Primary Flow Components

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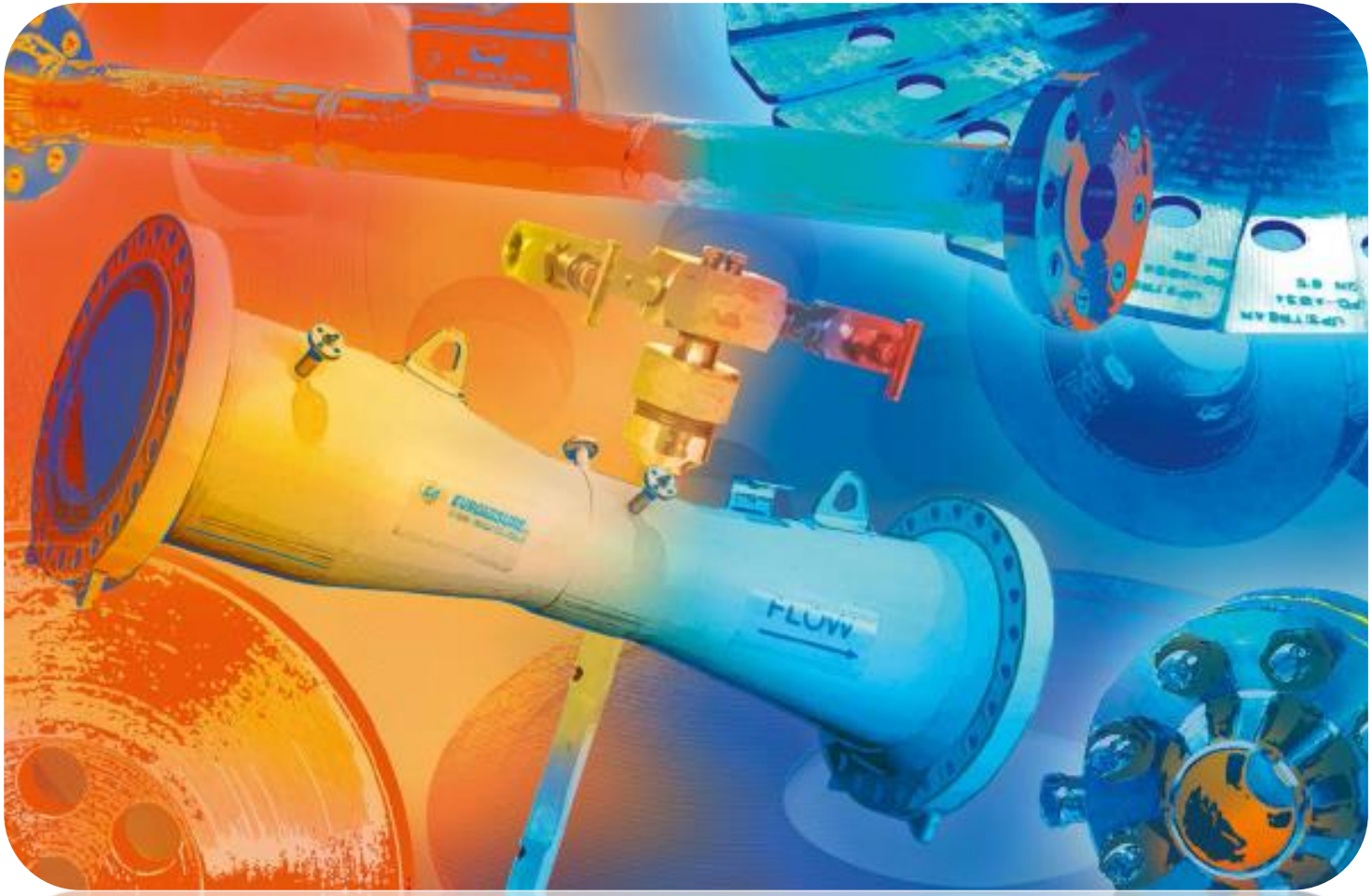

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Agenda

- WIKA
  - *Who is WIKA*
  - *Product Portfolio*
- Primary flow element
- Application
- Theory
  - *Beta*
  - *Flow profile*
  - *Engineering data*

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A family business

In the best hands for generations

- **1946** Dipl.-Ing. Alexander **Wi**egand founds the company WIKA together with Philipp **Ka**chel
- …
- **2008** Majority holding in KSR KUEBLER Niveau-Messtechnik AG
- **2011** WIKA acquires DH-Budenberg and strengthens its leading position in calibration technology
- **2012** Acquisition of the companies Euromisure (primary flow elements) and Gayesco (temperature measurement or furnace and reactor applications)

Dipl.-Ing.
Alexander Wiegand

Dr. jur.
Konrad Wiegand

Ursula Wiegand

Dipl.-Ing.
Alexander Wiegand

Production output

Precision from XS to XXL

- **Annual production** approx. 50,000,000 units worldwide
- **Daily production** approx. 200,000 units
- **Batch sizes** 1 up to 10,000 units and more
- **Measuring ranges** 0…0.5 mbar to 0…15,000 bar

  -250 ˚C to 1,800 ˚C
- **Prices per unit** 2 euros to over 20,000 euros

Product portfolio

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Primary Flow Components

Product Range

Orifice Plates & Assemblies

Venturi Tubes

Pitot Tubes

Flow Nozzles

Restriction Orifices

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Application

- Flow
  - *Gas*
  - *Steam*
  - *Liquid*

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When

- 2 wire power and communication
- Simple electronics (Differential pressure)
- High pressure
- High temperature
- Big sizes
- Exotic materials

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Examples

flow nozzle_07

Venturi (6)

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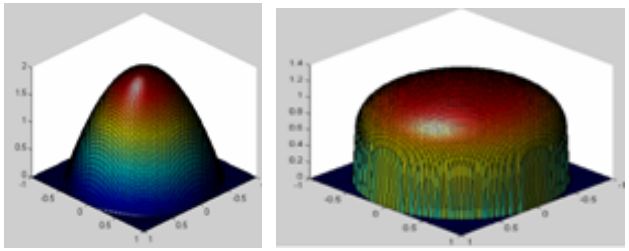
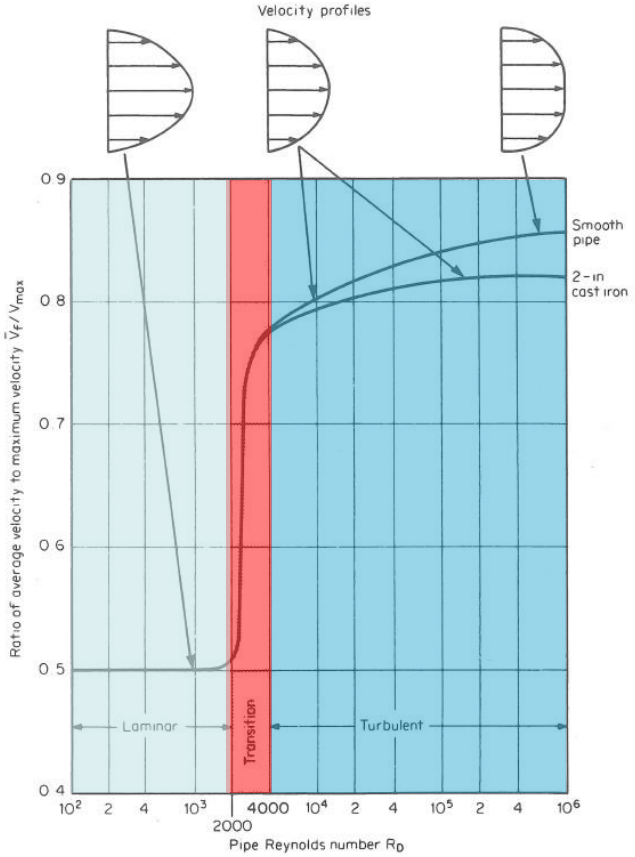
Reynolds number

- Laminar flow: $R_D \leq 2000$
- Turbulent flow: $R_D > 4000$
- Transition:
  the profile is complex and unstable in the narrow transition regime. Transition flow is a flow regime over which accurate measurement is quite difficult.





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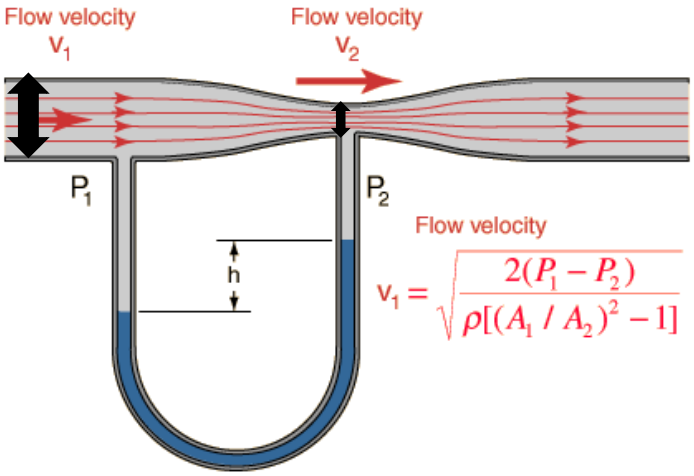
Bernoulli's application

- When a flow is contracted, either gradually or abruptly, kinetic energy increase at the expense of availablE potential energy (static pressure)
- Result: when the velocity increases, the pressure decreases and vice versa.
- The pressure difference between section 1 & 2 is related to:
  - the square of the velocity at section 1 less the square of the velocity at section 2
  - fluids properties
  - $\beta = d / D$



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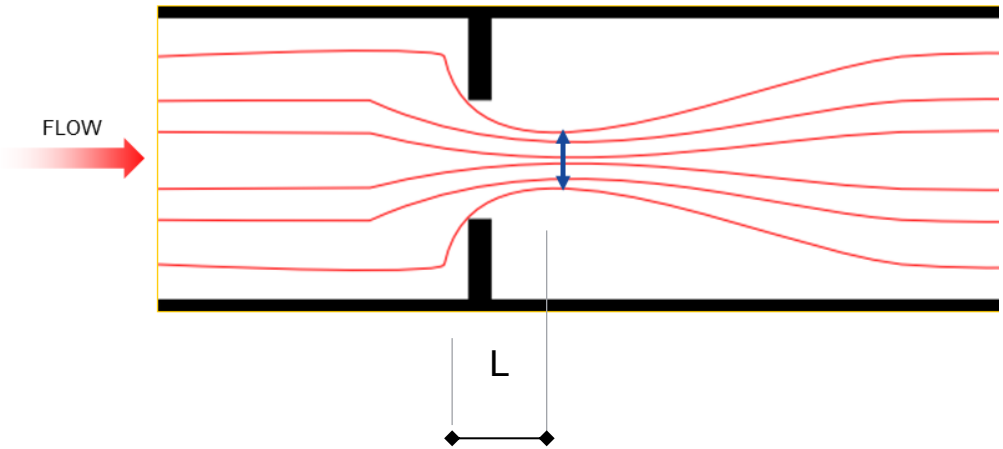
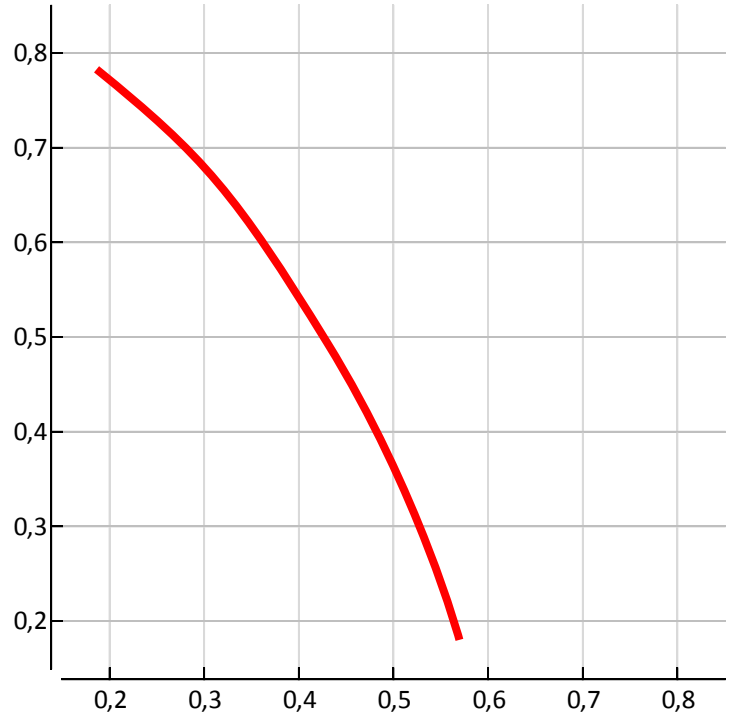
Basic Principles

The graph show the position of the Vena Contracta section *(L)* according to the β ratio of the orifice plate.





L = Pipe diameters from the inlet face of the orifice plate

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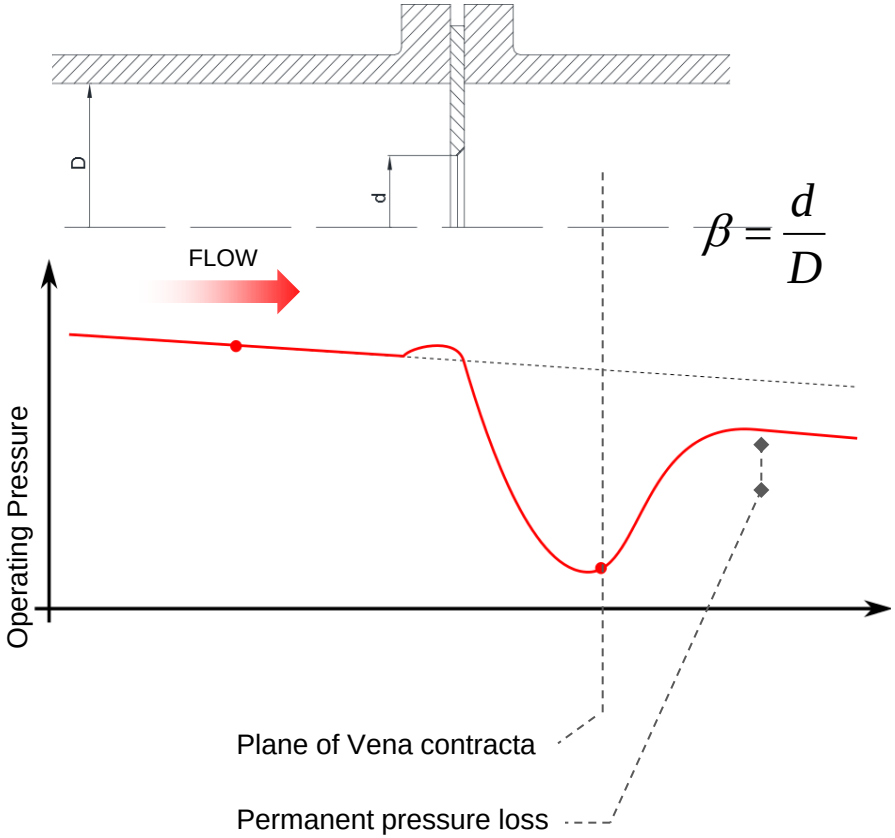
Fluid Pressure Profile

- Without the device, the pressure would decrease further because of the losses of load of the pipe (friction, viscosity, etc..).
- Just before the device, the pressure increases slightly due to the impact of the fluid onto the orifice plate.
- When the fluid goes through the device, the speed increases quickly and therefore the pressure decreases to its minimum value (the vena contracta).
- After the vena contracta, the passage area of the fluid has already increased.
- The pressure increases until the speed decreases and reaches its initial value; pressure does not reach its initial value.
  This difference is known as permanent pressure loss.



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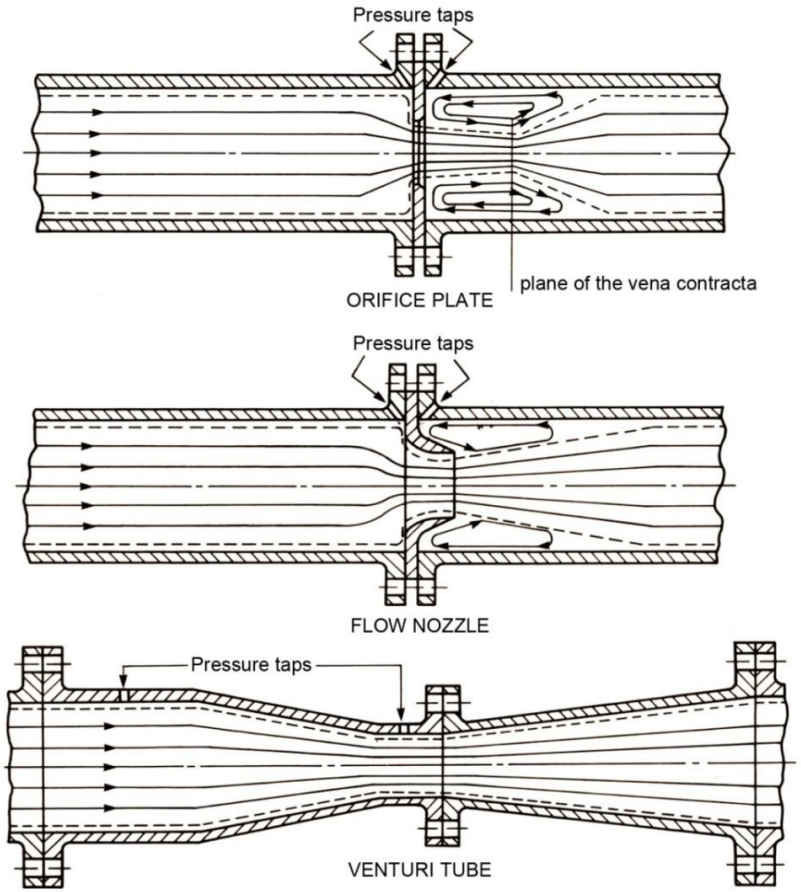
Line of fluids & turbulence

- Comparison between different primary flow elements in terms of turbulence generated by the device



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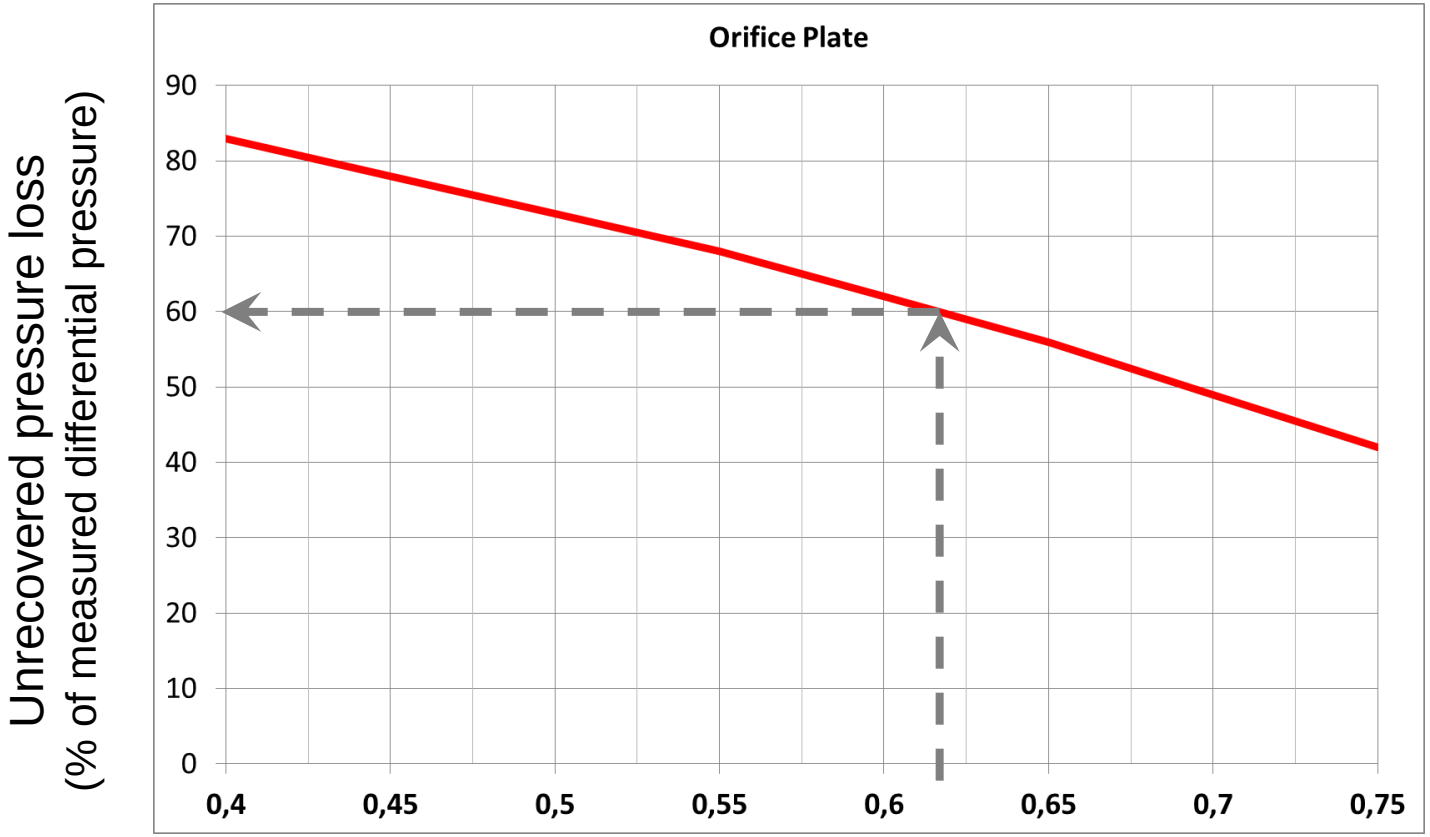
Permanent pressure loss



Orifice plate
β = 0,63

% pressure loss = 60%

DP @FS = 1000 mbar
UPL = 600 mbar

DP @Norm = 480 mbar
UPL = 288 mbar

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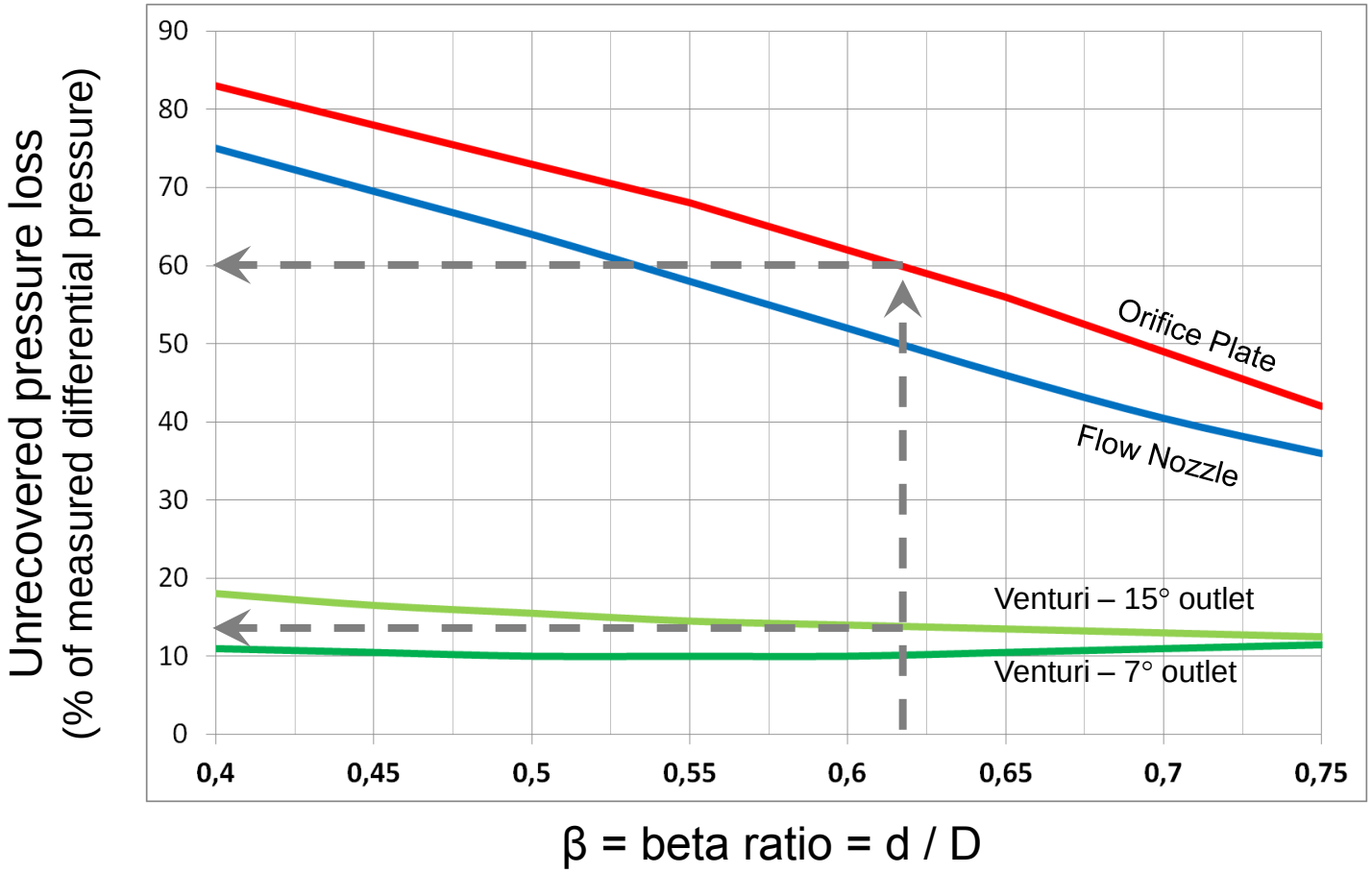
Permanent pressure loss



Orifice plate
β = 0,63

% pressure loss = 60%

DP @FS = 1000 mbar
UPL = 600 mbar

Venturi 15˚
β = 0,63

% pressure loss =12%

DP @FS = 1000 mbar
UPL = 120 mbar

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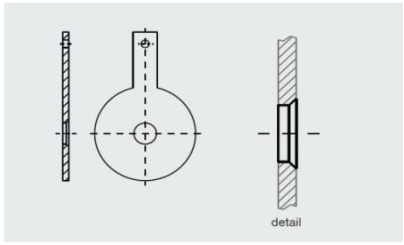
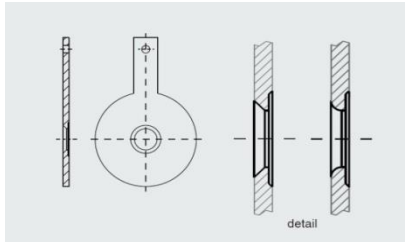
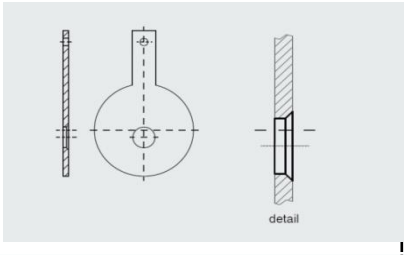
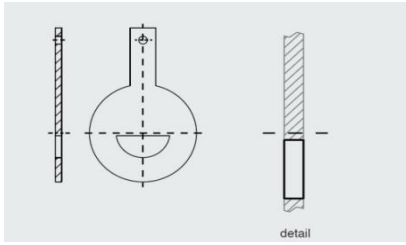
One name different executions

	Squared Edge	Quarter circle / Conical entrance	Eccentric	Segmental
				
Standards	ISO 5167-2:2003 ASME MFC-3M	ISO/TR 15377:2007 BS 1042	ISO/TR 15377:2007 BS 1042	ASME
Dimension limits & Reynols N. Range	D: 50÷1000 mm (2" ÷ 40") d: ≥ 12.5 mm (½") β: 0,1 ÷ 0,75 **Flange taps** Both ReD ≥ 5000 ReD ≥ 170 β^2 D **Corner or D-D/2 taps** ReD ≥ 5000 0.1 < β < 0.56 ReD ≥ 16000 β > 0.56	**Quarter circle** D: ≤ 500 mm (20") d: ≥ 15 mm β: 0,245 ÷ 0,6 ReD ≤ 10^5 β **Conical Entrance** D: ≤ 500 mm (20") d: ≥ 6 mm β: 0,1 ÷ 0,316 80 ≤ ReD ≤ 2x10^5 β	D: 100÷1000 mm (4" ÷ 40") d: ≥ 50 mm (½") β: 0,46 ÷ 0,84 2x10^5 β^2 ≤ ReD ≤ 10^6 β	D: 100÷350 mm (4" ÷ 14") d: ≥ 50 mm (½") β_c: 0,3 ÷ 0,8 $\beta_c = \frac{d_e}{D} = \frac{d_E}{0.98D}$ 10^4 ≤ ReD ≤ 10^6

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Quick selection guide

		Orifice Plate and relative assemblies (Orifice Flanges / Meter Run / Annular Chambers)		
		Square edge	Quadrant / Conical Entrance	Eccentric / Segmental
Gas	Clean	●	●	●
	Dirty	●	●	●
Liquids	Clean	●	●	●
	Viscous	●	●	●
	Dirty	●	●	●
	Corrosive	●	●	●
Steam		●	●	●
Accuracy		± 0,5÷0,8 %	± 2,0 %	± 2,0 %

● = Prefered
● = Suitable
● = not Suitable

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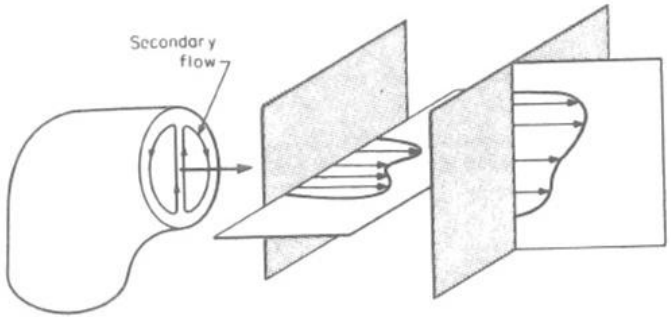
Profile distortion

- Pipe Fittings, reducers, expander, straines and elbows - necessary for normal plant piping – all affect profile
- Axial velocity vectors may be altered by one or a combination of the following>:
  - A pure swirl
  - Secondary flows
  - An asymmetric profile



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Installation requirements

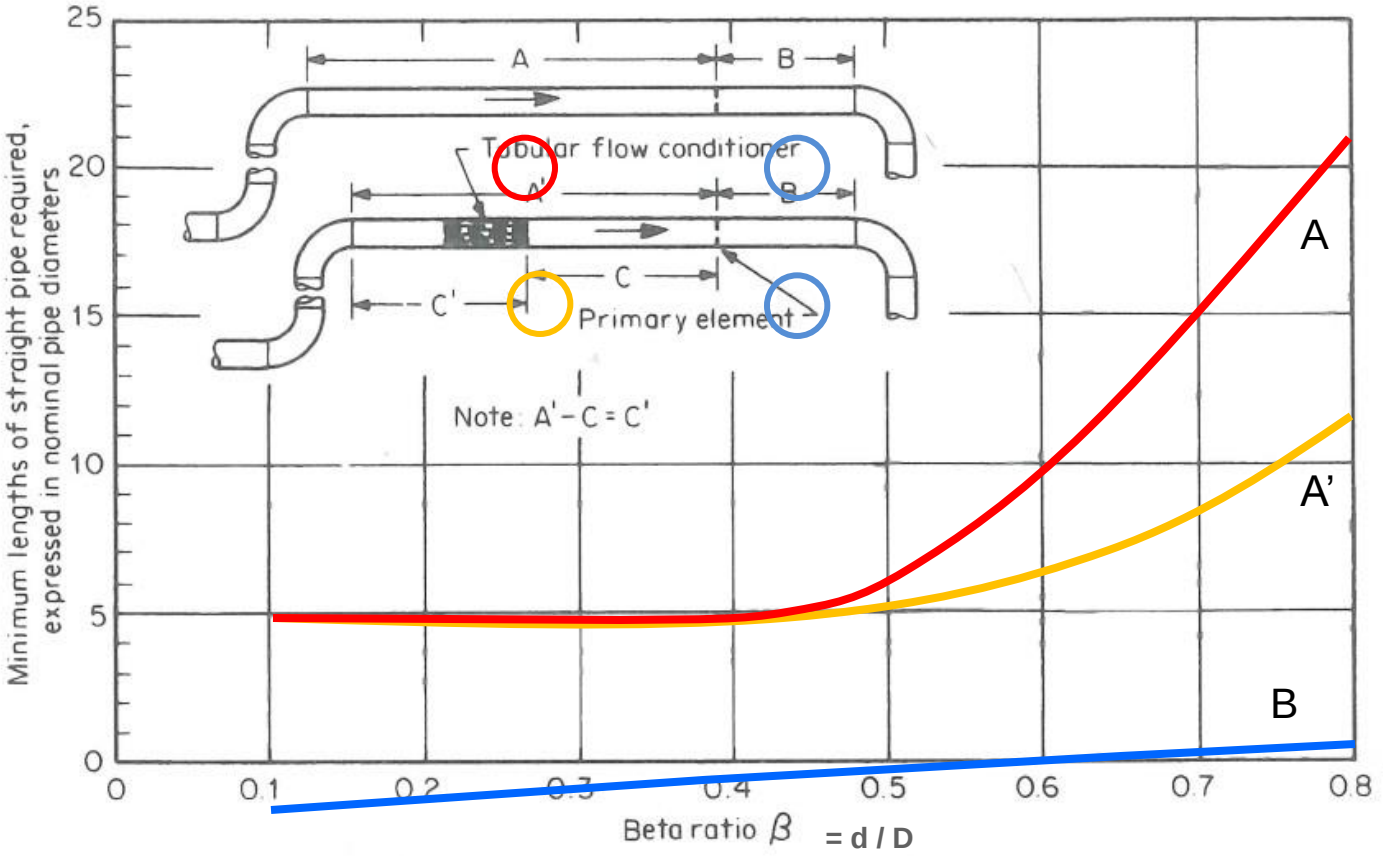
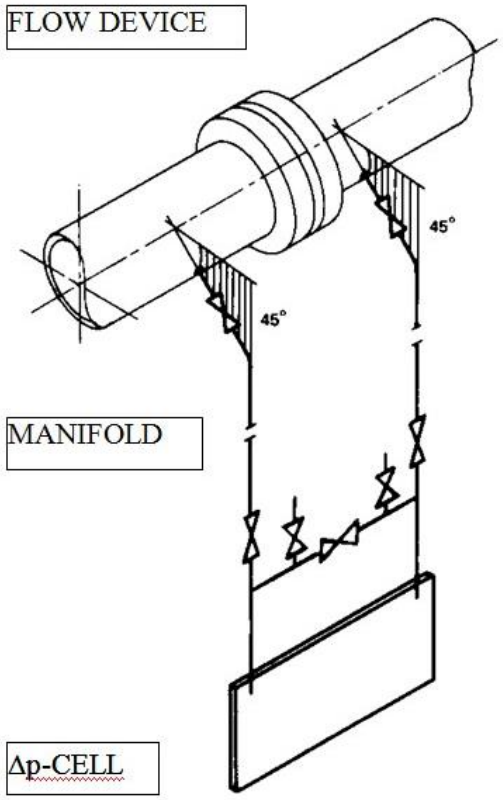
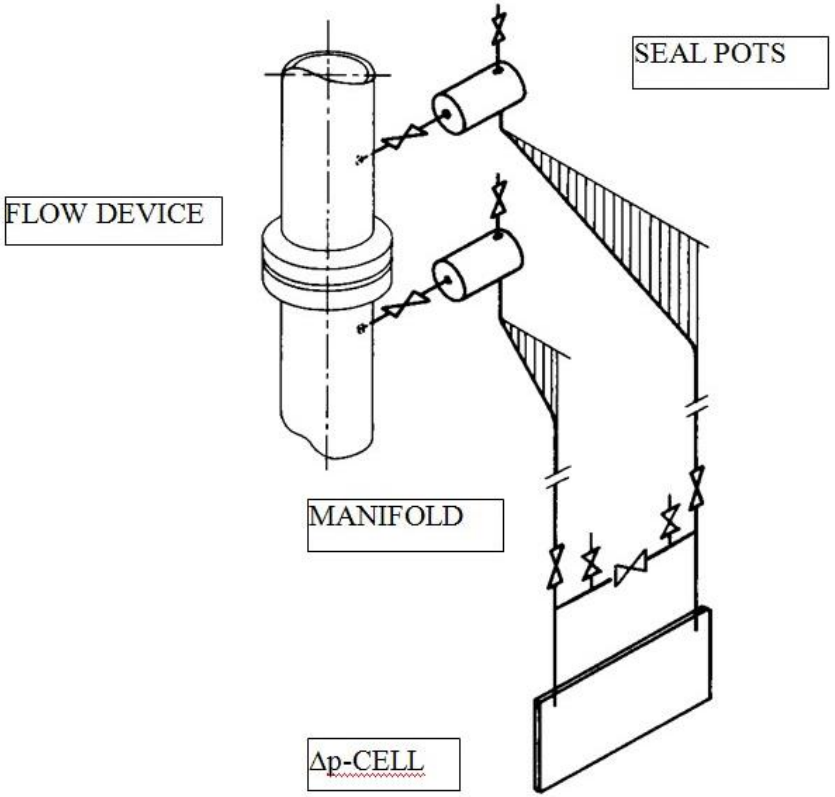


Figure 8.8 Installation lengths for primary element preceded by two elbows in one plane.

Each type of instrument has its specific requirements

Installations - Liquids





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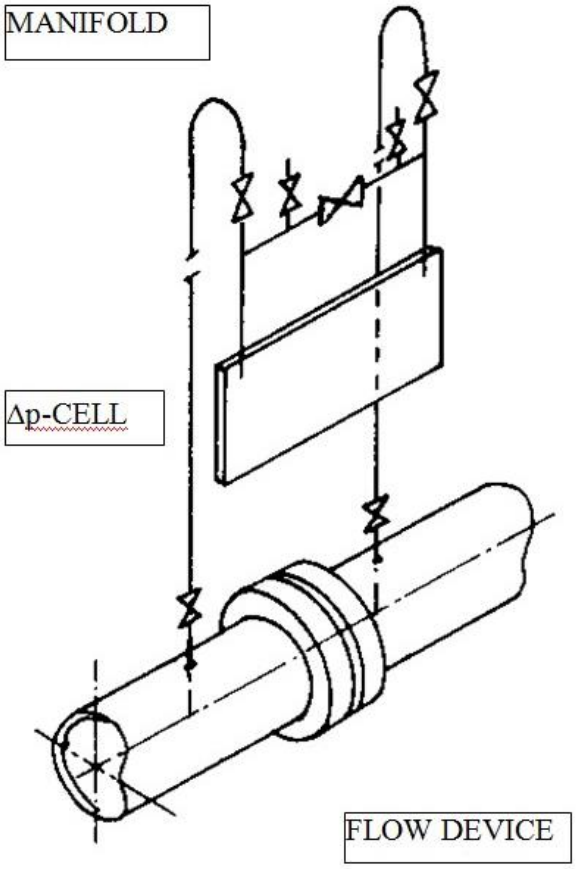
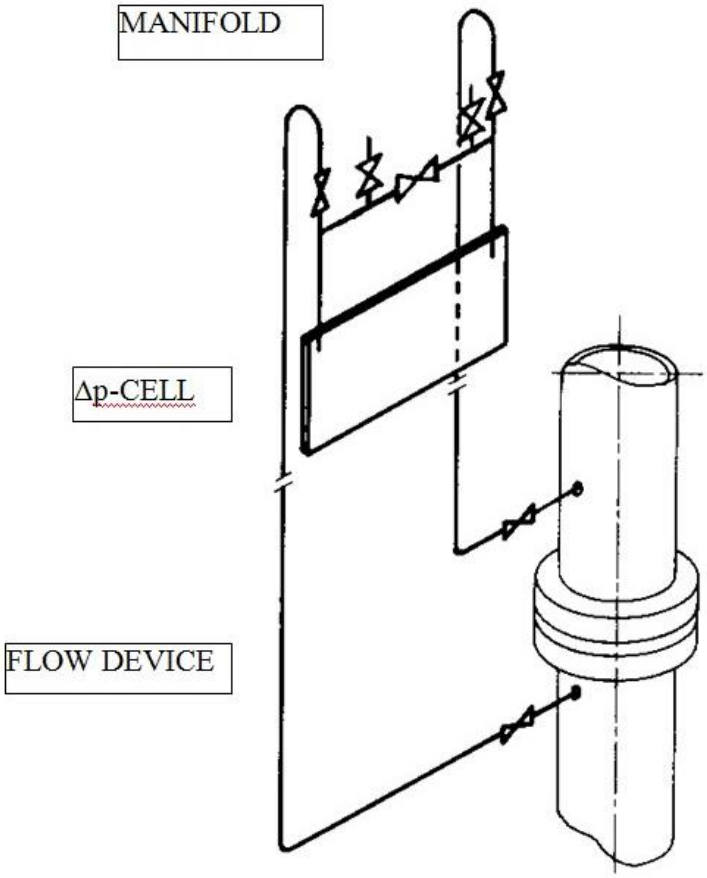
Installations - Gas





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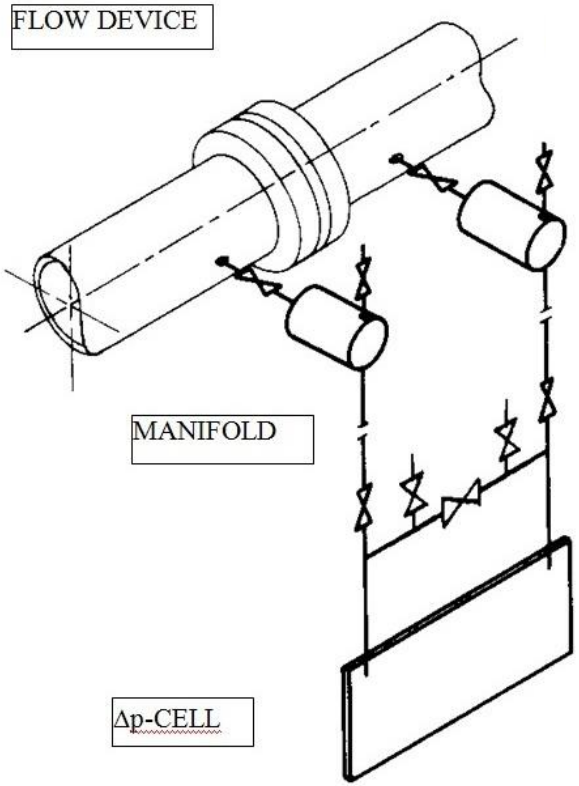
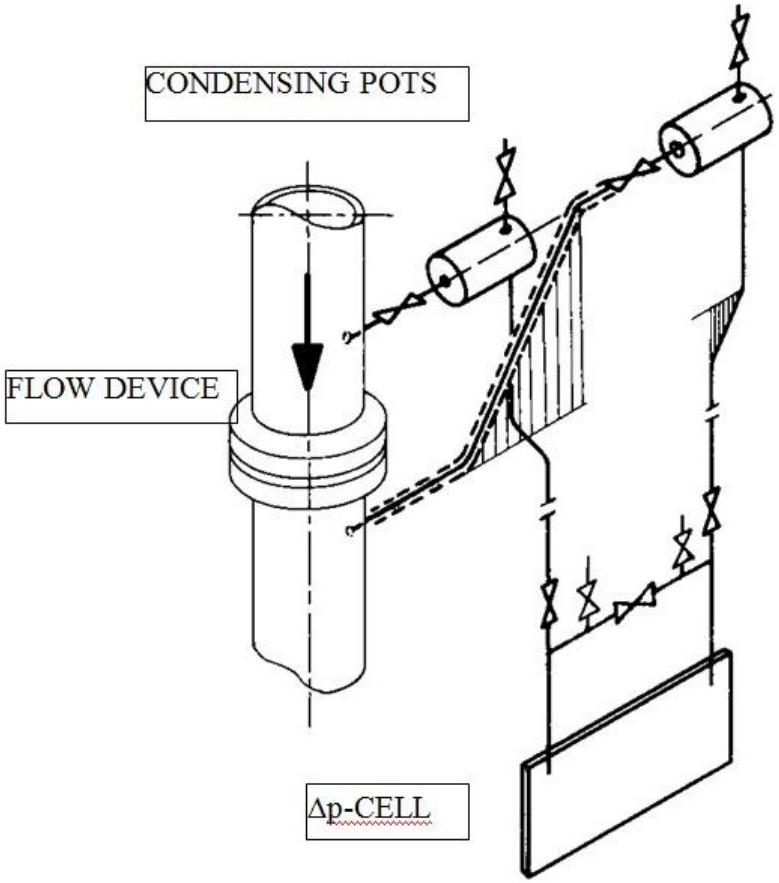
Installations - Steam





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Key messages (3)

Fluids	Process data (FS & operative)	Pipeline information
▪ Fluid data ▪ MW ▪ Density ▪ cp/cv ▪ Viscosity ▪ Compressibility factor ▪ Mix composition	▪ Pressure ▪ Temperature ▪ Flow rate ▪ DP @FS ▪ Instrument type	▪ Line Size ▪ Pipe schedule ▪ Flange Rating ▪ Flange facing ▪ Materials ▪ Pressure Taps (Type & Num) ▪ Tap Connections (NPT / SW) ▪ Drain/Vent Hole

Key messages (1)

		Orifice plate and related assemblies (Orifice flange / Meter run / Annular chambers)					Flow nozzle	Venturi tube	Pitot tube
		Square edge	Quadrant	Conical entrance	Eccentric	Segmental			
Gas	Clean	++	–	–	+	+	++	++	++
	Dirty	–	–	–	++	++	+	+	–
Liquids	Clean	++	++	++	+	+	++	++	++
	Viscous	–	++	++	–	–	+	+	+
	Dirty	+	+	+	++	++	+	+	–
	Corrosive	+	+	+	+	+	+	+	+
Steam		+	+	+	+	+	++	+	–

++ Preferred + Suitable – Not suitable

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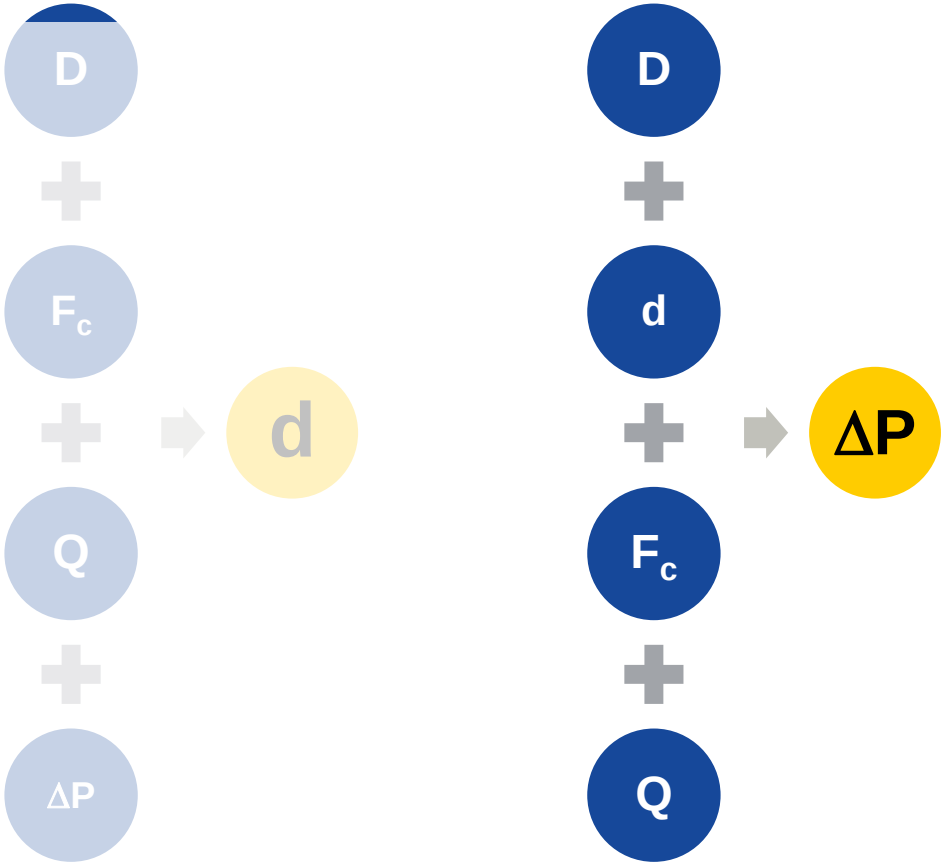
Design formula

Instrument design

- D = pipe ∅
- d = bore ∅
- F_c = fluid characteristics
- Q = flow rate
- ΔP = Delta pressure Required

Reverse calculation



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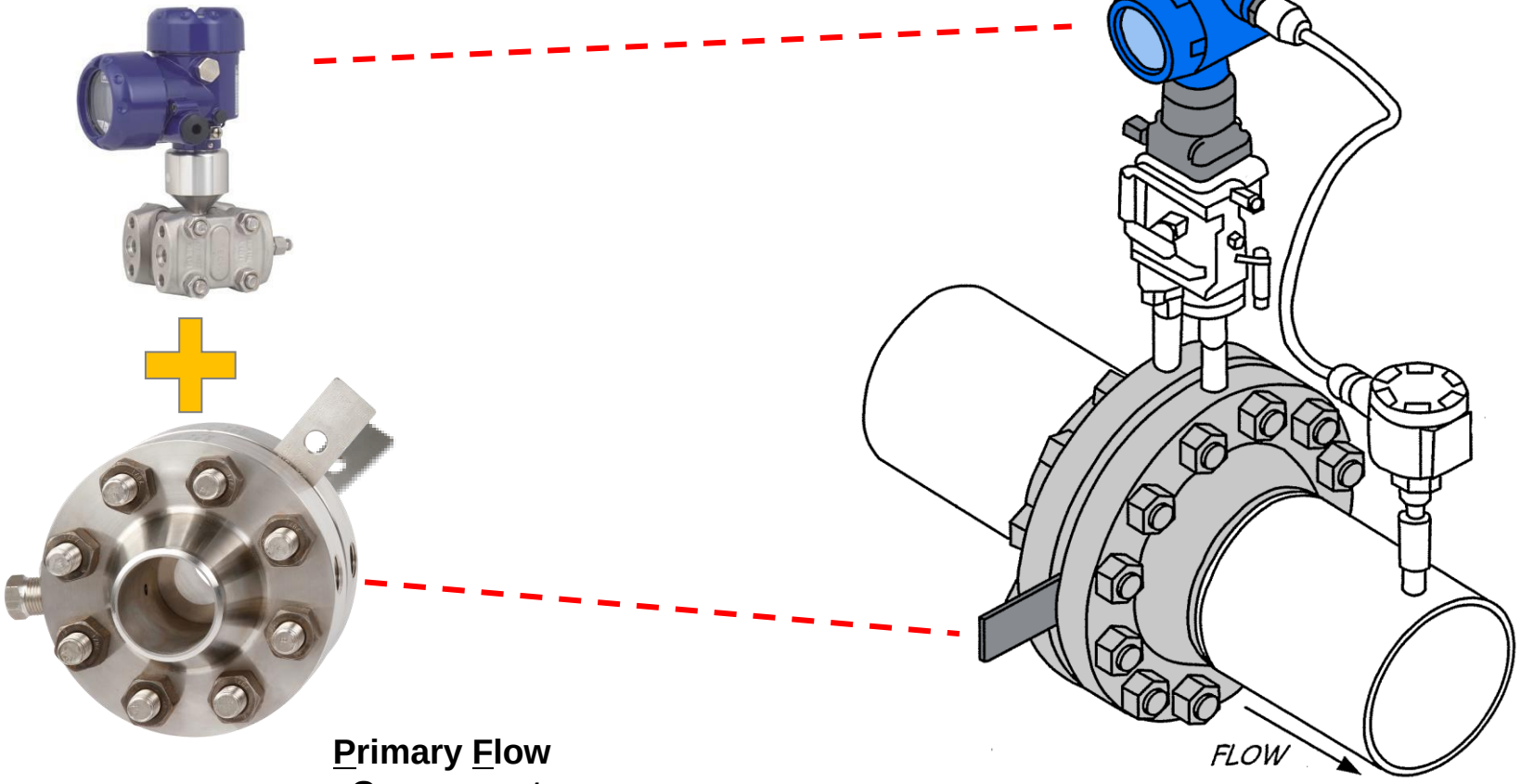
D/P Flow Measurement

DP Transmitter



Primary Flow Component

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