DP flow products and accessories

Deltatop, the universal measuring system for steam, gases and liquids

Endress+Hauser
People for Process Automation

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Endress+Hauser - experts in DP flow

Endress+Hauser offers a wealth of knowledge in engineering design, procurement of materials, project management and manufacture, along with inspection of equipment destined for high-end applications found in the chemical and oil & gas industry.

Complementing our existing flow portfolio of ultrasonic, electromagnetic, Coriolis, vortex and thermal meters, Endress+Hauser offers a range of primary devices from orifice plates and flow nozzles to Venturi tubes and cone meters – all designed and manufactured in accordance with BS EN ISO 5167.

Further to these standardised primary devices, we also offer averaging pitot tubes. Measuring the flow rate of liquid, steam or gas are some of the most important areas of application. Where upstream and downstream lengths are limited, a pitot tube may be the best available technology. Pitot tubes fabricated from tubing can be retrofitted to existing pipelines and ducting, providing a repeatable economic solution within larger pipe diameters with negligible pressure loss.

The square-edged orifice plate is one of our most popular low-cost flow measurement solutions. It can be used for general purpose flow measurement and is economical, easy to install and versatile. The scope of supply can include the plate, carrier, flanges, accessories or the full metering run.

Flow nozzles machined from a single piece can be provided for metering high velocities, high temperatures and high pressures, including superheated steam.

The classic Venturi tube, either machined from a single piece or fabricated from rolled plate metal, can be provided for reliable flow measurement with the additional benefit of minimal pressure loss. It is used extensively in arduous metering applications such as subsea manifolds, where space and energy conservation is at a premium.

Accessories such as valves, manifolds and condensate pots are available along with the differential pressure measuring cell to complete the volumetric flow metering solution. We also offer a mass flow solution by supplying static pressure and temperature measurements together with a flow computer.

All equipment is designed and manufactured in accordance with the requirements of the Pressure Equipment Directive 2014/68/EU and the PESR : 2016. DP flow stands out as a solution that can be fitted within your process, even in the most difficult applications.

Orifice plate variants

	Square edge orifice plate	Quarter circle orifice plate
	The square edge orifice plate is the most commonly used type of plate. This is used for applications with a Reynolds number of at least 5000. It has a sharp edge inlet and a chamfered outlet.	The quarter circle orifice plate has a fully rounded leading edge and no cylindrical section. This is used in liquids with low Reynolds number. The inlet shape of the orifice is rounded, like one quarter of a circle.
		
Model No.	OPSC	OPQC
Element ▪ Size [inches] ▪ Material	▪ ≥ 2" ▪ Stainless steel, Hastelloy C, Duplex ▪ Others upon request	▪ 1" to 20" ▪ Stainless steel, Hastelloy C, Duplex ▪ Others upon request
Technical data ▪ Accuracy ▪ Repeatability ▪ Pipe Reynolds no. ▪ Advantage ▪ Disadvantage ▪ Beta	 ▪ +/- 0.5% (Tapping dependent) ▪ 0.1% of reading ▪ ReD ≥ 5000 ▪ Economical, flexible ▪ High pressure loss, upstream length requirements ▪ 0.1-0.75	 ▪ +/- 2% ▪ 0.1% of reading ▪ ReD 200-60,000 ▪ Viscous fluids ▪ Critical manufacturing dimensions, less accurate, upstream length requirements ▪ 0.245-0.6
Typical applications ▪ Ideal ▪ Suitable ▪ Not suitable	 ▪ Clean gas/liquids ▪ Dirty liquids, corrosive liquids & steam ▪ Dirty gas, viscous liquids	 ▪ Clean liquids, viscous liquids ▪ Dirty liquids, corrosive liquids ▪ Clean/dirty gas

Orifice plate variants

	Eccentric orifice plate	Conical entrance orifice plate	Segmental orifice plate
	The eccentric orifice plate is used in service where severe entrainment may occur such as in dirty gas or liquid, which in the case of solids or slurries could plug the vent or drain.	The inlet bore edge of this plate is conical in shape. This plate is used for highly viscous fluids with low Reynolds number.	Like the eccentric orifice plate design, the segmental hole should be offset downward in gas flow applications and upward for liquid. Segmental bores are generally used for measuring liquids or gases which carry non-abrasive impurities such as sewage treatment.
			
Model No.	OPSE	OPCE	OPYY
Element ▪ Size [inches] ▪ Material	▪ 4" to 40" ▪ Stainless steel, Hastelloy C, Duplex ▪ Others upon request	▪ 1" to 20" ▪ Stainless steel, Hastelloy C, Duplex ▪ Others upon request	▪ ≥ 4" ▪ Stainless steel, Hastelloy C, Duplex ▪ Others upon request
Technical data ▪ Accuracy ▪ Repeatability ▪ Pipe Reynolds no. ▪ Advantage ▪ Disadvantage ▪ Beta	 ▪ +/- 2.5% ▪ 0.1% of reading ▪ ReD 42,320 - 840,000 ▪ Viscous fluids ▪ Less accurate ▪ 0.46-0.84	 ▪ +/- 2% ▪ 0.1% of reading ▪ ReD 80-263,200 ▪ Viscous fluids ▪ Critical manufacturing dimensions, less accurate, upstream length requirements ▪ 0.1-0.316	 ▪ +/- 1-2% ▪ 0.1% of reading ▪ ReD 40,000 - 1,000,000 ▪ Viscous fluids, gases in liquids ▪ Less accurate ▪ 0.316-0.707
Typical applications ▪ Ideal ▪ Suitable ▪ Not suitable	 ▪ Dirty gas/liquids, viscous liquids ▪ Clean gas/liquids, corrosive liquids	 ▪ Clean liquids, viscous liquids ▪ Dirty liquids, corrosive liquids ▪ Clean/dirty gas	 ▪ Dirty gas/liquids, viscous liquids ▪ Clean gas/liquids, corrosive liquids

Orifice overview

Orifice flange assembly

The orifice flange assembly takes away the need to drill further into the pipe, ensuring the tapping is as per ISO 5167-2, minimising any errors in the system. This type of assembly allows the orifice plate to be interchangeable.

The traditional orifice flange assembly consists of an orifice plate, pair of orifice flanges, nuts, bolts, gaskets, jack screw and plugs. As standard these flanges are weld neck; other types are available upon request.

Orifice carrier assemblies

The orifice carrier is required for applications where existing pipework has no facility for orifice tappings. The tapping is often attained by a bore through the carrier rings. The orifice with the carrier rings is mounted between two flanges.

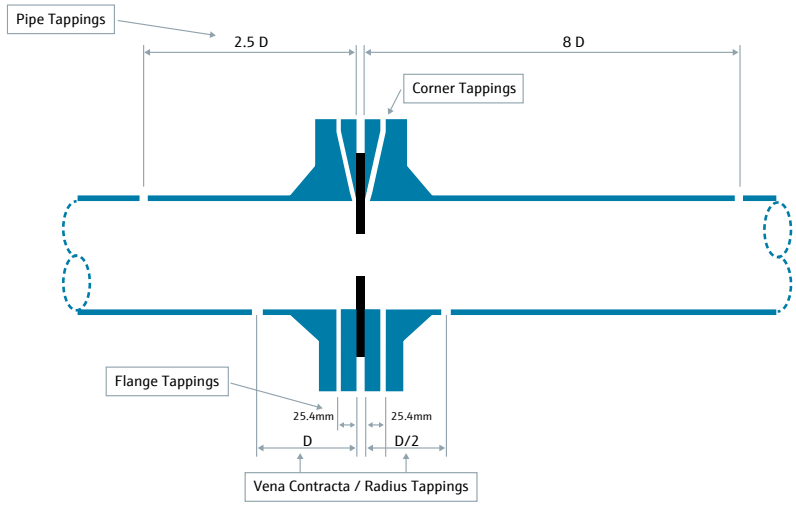
This can be supplied as either an integral carrier or a split ring assembly.

Orifice meter runs

Orifice flanged meter runs are generally used in small diameter pipes (DN15-DN40). The orifice meter run incorporates the upstream and downstream pipe sections required as per ISO5167 standards.

The orifice meter run consists of an annular chamber, orifice plate and flanged pipe section.

Types of mechanical construction



Flange Tapping

Flange taps are the most common and are generally used for pipe sizes of 2 inch and above. The pressure tapping is positioned 1" (25.4mm) from either face of the orifice plate. The pressure tapping is usually drilled through the body of Orifice Flanges as detailed in ANSI B16.36.

Corner Tapping

These taps are similar in many respects to flange taps, except that the pressure is measured at the 'Corner' between the orifice plate and the pipe wall. These are used for pipe sizes of 2 inch and below. This can be achieved by either a single tapping or an annular chamber within a carrier ring. The annular chamber "averages" the pressure around the pipe which improves accuracy.

D-D/2 (Vena Contracta / Radius) Tapping

Often referred to as "Vena contracta" or "Radius" taps, these offer the greatest differential pressure for any given flow rate. Tappings are positioned one pipe diameter upstream for the high pressure tap location and one-half pipe diameter downstream for the low-pressure tap location.

Pipe Tapping

Pipe taps are located 2.5 pipe diameters upstream and 8 diameters downstream from the orifice plate. They are typically used in existing installations, where other tapping configurations cannot be used. They are also used in applications of greatly varying flow however accuracy is reduced.

Classic Venturi tube / Venturi nozzle

	Venturi tube	Venturi nozzle
	Venturi tubes use the Venturi effect, which is the reduction of fluid pressure that results when a fluid runs through a constricted section of pipe. These meters create less pressure loss than orifice plates. 	Venturi nozzles combine the best features of a Venturi tube and a flow nozzle combined into one unit. Venturi nozzles excel when used with erosive fluids, high-velocity flow rates and/or non-viscous fluids. These meters, like the Venturi tube, create low pressure losses. 
Model No.	VT	VN
Element ▪ Size [inches] ▪ Material ▪ Types	 ▪ 2" and above ▪ Stainless steel, Hastelloy C, Duplex ▪ Others upon request ▪ Machined, welded	 ▪ 2" – 24" ▪ Stainless steel, Hastelloy C, Duplex ▪ Others upon request
Technical data ▪ Accuracy ▪ Repeatability ▪ Pipe Reynolds no. ▪ Advantage ▪ Disadvantage ▪ Beta	 ▪ +/- 1% ▪ 0.1% of reading ▪ ReD > 200,000 ▪ Accuracy, upstream length requirements. low pressure loss ▪ Length of device, installation cost ▪ 0.3-0.75	 ▪ +/- 1% ▪ 0.1% of reading ▪ ReD > 150,000 ▪ Erosive fluids, low pressure loss ▪ Less accurate, length of device ▪ 0.316-0.775
Typical applications	Accurate measurement with low pressure loss and minimal upstream piping requirements	High velocity, low pressure loss, low/non-viscous fluids

Flow nozzle / cone meter

	Long radius / flow nozzle	Cone meter
	The Nozzle is a good compromise between Venturi tubes and orifice plates. Due to the radiused inlet section, nozzles can handle very high flow velocities and are also a good choice for abrasive fluids. 	Cone meters are ideal for use with liquid, gas or steam where accuracy, low maintenance and cost are important. Cone meters are especially useful where the inlet runs of straight pipe required by other technologies are either impractical or unavailable. 
Model No.	FNLR - Long Radius FNIS - ISA 1932	CT
Element ▪ Size [inches] ▪ Material ▪ Types	 ▪ 2"– 24" ▪ Stainless steel, Hastelloy C, Duplex ▪ Others upon request ▪ ISA1932 nozzles, long radius nozzles	 ▪ 2" to 20" ▪ Stainless steel, Hastelloy C, Duplex ▪ Others upon request ▪ Mounting flange, cutting ring, retractable
Technical data ▪ Accuracy ▪ Repeatability ▪ Pipe Reynolds no. ▪ Advantage ▪ Disadvantage ▪ Beta	 ▪ +/- 1-2% ▪ 0.1% of reading ▪ ReD > 20,000 (ISA 1932) ▪ ReD > 10,000 (long radius) ▪ Erosive fluids ▪ High manufacturing costs ▪ 0.3-0.8	 ▪ +/- 5% uncalibrated ▪ 0.1% of reading ▪ ReD > 80,000 ▪ Economical, easy installation, minimum pressure loss ▪ High Reynolds number, clean fluids only ▪ 0.45-0.75
Typical applications	High velocity, suspended solids, low/non-viscous fluids	Clean fluids, steam

Wedge meter

	Wedge meter
	A wedge flowmeter is generally used in difficult applications, such as air entrained liquids, high viscous liquids or slurries, which are abrasive or fibrous.
	
Model No.	WM
Element ▪ Size [inches] ▪ Material ▪ Mounting	 ▪ 2" to 20" ▪ Stainless steel, Hastelloy C, Duplex, Others upon request ▪ Flanged, Butt-Weld, Hub
Technical data ▪ Accuracy ▪ Repeatability ▪ Pipe Reynolds no. ▪ Advantage ▪ Disadvantage ▪ Beta	 ▪ ±5% uncalibrated ▪ 0.1% of reading ▪ ReD ≥ 10,000 ▪ Low permanent pressure loss, suitable for most process conditions ▪ Low Reynolds number requirement Cost to manufacture ▪ 0.377-0.792
Typical applications	Liquids with suspended solids, slurries, high viscosity, corrosive and/or abrasive liquids.

Threaded / flanged Pitot / Inline Pitot

	Threaded/flanged Pitot tube	Inline Pitot tube
	Pitot tubes provide cost-effective flow measurement of clean fluids circulating within an enclosed conduit or ducting. They are ideally suited to larger pipework, where they offer significant savings over other flow measurement devices.	Pitot tubes provide cost-effective flow measurement of clean fluids circulating within an enclosed conduit or ducting.
		
Model No.	AP	AP
Element ▪ Size [inches] ▪ Pressure ▪ Material ▪ Mounting	 ▪ 2" and above ▪ From high vacuum to high pressure ▪ Stainless steel, Hastelloy C, Duplex, ▪ Others upon request ▪ Compression fitting or flanged	 ▪ 0.5" - 3" ▪ From high vacuum to high pressure ▪ Stainless steel, Hastelloy C, Duplex, ▪ Others upon request ▪ Flanged, threaded, weld-in
Technical data ▪ Accuracy ▪ Repeatability ▪ Pipe Reynolds no. ▪ Advantage ▪ Disadvantage	 ▪ +/- 3-5% ▪ 0.1% of reading ▪ ReD > 20000 ▪ Economical, easy installation, minimum pressure loss ▪ High Reynolds number, clean fluids only	 ▪ +/- 3-5% ▪ 0.1% of reading ▪ ReD > 20000 ▪ Economical, easy installation, minimum pressure loss ▪ High Reynolds number, clean fluids only
Typical applications	Clean fluids, steam	Clean fluids

Pitot tube head options

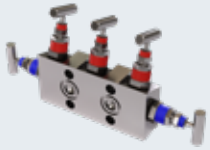
Integral 3-valve manifold

- Allows the DP transmitter to be direct mounted.
- Provides primary isolation to allow the DP transmitter to be removed or zeroed whilst in service.
- Eliminates costs associated with remote mounting and problems introduced by impulse lines.
- Materials: 316L stainless steel, others upon request

Integral 5-valve manifold

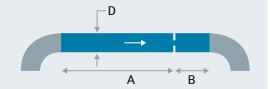
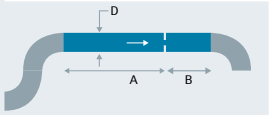
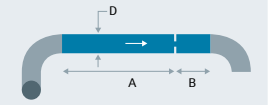
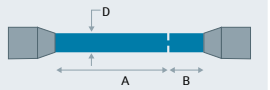
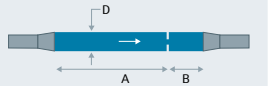
- Allows the DP transmitter to be direct mounted.
- Provides primary isolation to allow the DP transmitter to be removed or zeroed whilst in service.
- Provides the facility to vent through threaded ports.
- Eliminates costs associated with remote mounting and problems introduced by impulse lines.
- Materials: 316L stainless steel, others upon request

Pitot tube accessories

Flanged nozzle	Gasket	Bolting
		
All materials other than polypropylene	1.5mm elastomer or 4.5mm spiral wound	ASTM A193 B7 ASTM A194 2H
DP isolation valves	**Shut off valve**	**Condensate pots**
		
¼" or ½" 316 stainless steel ball/needle/gate/globe	Material: 316 st st, Max Pressure: 6000 psig/413 Barg, Max Temperature : 240°C. Other specifications available upon request	Construction: Fabricated, Material: Carbon steel. Other specifications available upon request
3-valve manifold	**5-valve manifold**	
		
Material: 316 st st rated to 6000psi/400 bar. Other specifications available upon request	Material: 316 st st rated to 6000psi/400 bar. Other specifications available upon request	

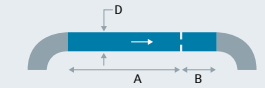
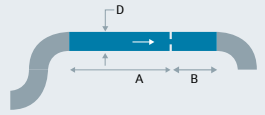
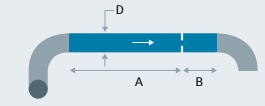
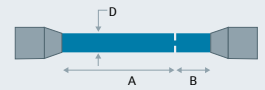
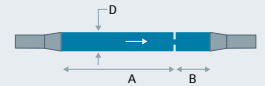
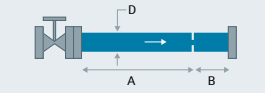
Orifice plate upstream and downstream lengths

In order to ensure a homogeneous flow profile it is necessary to mount the Primary Element away from narrowings or bends of the pipe. The required upstream lengths for different types of obstacles are summarised in the following table. Detailed specifications can be obtained from ISO 5167.

	Beta	A Upstream length 0% additional Uncertainty	B Downstream length 0% additional Uncertainty	A Upstream length 0.5% additional Uncertainty	B Downstream length 0.5% additional Uncertainty
	0.2	6	4	3	2
	0.5	22	6	9	3
	0.7	44	8	20	4
	0.2	10	4	9	2
	0.5	22	6	10	3
	0.7	44	8	22	4
	0.2	19	4	18	2
	0.5	44	6	18	3
	0.7	44	8	20	4
	0.2	5	4	9	2
	0.5	8	6	5	3
	0.7	13	8	8	4
	0.2	6	4	9	2
	0.5	20	6	9	3
	0.7	36	8	18	4
	0.2	12	4	6	2
	0.5	12	6	6	3
	0.7	24	8	12	4

1) for 0% of additional uncertainty
2) for 0.5% of additional uncertainty
3) The required lengths depend on the distance of the two elbows; typical values are given in this table.

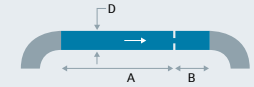
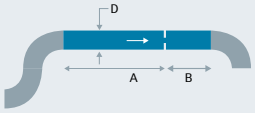
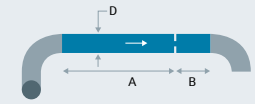
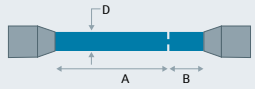
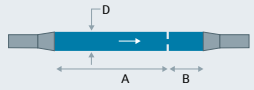
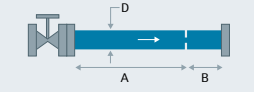
Venturi flow tube upstream lengths

	Beta	A Upstream length 0% additional Uncertainty	A Upstream length 0.5% additional Uncertainty
	0.3	8	3
	0.5	9	3
	0.7	14	3
	0.3	8	3
	0.5	10	3
	0.7	18	3
	0.3	8	3
	0.5	10	3
	0.7	18	3
	0.3	4	-
	0.5	4	-
	0.7	4	-
	0.3	4	-
	0.5	5	4
	0.7	7	5
	0.3	2.5	-
	0.5	3.5	2.5
	0.7	5.5	3.5

Note: For downstream lengths, fittings or other disturbances situated at least four throat diameters downstream from the throat pressure tapping plane do not affect the accuracy of the measurement.

Flow nozzle/Venturi nozzles upstream and downstream lengths

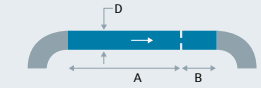
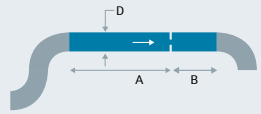
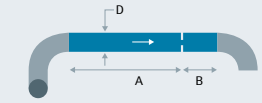
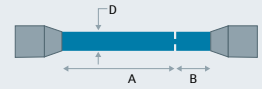
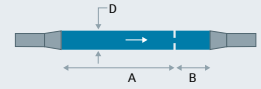
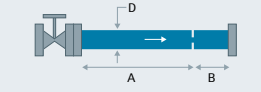
The required upstream lengths for different types of obstacles are summarised in the following table. Detailed specifications can be obtained from ISO 5167.

	Beta	A Upstream length 0% additional Uncertainty	B Downstream length 0% additional Uncertainty	A Upstream length 0.5% additional Uncertainty	B Downstream length 0.5% additional Uncertainty
	0.3	10	5	6	2.5
	0.5	14	6	7	3
	0.7	28	7	14	3.5
	0.3	16	5	8	2.5
	0.5	20	6	10	3
	0.7	36	7	18	3.5
	0.3	34	5	17	2.5
	0.5	40	6	20	3
	0.7	62	7	31	3.5
	0.3	5	5	-	2.5
	0.5	6	6	5	3
	0.7	14	7	7	3.5
	0.3	15	5	8	2.5
	0.5	18	6	9	3
	0.7	30	7	15	3.5
	0.3	12	5	6	2.5
	0.5	12	6	6	3
	0.7	20	7	10	3.5

Cone meters upstream lengths

Cone meters are relatively insensitive to common flow disturbances; however, the designer of the metering system should make reasonable efforts to minimize flow disturbances where possible.

The required upstream lengths for different types of obstacles are summarised in the following table. Detailed specifications can be obtained from ISO 5167.

	Beta	A Upstream length	B Downstream length
	0.45-0.6	3	2
	0.6-0.75	6	2
	0.45-0.6	3	2
	0.6-0.75	6	2
	0.45-0.6	3	2
	0.6-0.75	6	2
	0.45-0.6	3	2
	0.6-0.75	3	2
	0.45-0.6	3	2
	0.6-0.75	6	2
	0.45-0.6	3	2
	0.6-0.75	6	2

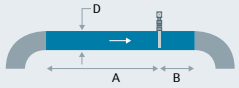
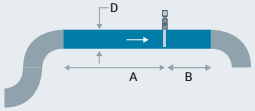
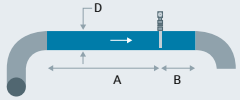
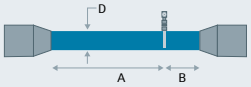
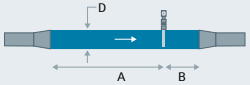
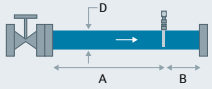
With a 0.75*D* to *D* concentric expander 3*D* upstream of a cone meter, you can expect an additional uncertainty of up to 0.5%.

You can expect less significant flow disturbance with a concentric reducer.

Pitot tube

Upstream / downstream straight length requirements

Dimensions shown are multiples of the inside pipe diameter - longer lengths are preferable.

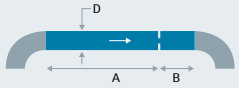
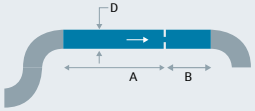
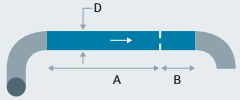
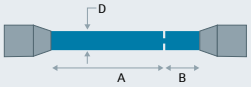
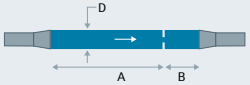
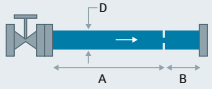
	A	B
	Upstream length	Downstream length
	7	4
	12	4
	24	4
	8	3
	8	3
	24	3

Wedge meter information

Minimum upstream and downstream straight lengths are required for installations between different fittings and the wedge meter.

Upstream straight lengths are to be calculated from the downstream end of the curved segment of the nearest bend or downstream end of the curved/conical part of the expander or reducer; to the plane of the upstream centre line tapping of the meter.

Downstream lengths are to be calculated from the plane of the centre line of the downstream tapping of the flowmeter, to the upstream end curved segment of the nearest bend or end of the conical part of the expander or reducer. No additional errors will occur if the fittings are greater than or equal to 6*D* downstream.

	A	B
	Upstream length	Downstream length
	7	6
	21	6
	22	6
	7	6
	7	6
	15	6

Fully open, full-bore isolation valves introduce no additional errors.

Certification and testing

Individual components of instruments are subject to careful examination at Endress+Hauser in our own test centres. The quality of the materials, processes and the important qualities of the flow elements are proved by reports and certificates and are fully traceable. Calibrations can be performed to national standards.

Several methods of non-destructive testing can be performed to guarantee components are free from material joint problems such as cracks, pores and cavities.

Conversion charts

Commonly used units of pressure

Bar	Millibar	Pa	Kpa	PSI	in H_20	mm H_20	in Hg
1	1000	100,000	100	14.50	401.46	10197.16	29.53
0.001	1	100	0.1	0.0145	0.402	10.197	0.0295
0.00001	0.01	1	0.001	0.000145	0.00402	0.102	0.000295
0.01	10	1000	1	0.145	4.015	101.971	0.295
0.0689	68.948	6894.757	6.895	1	27.68	703.07	2.036
0.00249	2.491	249.0889	0.249	0.0361	1	25.4	0.0736
0.000098	0.0981	9.807	0.0098	0.00142	0.0393	1	0.0029
0.0339	33.863	3386.389	3.386	0.491	13.595	345.316	1

Temperature conversion	
°C = °F x 9/5 + 32	°F = °C -32 x 5/9

Abbreviation	Prefix	Factor	Value
k	kilo	10^3	1,000
h	hecto	10^2	100
da	deca	10	10
d	deci	10^{-1}	0.1
c	centi	10^{-2}	0.01
m	milli	10^{-3}	0.001
µ	micro	10^{-6}	0.000001

Length	Volume
1 in = 25.4 mm	1 in^3 = 16.39 cm^3
1 ft = 0.3048 m	1 ft^3 = 0.02832 m^3
1 yd = 0.914 m	1 gal (imp) = 4546.09 cm^3
1 mile = 1.609 km	1 litre = 1000 cm^3

Mass	Density & flow
1 lb = 0.4536 kg	1 lb/in^3 = 27.68 g/cm^3
1 ton = 1016 kg	1 lb/ft^3 = 16.018 kg/m^3
1 tonne = 1000 kg	1 ft^3/s = 0.02832 m^3/s

Material temperature limits

ASME / AISI / ASTM

Designation	Short designation	Material code - UNS	Max. temperature
Steels			
C-Si	A105	K03504	425°C (790°F)
Heat-resistant steels			
C-1/2Mo	A182 Gr. F1	K12822	465°C (860°F)
1 1/4Cr-1/2Mo	A 182 Gr. F11 C1.2	K11572	590°C (1090°F)
2 1/4Cr-1Mo	A 182 Gr. F22 C1.3	K21590	590°C (1090°F)
Stainless steel			
18Cr-8Ni	A 182 Gr. F304	S30400	538°C (1000°F)
16Cr-12Ni-2Mo	A 182 Gr. F316	S31600	538°C (1000°F)
16Cr-12Ni-2Mo	A 182 Gr. F316L	S31603	450°C (840°F)
22Cr-5Ni-3Mo-N	A 182 Gr. F51	S31803	315°C (600°F)
	A 182 Gr. F904L	N08904	375°C (700°F)

1) Values for forgings: Maximum recommended temperature for permanent use or maximum temperature specification of the pressure-temperature ratings.

Other materials

Designation	Short designation	Material code - DIN	Max. temperature
Monel 400	(S-)NiCu 30 Fe	2.4360	425°C (790°F)
Hastelloy C4	NiMo 16 Cr 16 Ti	2.4610	400°C (750°F)
Hastelloy C276	NiMo 16 Cr 15 W	2.4819	450°C (840°F)
Alloy 625	NiCr 22 Mo 9 Nb	2.4856	Ca. 900°C (1650°F)
Alloy 825	NiCr 21 Mo	2.4858	450°C (840°F)

1) Values for forgings: Maximum temperature specification for fatigue strength and 1% creep limit.

Material temperature limits

DIN/EN

Designation	Short designation	Material code - DIN	Max. temperature
Steels			
P265 GH	HII (Kesselblech)	1.0425	400°C (750 °F)
P250 HG	C22.8	1.0460	480°C (890 °F)
Heat-resistant steels			
16 Mo 3		1.5415	530°C (980°F)
13 CrMo 4-5		1.7335	570°C (1050°F)
10 CrMo 9-10		1.7380	600°C (1110°F)
X10 CrMoVNb 9-1		1.4903	670°C (1230°F)
Stainless steel			
X 5 CrNi 18-10	304	1.4301	500°C (930°F)
X 5 CrNiMo 17-12-2	316	1.4401	350°C (660°F)
X 2 CrNiMo 17-12-2	316L	1.4404	500°C (930°F)
X 6 CrNiMoTi 17-12-2	316 Ti	1.4571	500°C (930°F)
X 2 CrNiMoN 22-5-3	31803	1.4462	280°C (530°F)
X 1 NiCrMoCuN 25-20-5	904L	1.4539	400°C (750°F)

1) Values for forgings: Maximum temperature specification for fatigue strength and 1% creep limit.
2) Values for forgings: Maximum temperature specification for ultimate tensile strength.

Plastics

Designation	Short designation	Max. temperature
PVC	polyvinyl chloride	up to approx. 70°C (150°F)
PP	polypropylene	up to approx. 90°C (190°F)
PE	polyethylene	up to approx. 80°C (170°F)
PVDF	polyvinylidene fluoride	up to approx. 130°C (260°F)
PTFE	polytetrafluorethylene	up to approx. 150°C (300°F)

Note: All temperature specifications are only guide values. The temperature limits have to be checked for the individual case. Depending on the pressure and the medium they may strongly deviate from these values.

ANSI pipe dimensions

Pipe dimensions in accordance with ANSI B36.10

Nominal bore		Outside diameter	Pipe schedule – inside diameter (all dimensions in mm)								Pipe schedule – inside diameter (all dimensions in mm)									
Inches	mm		5S	10S	10	20	30	40S	Std Wt		40	60	80S	XS	80	100	120	140	160	XXS
½	15	21.34	18.04	17.12				15.80	15.80		15.80		13.88	13.88	13.88				11.78	6.40
¾	20	26.67	23.37	22.45				20.93	20.93		20.93		18.85	18.85	18.85				15.55	11.03
1	25	33.40	30.10	27.86				26.64	26.64		26.64		24.30	24.30	24.30				20.70	15.22
1 ½	40	48.26	44.96	42.72				40.90	40.90		40.90		38.10	38.10	38.10				33.98	27.96
2	50	60.32	57.02	54.76				52.50	52.50		52.50		49.24	49.24	49.24				42.84	38.18
3	80	88.90	84.68	82.80				77.92	77.92		77.92		73.66	73.66	73.66				66.64	58.42
4	100	114.30	110.08	108.20				102.26	102.26		102.26		97.18	97.18	97.18		92.06		87.32	80.06
5	125	141.30	135.76	134.50				128.20	128.20		128.20		122.24	122.24	122.24		115.90		109.54	103.20
6	150	168.27	162.73	161.47				154.05	154.05		154.05		146.33	146.33	146.33		139.73		131.75	124.37
8	200	219.07	213.53	211.55		206.37	204.99	202.71	202.71		202.71	198.45	193.67	193.67	193.67	188.89	182.55	177.83	173.05	174.61
10	250	273.05	266.25	264.67		260.35	257.45	254.51	254.51		254.51	247.65	247.65	247.65	242.87	236.53	230.17	222.25	215.89	222.25
12	300	323.85	315.93	314.71		311.15	307.09	304.79	304.79		303.23	295.31	298.45	298.45	288.89	280.97	273.05	266.69	257.21	273.05
14	350	355.60	347.68	346.04	342.90	339.76	336.54		336.54		333.34	325.42		330.20	317.50	307.94	300.02	292.10	284.18	
16	400	406.40	398.02	396.84	393.70	390.56	387.34		387.34		381.00	373.08		381.00	363.52	354.02	344.48	333.34	325.42	
18	450	457.20	448.82	447.64	444.50	441.36	434.94		438.14		428.66	419.10		431.80	409.54	398.48	387.34	377.86	366.72	
20	500	508.00	498.44	496.92	495.30	488.94	482.60		488.94		477.82	466.76		482.60	455.62	442.92	431.80	419.10	407.98	
22	550	558.80	548.44	546.92	545.30	538.94	532.60		538.94			513.54		532.60	510.84	488.14	475.44	462.74	450.04	
24	600	609.60	598.52	596.90	596.90	590.54	581.06		590.54		574.64	560.38		584.20	547.68	531.82	517.56	504.86	490.52	
26	650	660.40			644.56	635.00			641.34					635.00						
28	700	711.20			695.36	685.80	679.44		692.14					685.80						
30	750	762.00	749.30	746.16	746.16	736.60	730.24		742.94					736.60						
32	800	812.80			796.96	787.40	781.04		793.74		777.84			787.40						
34	850	863.60			847.76	838.20	831.84		844.54		828.64			838.20						
36	900	914.40			898.56	889.00	882.64		895.34		876.30			889.00						

DIN pipe dimensions

DIN Pipe dimensions in accordance with EN 10220

Nominal bore		Outside diameter	Pipe – inside diameter (all dimensions in mm)							Pipe – inside diameter (all dimensions in mm)				
	DN		PN 2.5	PN 6	PN 10	PN 16	PN 25	PN 40	PN 63	PN 100	PN 160	PN 250	PN 320	PN 400
	15	21.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	16.1	14.9	11.3
	20	26.9	22.3	22.3	22.3	22.3	22.3	22.3	21.7	21.7				
	25	33.7	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5	27.9	26.5	23.7	19.5
	32	42.4	37.2	37.2	37.2	37.2	37.2	37.2	36.6	36.6				
	40	48.3	43.1	43.1	43.1	43.1	43.1	43.1	42.5	42.5	41.1	38.3	35.7	28.3
	50	60.3	54.5	54.5	54.5	54.5	54.5	54.5	54.5	53.9	52.3	47.7	44.3	35.3
	65	76.1	70.3	70.3	70.3	70.3	70.3	70.3	69.7	68.9	66.1	60.1	54.1	44.1
	80	88.9	82.5	82.5	82.5	82.5	82.5	82.5	81.7	80.9	76.3	66.9	63.9	53.9
	100	114.3	107.1	107.1	107.1	107.1	107.1	107.1	106.3	104.3	98.3	85.9	82.3	69.9
	125	139.7	131.7	131.7	131.7	131.7	131.7	131.7	130.7	127.1	119.7	107.7	99.7	79.7
	150	168.3	159.3	159.3	159.3	159.3	159.3	159.3	157.1	154.1	143.3	133.3	118.3	98.3
	200	219.1	206.5	206.5	206.5	206.5	206.5	206.5	204.9	199.1	187.1	169.1	159.1	139.1
	250	273	260.4	260.4	260.4	260.4	258.8	258.8	255.4	248	233	209	193	
	300	323.9	309.7	309.7	309.7	309.7	307.9	307.9	301.9	295.5	279.5			
	350	355.6	341.4	341.4	341.4	339.6	339.6	338	330.6	323.6				
	400	406.4	392.2	392.2	392.2	390.4	388.8	384.4	378					
	450	457	442.8	442.8	442.8	441	439.9	432						
	500	508	493.8	493.8	493.8	492	488	479.6						
	600	610	595.8	595.8	595.8	592.4	588	578						

Notes:

Notes:

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