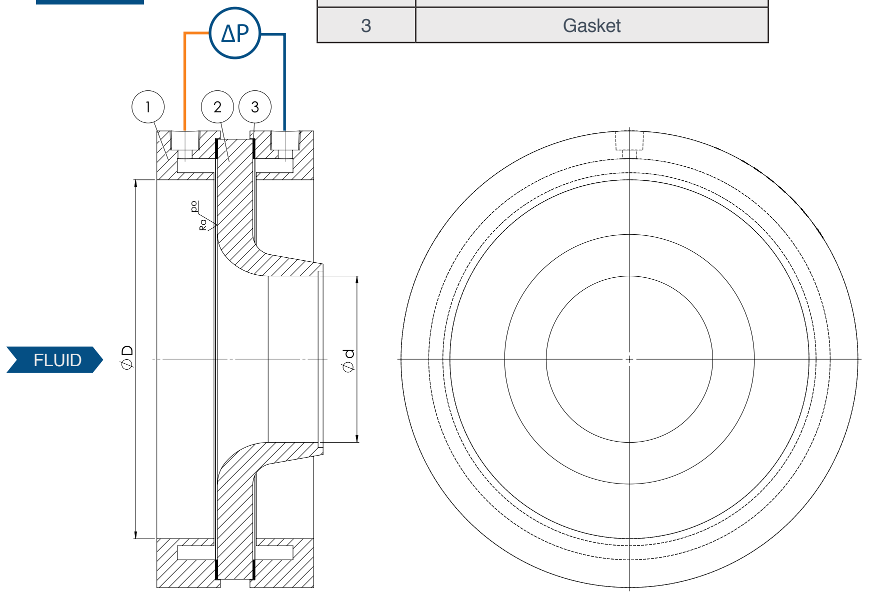
- Standards: ISO 5167-1&3 or ASME MFC-3M
- Flange mounting :
  - o ISO PN 2.5 to 420
  - o ASME 150# to 2500#
  - o Others: upon request

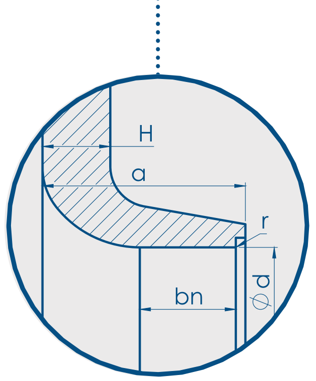
  or weld-end connection (BW)
- Material :
  - o Standard: carbon steel, stainless steel
  - o Others : according to your data sheet
- Fluid: liquid, gas, steam
- Pipes from ϕ 50 to 500 mm
- Accuracy: 0.8 % of the max flow rate
- Repeatability of measurement: 0.1 %



ΔP 0/0 pressure tap

MARK	DESIGNATION
1	Annular chamber
2	ISA 1932 nozzle
3	Gasket





TECHNICAL CHARACTERISTICS

		ISO 5167-1&3 & ASME MFC-3M
Re_D	Reynolds number in the pipe	$2.10^4 \leq Re_D \leq 10^7$
D	Inside pipe diameter	50 mm ≤ D ≤ 500 mm
ß	d/D	0.3 ≤ ß ≤ 0.8
Ra	Roughness of the upstream face and throat	$Ra \leq 10^{-4}.d$
b_n	Cylindrical throat length	$b_n = 0.3.d$
a	Nozzle total length	Upon request
r	Downstream sharp edge radius	r < 0.000 4.d
H	Thickness	H ≤ 0.1.D

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INTEGRATED ORIFICE

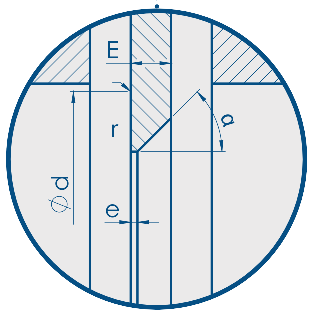
Complete measuring element with special flanges
Suitable for diameters of pipes ≤ 40 mm

GENERAL DATA

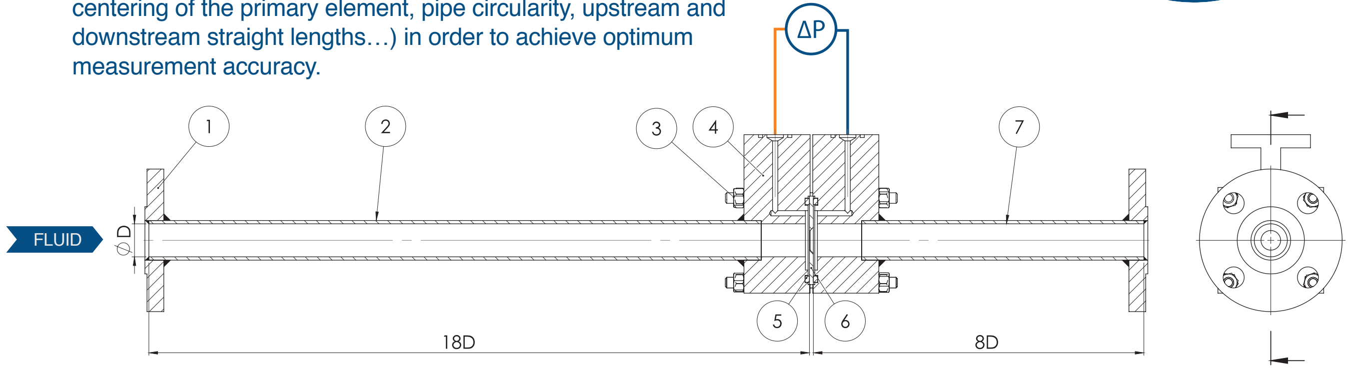
- Standard: ASME MFC-14M
- Mounting of the sharp edge orifice plate between special flanges (direct mounting of the manifold and of the differential pressure transmitter)
- Weld-end (BW) or flanged connection
- Material:
  - o Standard: carbon steel, stainless steel
  - o Others : according to your data sheet
- Fluid: liquid, gas, steam
- Pipes from ϕ 6 to 40 mm
- Accuracy: 0.5 % of the max flow rate
- Repeatability of measurement: 0.1 %

ΔP 0/0 pressure tap

MARK	DESIGNATION
1	Flange
2	Upstream pipe
3	Bolts
4	Annular chamber
5	Gasket
6	Sharp edge orifice plate
7	Upstream pipe



The construction is carried out in compliance with the standards (primary element, roughness of upstream and downstream pipes, centering of the primary element, pipe circularity, upstream and downstream straight lengths…) in order to achieve optimum measurement accuracy.



TECHNICAL CHARACTERISTICS		ASME MFC-14M
Re_D	Reynolds number in the pipe	Re_D > 1 000
D	Inside pipe diameter	6 mm ≤ D ≤ 40 mm
ß	d/D	0.1 ≤ ß ≤ 0.8
Sharp edge orifice plate		
Rα	Roughness of the upstream face	Rα < 1.27 µm
r	Sharp edge radius	r < 0.000 4.d or 0.025 µm
e	Orifice thickness	e < 0.02.D or 0.125.d
E	Plate thickness	E < 3.2 mm
α	Angle of the downstream bevel of the plate	α = 45° ± 15°

METER RUN

Complete and flexible measuring element to facilitate on-site installation

GENERAL DATA

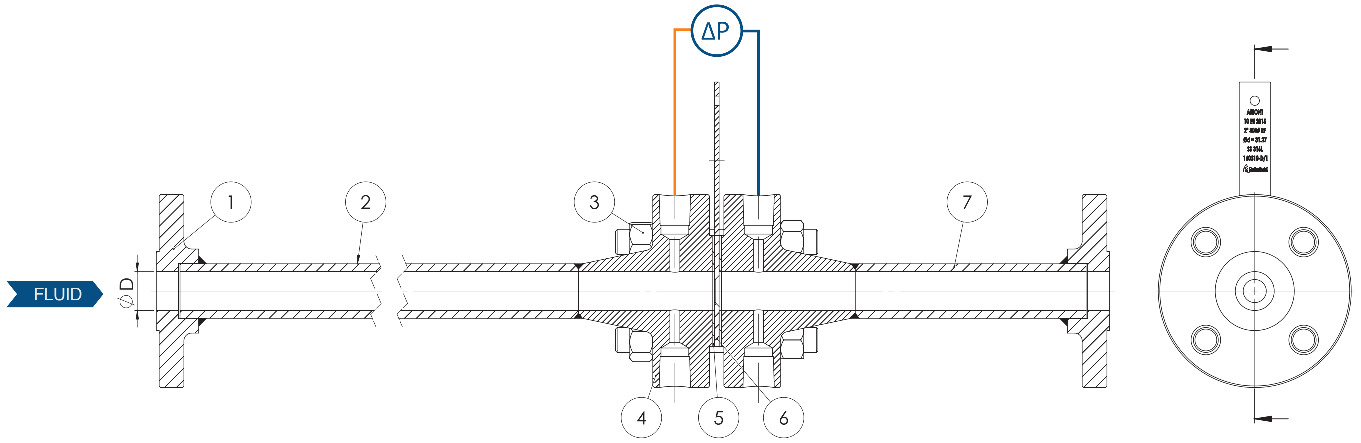
- Standards: ISO 5167-1&2, ASME MFC-3M or ISO/TR 15377
- Mounting of the primary element between flanges :
  - o ISO PN 2.5 to 420
  - o ASME 150# to 2500#
  - o Others: upon request
- Weld-end (BW) or flanged connection
- Material:
  - o Standard: carbon steel, stainless steel
  - o Others : according to your data sheet
- Fluid: liquid, gas, steam
- Pipes from ϕ 25 to 300 mm (for easy assembling)
- Accuracy: according to the primary element considered
- Repeatability of measurement: 0.1 %

ΔP 0/0 ΔP 25/25
pressure taps

MARK	DESIGNATION
1	Flange
2	Upstream pipe
3	Bolts
4	Orifice flange*
5	Gasket
6	Orifice plate**
7	Upstream pipe

* mounting also possible between annular chamber
** all types of orifice plates (as well as nozzles) can be mounted in a meter run

The assembly is carried out in our workshop in compliance with standards (roughness of upstream and downstream pipes, centering of the primary element, pipe circularity, ustream and downstream straight lengths…) in order to reach optimum measurement accuracy.



TECHNICAL CHARACTERISTICS - according to the primary element considered

Orifice plates	See corresponding technical datasheet
Nozzles	
Upstream and downstream straight lengths, pipe roughness and circularity, centering of the measuring element	

ACCESSORIES

Manifold	See corresponding technical datasheet
Differential pressure transmitter	

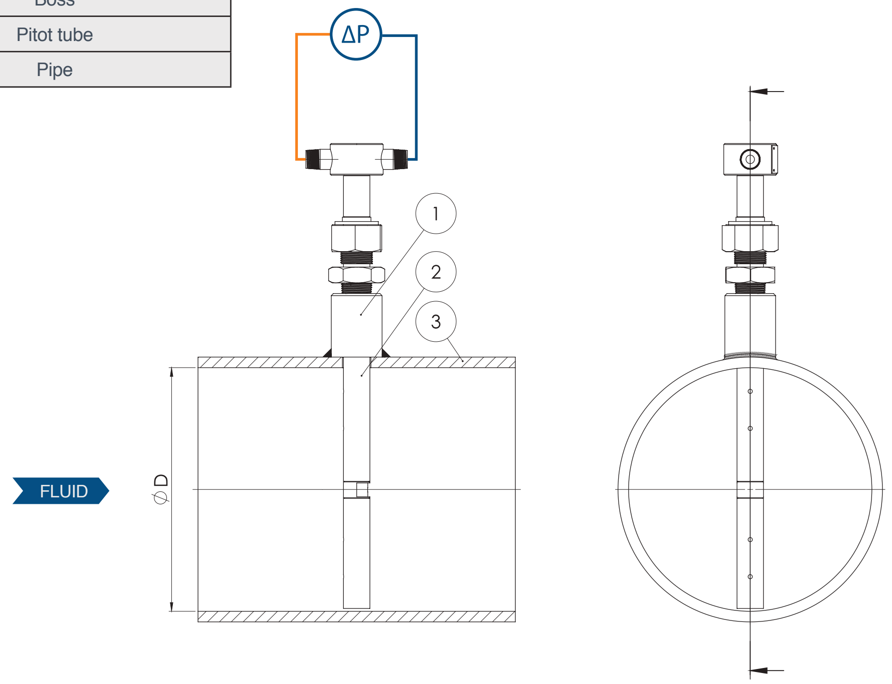
PITOT TUBE

Suitable for flow measurement in large pipes, for installations with low pressure

GENERAL DATA

- Standard: ASME MFC-12M
- Measurement averaged over the entire length of the tube
- Mounting on the pipe:
  - o compression fitting
  - o flange: ISO PN 2.5 to PN 420 or ASME 150# to 2500#
  - o retractable
- Material:
  - o Standard: stainless steel 304L / 316L
  - o Others : according to your data sheet
- Fluid: liquid, gas, steam
- Pipes from ϕ 100 to 5 000 mm
- Accuracy: contact us
- Repeatability of measurement: 0.1 %

MARK	DESIGNATION
1	Boss
2	Pitot tube
3	Pipe



TECHNICAL CHARACTERISTICS		ASME MFC-12M
Re_D	Reynolds number in the pipe	$Re_D > 1.2.10^4$
D	Inside pipe diameter	100 mm ≤ D ≤ 5 000 mm
L1	Upstream straight length	L1 ≥ 7.D
L2	Downstream straight length	L2 ≥ 3.D
P	Maximum allowable pressure	P ≤ 600 bar
T	Maximum allowable temperature	T ≤ 1 300 °C
µ	Maximum fluid viscosity	0.2 Pa.s

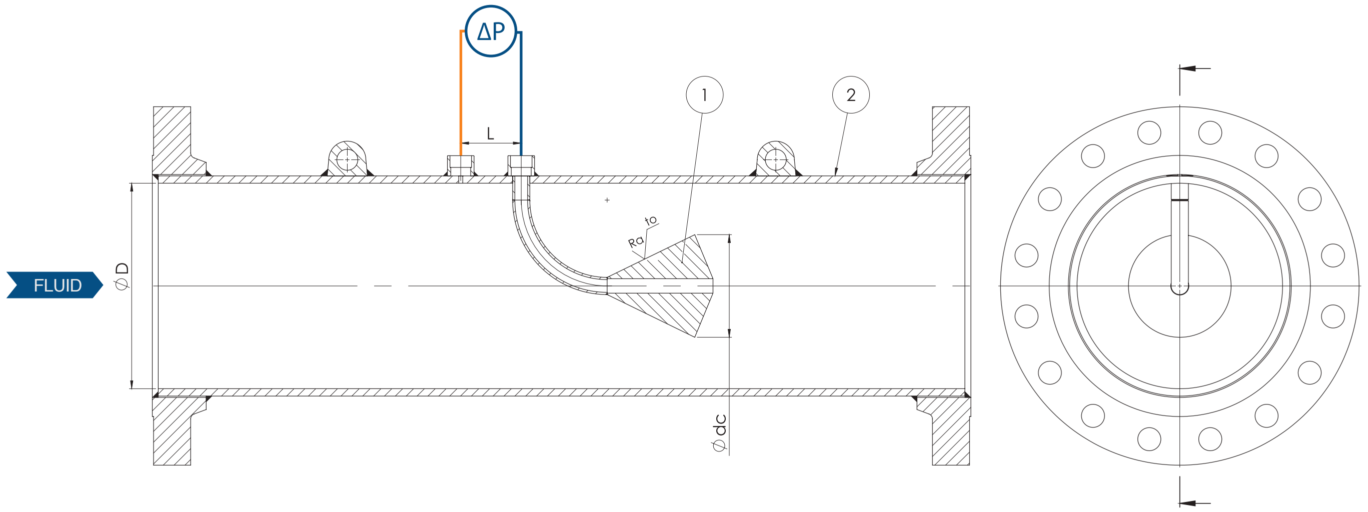
CONE METER

Suitable for short straight lengths and low flow rates

GENERAL DATA

- Standard: ISO 5167-1&5
- Weld-end (BW) or flanged connection
- Material:
  - o Standard: carbon steel, stainless steel
  - o Others : according to your data sheet
- Fluid: liquid, gas, steam
- Pipes from ϕ 50 to 500 mm
- Accuracy: 5 % of the max flow rate
- Repeatability of measurement: 0.1 %

MARK	DESIGNATION
1	Cone
2	Tube



TECHNICAL CHARACTERISTICS		ISO 5167-1&5
Re_D	Reynolds number in the pipe	$8.10^4 \leq Re_D \leq 1.2.10^7$
D	Inside pipe diameter	50 mm ≤ D ≤ 500 mm
β*	dc, diameter of the cone at the point where its circumference is maximum	0.45 ≤ β ≤ 0.75
Rα	Cone surface roughness	$R\alpha < 5.10^{-4}.d_c$
R_1	Bending radius of the cone at its maximum circumference	$R_1 < 0.000\ 5.d_c$ ou < 0.2 mm
L	Distance between upstream and downstream pressure tap	50 mm ≤ L ≤ 2.D

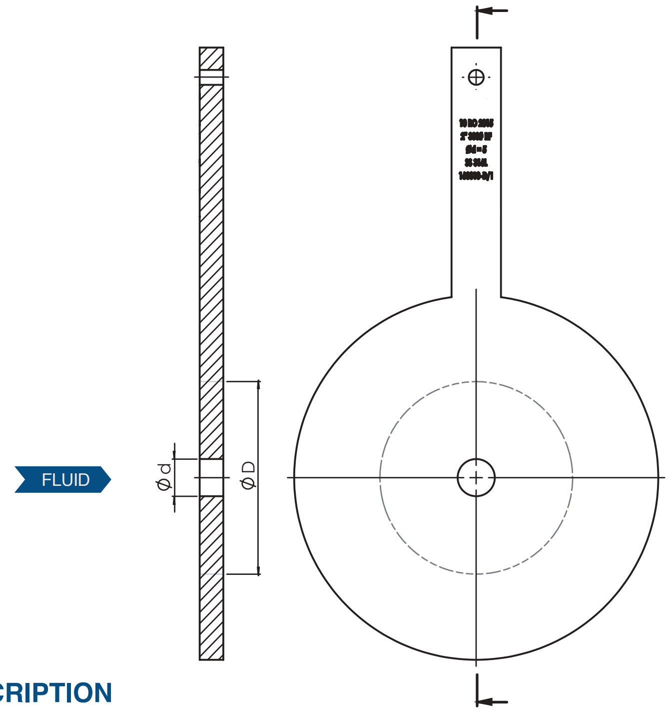
$^{*}\beta = \sqrt{1 - \frac{d_c^2}{D^2}}$

SIMPLE ORIFICE
RESTRICTION ORIFICE

Cost-saving solution

GENERAL DATA

- Design based on ISO 5167, ASME MFC-3M or R.W. Miller standards
- Flange mounting :
  - o ISO PN 2.5 to PN 420
  - o ASME 150# to 2500#
  - o Others: upon request
- Material:
  - o Standard: stainless steel 304L / 316L
  - o Others : according to your data sheet
- Fluid: liquid, gas, steam
- For all pipe sizes



TECHNICAL DESCRIPTION

Orifice diameter	Sized according to the fluid, to the desired pressure drop and flow rate when passing through the restriction.
Plate thickness	Calculation based on the pressure drop created by the plate and the piping inside diameter to prevent plate deformation during operation.
Noise	Noise level control estimated at 1 m. In the event of a high noise level, refer to the multi-hole plate.
Cavitation	The level of cavitation is checked for each plate. In the presence of cavitation, a multistage alternative can be proposed depending on the operating conditions of the restriction.
Critical flow or Choked flow	If the fluid reaches its maximum speed when passing through the restriction, its flow rate can no longer increase. A multi-stage solution can be proposed depending on the operating conditions of the restriction .

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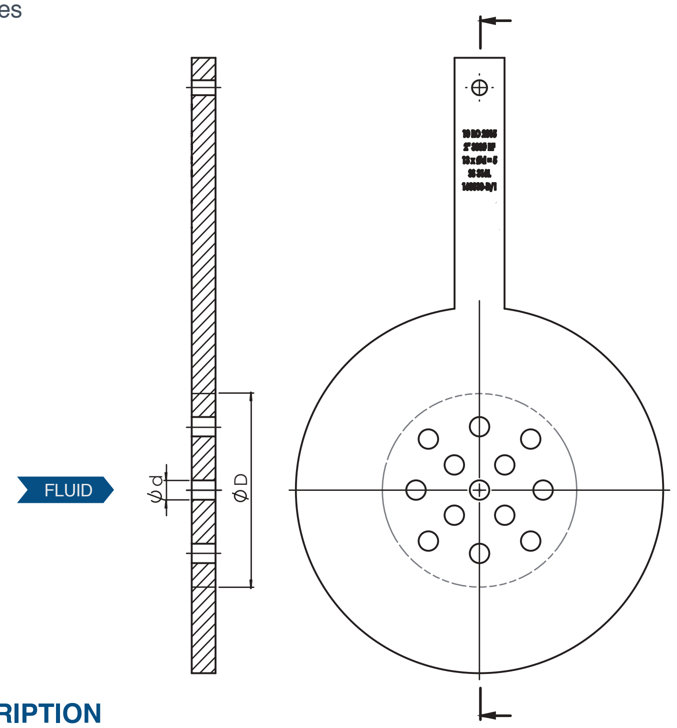
Technology Wins Dreams

MULTI HOLE
RESTRICTION ORIFICE

Suitable to reduce noise when passing through the orifice

GENERAL DATA

- Design based on ISO 5167, ASME MFC-3M or R.W. Miller standards
- Design according to Idel'cik for holes with rounded or bevelled edges possible on request
- Flange mounting :
  - o ISO PN 2.5 to PN 420
  - o ASME 150# to 2500#
  - o Others: upon request
- Material:
  - o Standard: stainless steel 304L / 316L
  - o Others : according to your data sheet
- Fluid: liquid, gas, steam
- For all pipe sizes



TECHNICAL DESCRIPTION

Orifices	Sized according to the fluid, pressure drop and flow rate passing through the restriction.
Plate thickness	Calculation based on the pressure drop created by the plate and the piping inside diameter to prevent plate deformation during operation.
Noise	The number of orifices is determined according to the noise level not to be exceeded. The maximum noise level depends on the operating conditions: limited to 85 dB(A) by the regulatory framework for average daily exposure in continuous operation. Intermittent or emergency operation - higher values acceptable (see corresponding regulations). If the noise level is still too high, it is possible to switch to a multi-stage restriction orifice.
Cavitation	The level of cavitation is checked for each plate and the orifices are calculated in order to avoid cavitation.
Critical flow ou Choked flow	Orifices are calculated at critical flow limit to generate a maximum pressure drop.

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RESTRICTION ORIFICES

CAVITATION - CRITICAL FLOW - NOISE

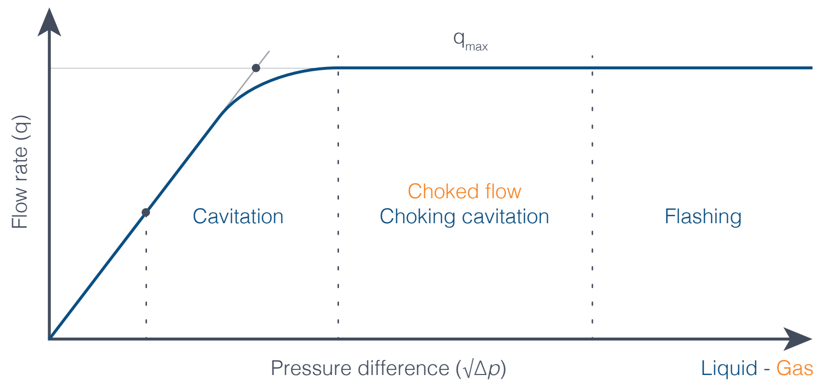
CAVITATION

Liquid cavitation occurs when low local pressure (lower than the vaporization pressure) is sufficient to allow the fluid to change phase from liquid to vapor (gas bubbles appearing). This phenomena can happen when the pressure is droping as the fluid is passing through the orifice. If downstream pressure is recovering above the phase change pressure, the implosion of these gas bubbles can generate significant noise levels and damage metallic components due to the energy dissipation.
If the pressure remains below the vaporization pressure downstream of the restriction, the fluid remains in gaseous form. This is the phenomenon of flashing.

CRITICAL FLOW

When approaching the restriction, the fluid velocity is increasing until it reaches its maximum speed as it flows through the restriction. If the sonic speed is reached (choked flow) or if the cavitation is too important (choking cavitation), the flow passing through this orifice does not increase even if the downstream pressure continues to drop.

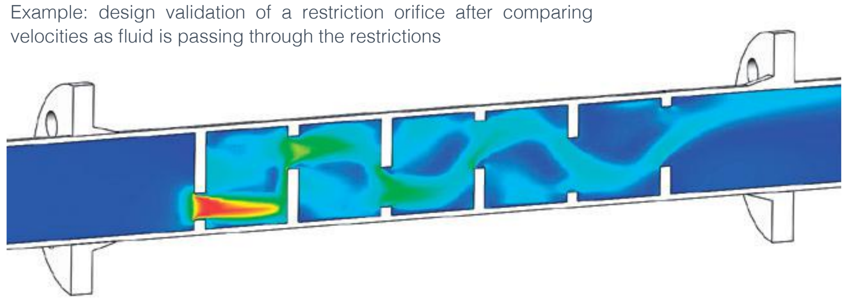
Maximum flow rate reached



To avoid the two phenomena mentioned above or **to reduce the noise level of the device**, a multi-stage restriction orifice can be proposed.

To optimize the design and validate analytical calculations of complex applications, our engineering office is able to perform fluid flow simulations (CFD).

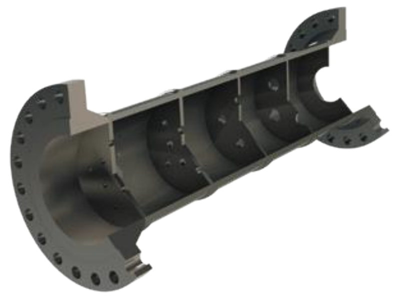
Example: design validation of a restriction orifice after comparing velocities as fluid is passing through the restrictions



Fluid velocity with simple orifice plates

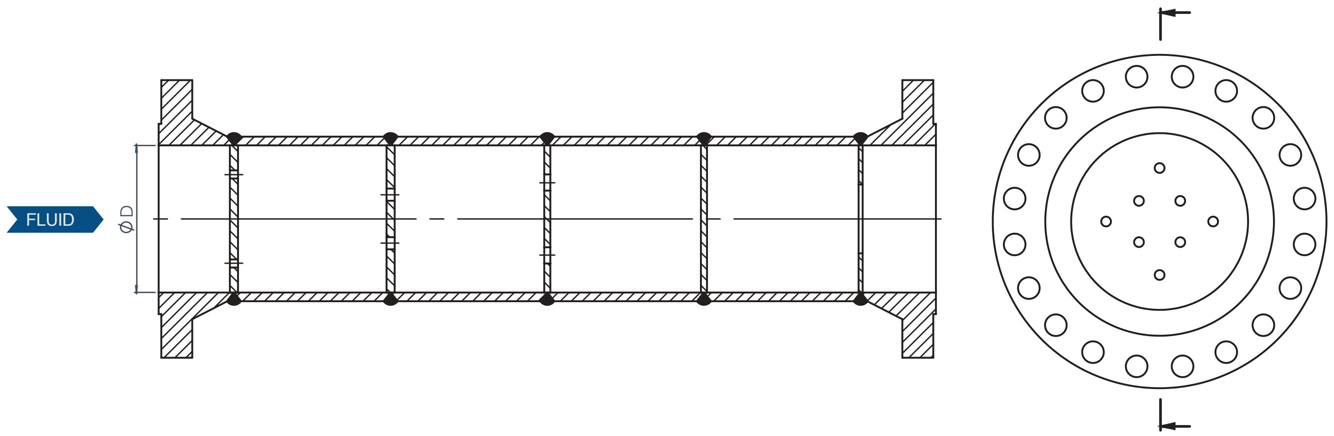
MULTI-STAGE RESTRICTION ORIFICE

Multiple plates in series when the desired pressure drop cannot be achieved with a single plate



GENERAL DATA

- Design based on ISO 5167, ASME MFC-3M or R.W. Miller standards
- Weld-end (BW) or flanged connection
- Material:
  - o Standard: stainless steel 304L / 316LL
  - o Others : according to your application
- Fluid: liquid, gas, steam
- For all pipe sizes



TECHNICAL DESCRIPTION

Plate mounting	Plates mounted in series – spacing between plates from 1D to 5D optimized for each device (D, inside pipe diameter)
Number of plates	Calculation of the number of stages optimized according to the specifications of the application, each plate enabling to reduce the pressure to the maximum while avoiding the phenomena of cavitation and critical flow
Noise	Control of the noise level of the complete device estimated at 1 m. Multi-hole plates reduce the noise level per stage. External enclosure solutions can be added if the noise level remains too high (contact us)
Thermodynamics	Thermodynamic properties of the fluid are taken into account for the calculation of each stage: phase change, temperature, composition and density of the mixture, viscosity, compressibility factor
3D simulation	Possibility of a numerical simulation to complete the analytical calculations .