Pipes and tubes

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Tube and pipe specification

Recommended carbon steel tubes and pipes

Parker recommends the use of cold drawn seamless hydraulic tubes and pipes acc. to DIN EN 10305-4.
E 355N (St. 52.4 NBK) or E 235N (St. 37.4 NBK).

+ precision dimension/shape
+ high pressure capability
+ clean inside (no scale)
+ excellent scaling surface after roll flaring

Recommended stainless steel tubes and pipes

Parker recommends the use of seamless cold drawn stainless steel tubes and pipes acc. to
DIN EN 10216-5
ASTM A269/A213
ASTM A312

+ precision dimension/shape
+ high pressure capability
+ excellent scaling surface after roll flaring

Welded tubes and pipes

Tubes and pipes acc. to above specification but welded and cold redrawn instead of seamless drawn are usually suitable. Pressure capability might be reduced due to the welding seam zone. Welding seam quality might effect roll flaring surface results.

Hot rolled pipes

Hot rolled pipes are not recommended for the following reasons:
Hot rolled pipes do not have precision dimensions and may slip in machine dies.
They have scales inside and outside. The inside scales effect the cleanliness level of the fluid and reduces fatigue levels.
Used in roll flaring process the scales will contaminate the flaring tools (high cleaning effort) and cause poor flare surface quality.

The permitted maximum working pressure is calculated either acc. to DNV, DIN or ANSI.

Material Specifications & Values

1.0308 (E235/St.35.4) acc. to DIN EN 10305-4	
Tensile strength	min 340 N/mm²
Yield strength	min 235 N/mm²
Fatigue strength	225 N/mm² [1]
Elongation at break	min. 25%

1.0508 (E355/St.52.4) acc. to DIN EN 10305-4	
Tensile strength	min 490 N/mm²
Yield strength	min 355 N/mm²
Fatigue strength	265 N/mm²
Elongation at break	min. 22 %

1.4571 (316 Ti) cold drawn (CFA)[3] acc. to DIN EN 10216-5	
Tensile strength	min 500 N/mm²
0.2 % proof stress	min 210 N/mm²
1 % proof stress	min 245 N/mm²
Fatigue strength	220 N/mm²
Elongation at break	min. 35 %

1.4404 (316L) cold drawn (CFA)[3] acc. to DIN EN 10216-5	
Tensile strength	min 500 N/mm²
0.2 % proof stress	min 210 N/mm²
1 % proof stress	min 245 N/mm²
Elongation at break	min. 35 %

1.4401 (316) acc. to DIN EN 10216-5	
Tensile strength	min 510 N/mm²
0.2 % proof stress	min 205 N/mm²
1 % proof stress	min 240 N/mm²
Elongation at break	min. 40 %

1.4301 (304) acc. to DIN EN 10216-5	
Tensile strength	min 500 N/mm²
0.2 % proof stress	min 195 N/mm²
1 % proof stress	min 230 N/mm²
Fatigue strength	195 N/mm² [2]
Elongation at break	min. 40 %

1.4404 (316L) ASTM A269 / A213	
Tensile strength	min 530 N/mm²
Yield strength	min 276 N/mm²
0.2 % proof stress / 1.6 [4]	172.5 N/mm²

1.4404 (316L) ASTM A312 / A530	
Tensile strength	min 515 N/mm²
Yield strength	min 234 N/mm²
0.2 % proof stress / 1.6 [4]	146 N/mm²

[1] DIN 2413 Template, Tab. 4
[2] Rollof/Matek ME Ausg. 14, (no standard value)
[3] Strength increase due to cold forming following 1.4571
[4] Pressure rating calculation based on this mechanical properties require certification according to 3.1 - EN 10204 that confirmes the mechanical properties.

Tube calculation for marine and offshore acc. to DNV rules

Calculation of working pressure of steel and stainless steel tubes for ship building acc. to DNV Part 4, Chapter 6, Section 6.

$$P = \frac{20 \cdot \sigma_t \cdot e \cdot t_0}{D - t_0}$$

P = permissible working pressure [bar]
σ_t = permissible stress [N/mm²]
calculated from the lower value off:

stainless steel: $\sigma_t = \frac{R_m}{2.7}$ or $\frac{K}{1.6}$

carbon steel: $\sigma_t = \frac{R_m}{2.7}$ or $\frac{K}{1.8}$

t_0 = tube wall thickness without allowences [mm]

$t_0 = t_n \cdot a - c - b$

t_n = tube wall thickness nominal [mm]
a = factor for wall thickness allowence [mm]
= 0.8 for Tube-OD 4-5, 0.85 for Tube-OD 6-8, 0.9 for Tube OD >=10
= 0.9 for all stainless steel tubes
b = bending allowence

$b = 0.1333 \cdot t_0$ (at R/D=3) $\rightarrow$ $t_0 = \frac{t_n \cdot a - c}{1.1333}$

c = corrosion tolerance, c = 0.3 mm for hydraulic steel tube, c = 0 mm for SS tubes
e = strength ratio: for seamless tubes e = 1
D = tube outside diameter [mm]
R_m = min. tensile strength [N/mm²]
K = min. yield strength or min 0.2% proof stress [N/mm²]

Tube calculation for landbased and industrial applications acc. to DIN rules

DIN 2413 I, only for static load

Calculation of working pressure of steel tubes for static stress up to 120°C. Corrosion – additional allowences are not considered for the calculation of pressures. Tubes with a diameter of OD/ID > 2 are calculated for static stress in accordance with DIN 2413 III, but with K = yield strength.

$$P = \frac{20 \cdot K \cdot s \cdot c}{S \cdot D}$$

P = permissible working pressure [bar]
K = yield strength [N/mm²]
s = tube wall thickness [mm]
c = factor for wall thickness allowance
= 0.8 for Tube-OD 4-5, 0.85 for Tube-OD 6-8, 0.9 for Tube-OD 10
= 0.9 for all stainless steel tubes
S = Safety factor = 1.5
D = tube outside diameter [mm]

DIN 2413 III, for dynamic load

Calculation of working pressure of steel tubes for dynamic stress up to 120°C.
Corrosion – additional allowences are not considered for the calculation of pressures.

$$P = \frac{20 \cdot K \cdot s \cdot c}{S \cdot (D + s \cdot c)}$$

P = permissible working pressure [bar]
K = fatigue strength [N/mm²]
s = tube wall thickness [mm]
c = factor for wall thickness allowance
= 0.8 for Tube-OD 4-5, 0.85 for Tube-OD 6-8, 0.9 for Tube-OD 10-80
= 0.9 for all stainless steel tubes
S = Safety factor = 1.5
D = tube outside diameter [mm]

Burst Pressure calculation

Calculation acc. to Formula of DIN 2413 but without safety

BP = Burst Pressure
Rm = min tensile strength
s = tube wall thickness
c = factor for wall thickness allowance
= 0.8 for Tube-OD 4-5,
0.85 for Tube-OD 6-8,
0.9 for Tube-OD 10
0.9 for all stainless steel tubes
D = tube outside diameter [mm]

$$BP = \frac{20 \cdot Rm \cdot s \cdot c}{D}$$

Pressure reductions and temperatures

Required pressure reductions (depending on the material) with reference to the catalogue pressures for higher temperatures. Both metal fitting material and elastomeric sealing compound have to be selected according to the temperature range of the system.
DNV may require different pressure reduction based on application

Material	Pressure reduction of permissable operating temperatures TB in °C														
	-60	-54	-40	-35	-25	+20	+50	+100	+120	+150	+175	+200	+250	+300	+400
Steel components			0 %							-11 %	-19 %		-28 %		
Steel, tubes			0 %							-19 %			-27 %		
Stainless steel components	0 %								-11 %			-20 %		-30 %	
Stainless steel, tubes	0 %						-5.5 %	-11.5%	-21.5 %				-29 %		-34%
Sealing material NBR (e.g. Perbunan)															
Sealing material FKM															
Sealing material Polyurethan (P5008)															

Permissible operating temperature
Ambient temperature of hydraulic and pneumatic applications
Temperature not permissible

Calculation example:
Temperature = 200°C
Material = Stainless steel
Pressure reduction = 29%
Pressure reduction tubes = 21.5%
PN tube 16x2.5/71. DIN2413 III = 362 bar

Formula:

$$PN_{200°C} = \frac{400\ \text{bar}}{100\%} \times (100\% - 29\%) = 284\ \text{bar}$$

$$PN_{\text{tube } 200°C} = \frac{362\ \text{bar}}{100\%} \times (100\% - 21.5\%) = 284\ \text{bar}$$

Flow diameter of tube lines

Determining tube sizes for hydraulic systems

Proper tube material, type and size for a given application and type of fitting are critical for efficient and trouble-free operation of the fluid system. Selection of proper tubing involves choosing the right tube material, and determining the optimum tube size (O.D. and wall thickness).
Proper sizing of the tube for various parts of a hydraulic system results in an optimum combination of efficient and cost effective performance.
A tube that is too small causes high fluid velocity, which has many detrimental effects. In pressure lines, it causes high friction losses and turbulence, both resulting in high pressure drops and heat generation. High heat accelerates wear in moving parts and rapid aging of seals and hoses, all resulting in reduced component life. High heat generation also means wasted energy, and hence, low efficiency.
Too large tubes increase system cost. Thus, optimum tube sizing is very critical. The following is a simple procedure for sizing tubes.

Determine required flow diameter

Use table to determine recommended flow diameter for the required flow rate and type of line.

The table is based on the following recommended flow rates that are common in the shipbuilding and offshore engineering:

$$\text{Pressure lines} - 3 \rightarrow 7.2 \left[\frac{\text{m}}{\text{s}}\right]$$

$$\text{Return lines} - 2 \rightarrow 4.5 \left[\frac{\text{m}}{\text{s}}\right]$$

$$\text{Suction lines} - 1 \rightarrow 1.8 \left[\frac{\text{m}}{\text{s}}\right]$$

Avoid flow rates > 8 m/s!
The resulting forces are high and can destroy the tube lines.

If you desire to use different velocities than the above, use the following formula to determine the required flow diameter.

$$\text{Tube – I.D. [mm]} = 4{,}61 \times \sqrt{\frac{\text{Flow}\ \left[\frac{\text{ltr.}}{\text{min}}\right]}{\text{Velocity}\ \left[\frac{\text{m}}{\text{s}}\right]}}$$

Determine required wall thickness

Use tube/pressure calculation tables shown in the tube chapter to determine recommended wall thickness for the required working pressure and flow diameter of the line. Therefore choose a working pressure which is equal or higher than the required working pressure.

Flow characteristics

Hydraulic systems are in most cases only rated with a flow velocity defined on the basis of experience. The pressure losses in lines are not taken into account, or measured later on when testing the system. As the pressure losses increase porportionally greater than the flow resistance, it is important to achieve the best rating of the system, so that they are already taken into account when planning the tube connections. Calculation is not as difficult as it is often thought, and this chapter is intended to provide a guideline. Besides, it provides information on how excessive pressure losses can be avoided, because pressure losses result in losses in performance and excessive heat. Noise occurs and possibly cavitation in suction lines.

Medium

All indication given with regard to flow restrictions and to flow properties refer exclusively to liquids. For gaseous media, the variable density of the gas must additionally be taken into account.

Units

c = Flow velocity $\left[\frac{m}{s}\right]$

d = Pipe inside diameter [m]

L = Pipe length [m]

p = Pressure [Pa], 1 bar = 100000 Pa

$\dot{V}$ = Flow rate $\left[\frac{m^3}{s}\right]$, $1\ \frac{m^3}{s} = 6000\ \frac{l}{min}$

λ = Pipe friction factor

$\upsilon(T)$ = Kinematic viscosity of the medium depending on temperature $\left[\frac{m^2}{s}\right]$

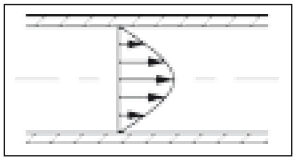
$\rho(T)$ = Density of the medium depending on temperature $\left[\frac{kg}{m^3}\right]$

ζ = Individual pressure loss coefficient

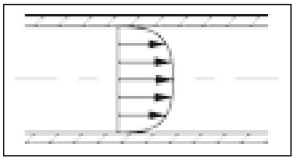
Only base units have been used. This has the advantage that the formula do not contain correction factors and there is no danger of confusion, e.g. that values are used with the wrong unit. In case values are given in other units – the flow rate is e.g. often given in l/min – it is advisable to convert them into the base units before starting calculation.

Pressure losses in pipe lines

To calculate pressure losses in pipe lines, it must first be determined whether there is a laminar or a turbulent flow. Laminar flow is homogenous and without turbulence. In case of turbulent flow, the losses increase much more quickly.



Flow profile with laminar flow



Flow profile with turbulent flow

The kind of flow is defined by the Reynolds' number. With a Reynolds' number of more than 2320, the flow changes to turbulent. The Reynolds' number is calculated according to the formula:

$$Re = \frac{c \cdot d}{\upsilon(T)}$$

The Reynolds' number is a non-dimensional number. The critical fluid velocity at which the flow regime can change, is thus calculated from:

$$c_{cr} = 2320 \cdot \frac{\upsilon(T)}{d} \left[\frac{m}{s}\right]$$

With a given flow rate, the fluid velocity can be calculated according to the formula:

$$c = \frac{\dot{V} \cdot 4}{d^2 \cdot \pi} \left[\frac{m}{s}\right]$$

Subsequently, the pipe friction factor λ can be calculated. The pipe friction factor λ is a function of the Reynolds' number and also depends on the roughness of the pipe. As hydraulically smooth pipes can generally be assumed in hydraulic applications, the pipe friction factor λ is calculated according to the following formula:

$$\text{laminar flow, } (Re < 2320): \lambda = \frac{64}{Re}$$

$$\textit{turbulent flow, } (Re > 2320): \lambda = \frac{0.3164}{\sqrt[4]{Re}}$$

Finally, if all factors are known, the pressure loss in a certain pipe line can be calculated according to the formula:

$$\Delta p = \lambda \cdot \frac{L}{d} \cdot \frac{\rho(T) \cdot c^2}{2} \text{ [Pa]}$$

Calculation of individual losses

A hydraulic system does not only incorporate pipes, but also valves, fittings, pipe bends etc. that cause flow losses. These individual losses are often much higher than the pipe losses and are calculated according to the following formula:

$$\Delta p = \zeta \cdot \rho(T) \cdot \frac{c^2}{2} \text{ [Pa]}$$

Tubes – Marine and offshore applications (DNV Rules)

1 DNV Bended pipe including manufacturing and corrosion tolerances
2 DNV Straight pipe including manufacturing and corrosion tolerances
3 Burst pressure (B.P.) calculation including manufacturing tolerance

Tube E 235N /St. 37.4 NBK - Cr(VI)-free plated or phosphated and oiled

Tube O.D. x W.T.	1 DNV W.P. bar	2 DNV W.P. bar	3 B.P. bar	Weight kg/mtr.	Phosphated and oiled Order code	Cr(VI)-free Order code
06x1.0	230	373	1105	0.07	**R06x1**	**R06x1CF**
06X1.5	437	506	1658	0.17	**R06X1.5**	**R06X1.5CF**
08X1.0	169	193	829	0.17	**R08X1**	**R08X1CF**
08X1.5	315	362	1243	0.24	**R08X1.5**	**R08X1.5CF**
10X1.0	146	167	702	0.22	**R10X1**	**R10X1CF**
10X1.5	267	306	1053	0.31	**R10X1.5**	**R10X1.5CF**
12X1.5	218	250	878	0.39	**R12X1.5**	**R12X1.5CF**
12X2.0	324	373	1170	0.49	**R12X2**	**R12X2CF**
14X2.0	273	313	1003	0.59	**R14X2**	**R14X2CF**
15X1.5	172	196	702	0.50	**R15X1.5**	**R15X1.5CF**
15X2.0	253	290	936	0.64	**R15X2**	**R15X2CF**
16X1.5	160	183	658	0.54	**R16X1.5**	**R16X1.5CF**
16X2.0	235	270	878	0.69	**R16X2**	**R16X2CF**
16X2.5	315	362	1097	0.83	**R16X2.5**	**R16X2.5CF**
18X1.5	142	162	585	0.61	**R18X1.5**	**R18X1.5CF**
18X2.0	207	237	780	0.79	**R18X2**	**R18X2CF**
20X2.0	185	212	702	0.89	**R20X2**	**R20X2CF**
20X2.5	246	282	878	1.08	**R20X2.5**	**R20X2.5CF**
20X3.0	309	356	1053	1.26	**R20X3**	**R20X3CF**
20X4.0	445	516	1404	1.58		**R20X4CF**
22X1.5	115	131	479	0.76	**R22X1.5**	**R22X1.5CF**
22X2.0	167	191	638	0.99	**R22X2**	**R22X2CF**
22X2.5	221	254	798	1.20	**R22x2.5**	**R22X2.5CF**
25X2.0	146	167	562	1.13	**R25X2**	**R25X2CF**
25X2.5	193	221	702	1.39	**R25X2.5**	**R25X2.5CF**
25X3.0	242	277	842	1.63	**R25X3**	**R25X3CF**
25X4.0	344	397	1123	2.07	**R25X4**	**R25X4CF**
28X2.0	129	148	501	1.28	**R28X2**	**R28X2CF**
28X3.0	214	245	752	1.85	**R28X3**	**R28X3CF**
30X2.0	120	137	468	1.38		**R30X2CF**
30X3.0	198	227	702	2.00	**R30X3**	**R30X3CF**
30X4.0	281	323	936	2.56	**R30X4**	**R30X4CF**
30X5.0	368	425	1170	3.08	**R30X5**	**R30X5CF**
35X2.0	103	117	401	1.63	**R35X2**	**R35X2CF**
35X3.0	168	192	602	2.37	**R35X3**	**R35X3CF**
38X2.5	124	141	462	2.19		**R38X2.5CF**
38X3.0	154	176	554	2.59	**R38X3**	**R38X3CF**
38X4.0	217	248	739	3.35	**R38X4**	**R38X4CF**
38X5.0	282	324	924	4.07	**R38X5**	**R38X5CF**
42X2.0	85	97	334	1.97	**R42X2**	**R42X2CF**
42X3.0	139	158	501	2.89	**R42X3**	**R42X3CF**
42X4.0	194	223	669	3.75	**R42X4**	**R42X4CF**
50X3.0	115	132	421	3.48	**R50X3**	**R50X3CF**
60X3.0	95	109	351	4.22	**R60X3**	**R60X3CF**
75X3.0	76	86	281	5.32	**R75X3**	**R75X3CF**
90X3.5	75	85	273	7.47	**R90X3.5**	**R90X3.5CF**
100X4.0	78	89	281	9.47	**R100X4**	
115X4.0	68	77	244	10.98	**R115X4**	
140X4.5	63	72	226	15.04	**R140X4.5**	
165X5.0	60	68	213	19.73	**R165X5**	
220X6.0	55	62	191	31.66	**R220X6**	
273X6.0	44	50	154	39.51	**R273X6**	

Other sizes on request

Tubes – Landbased and industrial applications (DIN Rules)

1 DIN 2413 I static pressure (W.P.) capability for straight pipe including manufacturing tolerance
2 DIN 2413 III dynamic pressure (W.P.) capability for straight pipe including manufacturing tolerance
3 Burst pressure (B.P.) calculation including manufacturing tolerance

Tube E 235N /St. 37.4 NBK - Cr(VI)-free plated or phosphated and oiled

Tube O.D. x W.T.	1 DIN 2413 I W.P. bar	2 DIN 2413 III W.P. bar	3 B.P. bar	Weight kg/mtr.	Phosphated and oiled Order code	Cr(VI)-free Order code
06x1.0	444	372	1105	0.07	**R06x1**	**R06x1CF**
06X1.5	666	526	1658	0.17	**R06X1.5**	**R06X1.5CF**
08X1.0	333	288	829	0.17	**R08X1**	**R08X1CF**
08X1.5	499	412	1243	0.24	**R08X1.5**	**R08X1.5CF**
10X1.0	282	248	702	0.22	**R10X1**	**R10X1CF**
10X1.5	423	357	1053	0.31	**R10X1.5**	**R10X1.5CF**
12X1.5	353	303	878	0.39	**R12X1.5**	**R12X1.5CF**
12X2.0	470	391	1170	0.49	**R12X2**	**R12X2CF**
14X2.0	403	342	1003	0.59	**R14X2**	**R14X2CF**
15X1.5	282	248	702	0.50	**R15X1.5**	**R15X1.5CF**
15X2.0	376	321	936	0.64	**R15X2**	**R15X2CF**
16X1.5	264	233	658	0.54	**R16X1.5**	**R16X1.5CF**
16X2.0	353	303	878	0.69	**R16X2**	**R16X2CF**
16X2.5	441	370	1097	0.83	**R16X2.5**	**R16X2.5CF**
18X1.5	235	209	585	0.61	**R18X1.5**	**R18X1.5CF**
18X2.0	313	273	780	0.79	**R18X2**	**R18X2CF**
20X2.0	282	248	702	0.89	**R20X2**	**R20X2CF**
20X2.5	353	303	878	1.08	**R20X2.5**	**R20X2.5CF**
20X3.0	423	357	1053	1.26	**R20X3**	**R20X3CF**
20X4.0	564	458	1404	1.58		**R20X4CF**
22X1.5	192	173	479	0.76	**R22X1.5**	**R22X1.5CF**
22X2.0	256	227	638	0.99	**R22X2**	**R22X2CF**
22X2.5	320	278	798	1.20	**R22x2.5**	**R22X2.5CF**
25X2.0	226	201	562	1.13	**R25X2**	**R25X2CF**
25X2.5	282	248	702	1.39	**R25X2.5**	**R25X2.5CF**
25X3.0	338	292	842	1.63	**R25X3**	**R25X3CF**
25X4.0	451	378	1123	2.07	**R25X4**	**R25X4CF**
28X2.0	201	181	501	1.28	**R28X2**	**R28X2CF**
28X3.0	302	264	752	1.85	**R28X3**	**R28X3CF**
30X2.0	188	170	468	1.38		**R30X2CF**
30X3.0	282	248	702	2.00	**R30X3**	**R30X3CF**
30X4.0	376	321	936	2.56	**R30X4**	**R30X4CF**
30X5.0	470	391	1170	3.08	**R30X5**	**R30X5CF**
35X2.0	161	147	401	1.63	**R35X2**	**R35X2CF**
35X3.0	242	215	602	2.37	**R35X3**	**R35X3CF**
38X2.5	186	168	462	2.19		**R38X2.5CF**
38X3.0	223	199	554	2.59	**R38X3**	**R38X3CF**
38X4.0	297	260	739	3.35	**R38X4**	**R38X4CF**
38X5.0	371	318	924	4.07	**R38X5**	**R38X5CF**
42X2.0	134	123	334	1.97	**R42X2**	**R42X2CF**
42X3.0	201	181	501	2.89	**R42X3**	**R42X3CF**
42X4.0	269	237	669	3.75	**R42X4**	**R42X4CF**
50X3.0	169	154	421	3.48	**R50X3**	**R50X3CF**
60X3.0	141	129	351	4.22	**R60X3**	**R60X3CF**
75X3.0	113	104	281	5.32	**R75X3**	**R75X3CF**
90X3.5	110	101	273	7.47	**R90X3.5**	**R90X3.5CF**
100X4.0	113	104	281	9.47	**R100X4**	
115X4.0	98	91	244	10.98	**R115X4**	
140X4.5	91	84	226	15.04	**R140X4.5**	
165X5.0	85	80	213	19.73	**R165X5**	
220X6.0	77	72	191	31.66	**R220X6**	
273X6.0	62	58	154	39.51	**R273X6**	

Other sizes on request

Tubes – Marine and Offshore applications (DNV Rules)

1 DNV Bended pipe including manufacturing and corrosion tolerances
2 DNV Straight pipe including manufacturing and corrosion tolerances
3 Burst pressure (B.P.) calculation including manufacturing tolerance

Tube E 355N /St.52.4 NBK - Cr(VI)-free plated or phosphated and oiled

Tube O.D. x W.T.	1 DNV W.P. bar	2 DNV W.P. bar	3 B.P. bar	Weight kg/mtr.	Phosphated and oiled Order code	Cr(VI)-free Order code
15X1.5	259	297	959	0.50		**R15X1.5ST52CF**
15X2.0	381	438	1279	0.61		**R15X2ST52CF**
16X2.0	355	408	1199	0.69		**R16X2ST52CF**
16X2.5	475	547	1499	0.83		**R16X2.5ST52CF**
18X1.5	214	244	800	0.61		**R18X1.5ST52CF**
18X2.0	313	358	1066	0.79		**R18X2ST52CF**
20X2.0	279	319	959	0.89		**R20X2ST52CF**
20X2.5	371	426	1199	1.08		**R20X2.5ST52CF**
20X3.0	467	537	1439	1.25		**R20X3ST52CF**
22X1.5	173	197	654	0.76		**R22X1.5ST52CF**
22X2.0	252	288	872	0.99		**R22X2ST52CF**
25X2.5	291	333	959	1.39		**R25X2.5ST52CF**
25X3.0	365	418	1151	1.63		**R25X3ST52CF**
25X4.0	519	599	1535	2.07		**R25X4ST52CF**
28X2.0	195	223	685	1.28		**R28X2ST52CF**
30X3.0	299	343	959	2.00		**R30X3ST52CF**
30X4.0	424	487	1279	2.56		**R30X4ST52CF**
30X5.0	555	641	1599	3.08		**R30X5ST52CF**
35X3.0	254	290	822	2.37		**R35X3ST52CF**
38X3.0	233	266	757	2.37		**R38X3ST52CF**
38X4.0	327	375	1010	3.35		**R38X4ST52CF**
38X5.0	426	490	1262	4.07		**R38X5ST52CF**
39X7.5	673	781	1845	8.53		**R39X7.5ST52CF**
42X3.0	209	239	685	2.89		**R42X3ST52CF**
42X4.0	294	336	914	3.75		**R42X4ST52CF**
46X8.0	601	695	1669	7.50		**R46X8ST52CF**
50X5.0	315	361	959	5.55	**R50X5ST52**	**R50X5ST52CF**
50X6.0	390	448	1151	6.50	**R50X6ST52**	**R50X6ST52CF**
56X8.5	516	595	1456	9.96	**R56X8.5ST52**	
60X5.0	259	297	800	6.78		**R60X5ST52CF**
60X6.0	319	366	959	7.97	**R60X6ST52**	**R60X6ST52CF**
65X8.0	407	468	1121	11.25		**R65X8ST52CF**
66X8.5	429	494	1236	12.05	**R66X8.5ST52**	
73X7.0	309	353	920	11.22	**R73X7ST52**	**R73X7ST52CF**
75X5.0	205	234	640	8.63	**R75X5ST52**	**R75X5ST52CF**
80X10	418	481	1199	17.21	**R80X10ST52**	
90X5.0	169	193	533	10.48	**R90X5ST52**	**R90X5ST52CF**
90X9.0	326	374	959	17.98	**R90X9ST52**	**R90X9ST52CF**
97X12	416	478	1187	25.15	**R97X12ST52**	
115X15	444	511	1251	36.95	**R115X15ST52**	
130X15	388	445	1107	42.54	**R130X15ST52**	
150X15	332	380	959	49.94	**R150X15ST52**	
190X20	353	405	1010	83.84	**R190X20ST52**	
250X25	335	384	959	138.72	**R250X25ST52**	

Other sizes on request

Tubes – Landbased and industrial applications (DIN Rules)

1 DIN 2413 I static pressure (W.P.) capability for straight pipe including manufacturing tolerance
2 DIN 2413 III dynamic pressure (W.P.) capability for straight pipe including manufacturing tolerance
3 Burst pressure (B.P.) calculation including manufacturing tolerance

Tube E 355N /St.52.4 NBK - Cr(VI)-free plated or phosphated and oiled

Tube O.D. x W.T.	1 DIN 2413 I W.P. bar	2 DIN 2413 III W.P. bar	3 B.P. bar	Weight kg/mtr.	Phosphated and oiled Order code	Cr(VI)-free Order code
15X1.5	426	292	959	0.50		**R15X1.5ST52CF**
15X2.0	568	379	1279	0.61		**R15X2ST52CF**
16X2.0	533	357	1199	0.69		**R16X2ST52CF**
16X2.5	666	436	1499	0.83		**R16X2.5ST52CF**
18X1.5	355	247	800	0.61		**R18X1.5ST52CF**
18X2.0	473	321	1066	0.79		**R18X2ST52CF**
20X2.0	426	292	959	0.89		**R20X2ST52CF**
20X2.5	533	357	1199	1.08		**R20X2.5ST52CF**
20X3.0	639	420	1439	1.25		**R20X3ST52CF**
22X1.5	290	204	654	0.76		**R22X1.5ST52CF**
22X2.0	387	267	872	0.99		**R22X2ST52CF**
25X2.5	426	292	959	1.39		**R25X2.5ST52CF**
25X3.0	511	344	1151	1.63		**R25X3ST52CF**
25X4.0	682	445	1535	2.07		**R25X4ST52CF**
28X2.0	304	213	685	1.28		**R28X2ST52CF**
30X3.0	426	292	959	2.00		**R30X3ST52CF**
30X4.0	568	379	1279	2.56		**R30X4ST52CF**
30X5.0	710	461	1599	3.08		**R30X5ST52CF**
35X3.0	365	253	822	2.37		**R35X3ST52CF**
38X3.0	336	234	757	2.37		**R38X3ST52CF**
38X4.0	448	306	1010	3.35		**R38X4ST52CF**
38X5.0	561	374	1262	4.07		**R38X5ST52CF**
39X7.5	819	521	1845	8.53		**R39X7.5ST52CF**
42X3.0	304	213	685	2.89		**R42X3ST52CF**
42X4.0	406	279	914	3.75		**R42X4ST52CF**
46X8.0	741	478	1669	7.50		**R46X8ST52CF**
50X5.0	426	292	959	5.55	**R50X5ST52**	**R50X5ST52CF**
50X6.0	511	344	1151	6.50	**R50X6ST52**	**R50X6ST52CF**
56X8.5	647	425	1456	9.96	**R56X8.5ST52**	
60X5.0	355	247	800	6.78		**R60X5ST52CF**
60X6.0	426	292	959	7.97	**R60X6ST52**	**R60X6ST52CF**
65X8.0	524	352	1121	11.25		**R65X8ST52CF**
66X8.5	549	367	1236	12.05	**R66X8.5ST52**	
73X7.0	408	281	920	11.22	**R73X7ST52**	**R73X7ST52CF**
75X5.0	284	200	640	8.63	**R75X5ST52**	**R75X5ST52CF**
80X10	533	357	1199	17.21	**R80X10ST52**	
90X5.0	237	168	533	10.48	**R90X5ST52**	**R90X5ST52CF**
90x9.0	426	292	959	17.98	**R90X9ST52**	**R90X9ST52CF**
97X12	527	354	1187	25.15	**R97X12ST52**	
115X15	556	371	1251	36.95	**R115X15ST52**	
130X15	492	332	1107	42.54	**R130X15ST52**	
150X15	426	292	959	49.94	**R150X15ST52**	
190X20	448	306	1010	83.84	**R190X20ST52**	
250X25	426	292	959	138.72	**R250X25ST52**	

Other sizes on request

Tubes – Marine and Offshore applications (DNV Rules)

1 DNV: Bended pipe including manufacturing and corrosion tolerances
2 Burst pressure (B.P.) calculation including manufacturing tolerance

Seamless cold drawn Stainless Steel Tube ASTM A269/A213 - AISI 316L

Tube O.D. x W.T.	1 DNV W.P. bar	2 B.P. bar	Weight kg/mtr.	AISI 316L Order code
06X1	493	1590	0.13	**R06X1-316**
08X1	357	1193	0.18	**R08X1-316**
10X1	298	954	0.23	**R10X1-316**
10X1.5	467	1431	0.32	**R10X1.5-316**
12X1	244	795	0.28	**R12X1-316**
12X1.5	380	1193	0.39	**R12X1.5-316**
12X2	526	1590	0.50	**R12X2-316**
15X1.5	298	954	0.51	**R15X1.5-316**
16X2	380	1193	0.70	**R16X2-316**
16X2.5	489	1491	0.85	**R16X2.5-316**
18X1.5	244	795	0.62	**R18X1.5-316**
18X2	334	1060	0.80	**R18X2-316**
20X2	298	954	0.90	**R20X2-316**
20X2.5	380	1193	1.10	**R20X2.5-316**
20X3	467	1431	1.28	**R20X3-316**
22X2	268	867	1.00	**R22X2-316**
25X2	234	763	1.13	**R25X2-316**
25X2.5	298	954	1.41	**R25X2.5-316**
25X3	363	1145	1.65	**R25X3-316**
28X2	207	681	1.30	**R28X2-316**
30X2.5	244	795	1.70	**R30X2.5-316**
30X3	298	954	2.03	**R30X3-316**
30X4	409	1272	2.60	**R30X4-316**
35X2	164	545	1.65	**R35X2-316**
35X3	252	818	2.40	**R35X3-316**
38X3	231	753	2.63	**R38X3-316**
38X4	315	1004	3.41	**R38X4-316**
38X5	403	1255	4.12	**R38X5-316**
38X6	495	1506	4.81	**R38X6-316**
42X2	136	454	1.97	**R42X2-316**
42X3	207	681	2.93	**R42X3-316**
50X3	173	572	3.53	**R50X3-316**
50X5	298	954	5.63	**R50X5-316**
50X6	363	1145	6.61	**R50X6-316**
60X3	143	477	4.28	**R60X3-316**
60X5	244	795	6.89	**R60X5-316**
66X8.5	393	1229	12.24	**R66X8.5-316**
73X7	284	915	11.57	**R73X7-316**
75X3	113	382	5.41	**R75X3-316**
75X5	193	636	8.76	**R75X5-316**
80X10	380	1193	17.53	**R80X10-316**
97X12	376	1180	25.54	**R97X12X5000-316**

Other sizes on request

Tubes - Landbased and industrial applications (DIN Rules)

1 DIN 2413 I static pressure (W.P.) capability for straight pipe including manufacturing tolerance
2 Burst pressure (B.P.) calculation including manufacturing tolerance

Seamless cold drawn Stainless Steel Tube ASTM A269/A213 - AISI 316L

Tube O.D. x W.T.	1 DIN 2413 I W.P. bar	2 B.P. bar	Weight kg/mtr.	AISI 316L Order code
06X1	490	1590	0.13	**R06X1-316**
08X1	368	1193	0.18	**R08X1-316**
10X1	294	954	0.23	**R10X1-316**
10X1.5	441	1431	0.32	**R10X1.5-316**
12X1	245	795	0.28	**R12X1-316**
12X1.5	368	1193	0.39	**R12X1.5-316**
12X2	490	1590	0.50	**R12X2-316**
15X1.5	294	954	0.51	**R15X1.5-316**
16X2	368	1193	0.70	**R16X2-316**
16X2.5	459	1491	0.85	**R16X2.5-316**
18X1.5	245	795	0.62	**R18X1.5-316**
18X2	327	1060	0.80	**R18X2-316**
20X2	294	954	0.90	**R20X2-316**
20X2.5	368	1193	1.10	**R20X2.5-316**
20X3	441	1431	1.28	**R20X3-316**
22X2	267	867	1.00	**R22X2-316**
25X2	235	763	1.13	**R25X2-316**
25X2.5	294	954	1.41	**R25X2.5-316**
25X3	353	1145	1.65	**R25X3-316**
28X2	210	681	1.30	**R28X2-316**
30X2.5	245	795	1.70	**R30X2.5-316**
30X3	294	954	2.03	**R30X3-316**
30X4	392	1272	2.60	**R30X4-316**
35X2	168	545	1.65	**R35X2-316**
35X3	252	818	2.40	**R35X3-316**
38X3	232	753	2.63	**R38X3-316**
38X4	309	1004	3.41	**R38X4-316**
38X5	387	1255	4.12	**R38X5-316**
38X6	464	1506	4.81	**R38X6-316**
42X2	140	454	1.97	**R42X2-316**
42X3	210	681	2.93	**R42X3-316**
50X3	176	572	3.53	**R50X3-316**
50X5	294	954	5.63	**R50X5-316**
50X6	353	1145	6.61	**R50X6-316**
60X3	147	477	4.28	**R60X3-316**
60X5	245	795	6.89	**R60X5-316**
66X8.5	379	1229	12.24	**R66X8.5-316**
73X7	282	915	11.57	**R73X7-316**
75X3	118	382	5.41	**R75X3-316**
75X5	196	636	8.76	**R75X5-316**
80X10	368	1193	17.53	**R80X10-316**
97X12	364	1180	25.54	**R97X12X5000-316**

Other sizes on request

Pipe according to ANSI B36.19 ASTM - A - 312 - TP - 316L

Pressure table acc. to DNV Rules for Classification of Ships Newbuilding and Mobile Offshore Units Drilling Plants.

1 ANSI B313 pipe including manufacturing tolerance, bending and corrosion considered
2 Burst pressure (B.P.) including manufacturing tolerance

Nom. Pipe Size SCH size	Tube/Pipe O.D-x W.T.	1 W.P. bar	2 B.P. bar	Weight kg/mtr.	Order code
1/2" SCH 10	21.34x2.11	249	917	1.02	**on request**
1/2" SCH 40	21.34x2.77	336	1203	1.29	**on request**
1/2" SCH 80	21.34x3.73	471	1620	1.65	**on request**
1/2" SCH 160	21.34x4.78	632	2076	1.98	**on request**
1/2" SCH xxs	21.34x7.47	1124	3245	2.55	**on request**
3/4" SCH 10	26.67x2.11	196	733	1.30	**on request**
3/4" SCH 40	26.67x2.81	267	977	1.71	**on request**
3/4" SCH 80	26.67x3.91	385	1359	2.33	**on request**
3/4" SCH 160	26.67x5.56	579	1933	2.94	**on request**
3/4" SCH xxs	26.67x7.82	886	2718	3.64	**on request**
1" SCH 10	33.40x2.77	206	769	2.13	**on request**
1" SCH 40	33.40x3.38	255	938	2.54	**on request**
1" SCH 80	33.40x4.55	354	1263	3.29	**on request**
1" SCH 160	33.40x6.35	805	1762	4.30	**on request**
1" SCH xxs	33.40x9.09	805	2523	5.45	**on request**
1 1/4" SCH 10	42.16x2.77	161	609	2.73	**on request**
1 1/4" SCH 40	42.16x3.56	210	783	3.44	**on request**
1 1/4" SCH 80	42.16x4.85	294	1066	4.53	**on request**
1 1/4" SCH 160	42.16x6.35	397	1396	5.69	**on request**
1 1/4" SCH xxs	42.16x9.70	653	2133	7.76	**on request**
1 1/2" SCH 10	48.26x2.77	139	532	3.16	**on request**
1 1/2" SCH 40	48.26x3.68	188	707	4.11	**on request**
1 1/2" SCH 80	48.26x5.08	266	976	5.49	**on request**
1 1/2" SCH 160	48.26x7.14	389	1371	7.35	**on request**
1 1/2" SCH xxs	48.26x10.16	586	1952	9.55	**on request**
2" SCH 10	60.30x2.77	111	426	3.99	**on request**
2" SCH 40	60.30x3.91	159	601	5.52	**on request**
2" SCH 80	60.30x5.54	230	852	7.60	**on request**
2" SCH 160	60.30x8.74	380	1344	11.28	**on request**
2" SCH xxs	60.30x11.07	498	1702	13.44	**on request**
2 1/2" SCH 5	73.00x2.11	69	268	3.76	**on request**
2 1/2" SCH 10	73.00x3.05	100	387	5.37	**on request**
2 1/2" SCH 40	73.00x5.16	174	655	8.80	**on request**
2 1/2" SCH 80	73.00x7.01	241	890	11.64	**on request**
2 1/2" SCH 160	73.00x9.53	338	1210	15.15	**on request**
2 1/2" SCH xxs	73.00x14.02	526	1780	20.50	**on request**
3" SCH 5	88.90x2.11	56	220	4.59	**on request**
3" SCH 10	88.90x3.05	82	318	6.45	**on request**
3" SCH 40	88.90x5.49	151	572	11.64	**on request**
3" SCH 80	88.90x7.67	215	800	15.51	**on request**
3" SCH 160	88.90x11.13	322	1161	21.67	**on request**
3" SCH xxs	88.90x15.24	460	1589	27.68	**on request**
4" SCH 5	114.30x2.11	43	171	5.93	**on request**
4" SCH 10	114.30x3.05	63	247	8.50	**on request**
4" SCH 40	114.30x6.07	129	492	16.32	**on request**
4" SCH 80	114.30x8.56	185	694	22.67	**on request**
4" SCH 160	114.30x13.49	302	1094	34.05	**on request**
4" SCH xxs	114.30x17.12	394	1388	41.03	**on request**
5" SCH 10	141.30x3.40	57	233	41.03	**on request**
5" SCH 40	141.30x6.55	112	430	41.03	**on request**
5" SCH 80	141.30x9.53	165	625	41.03	**on request**
5" SCH 160	141.30x15.88	286	1042	41.03	**on request**
5" SCH xxs	141.30x19.05	350	1250	41.03	**on request**
6" SCH 40	168.30x7.11	101	392	28.69	**on request**
6" SCH 160	168.30x18.26	275	1006	67.56	**on request**
6" SCH xxs	168.30x21.95	337	1209	79.21	**on request**
8" SCH 40	219.10x8.18	89	346	43.20	**on request**
8" SCH 160	219.10x23.01	266	974	111.30	**on request**
8" SCH xxs	219.10x22.00	253	931	106.88	**on request**
10" SCH xxs	273.00x25.40	233	862	101.90	**on request**

Other sizes on request

Temperature conversion table

Celsius to Fahrenheit

°C	°F
150	302
145	293
140	284
135	275
130	266
125	257
120	248
115	239
110	230
105	221
100	212
95	203
90	194
85	185
80	176
75	167
70	158
65	149
60	140
55	131
50	122
45	113
40	104
35	95
30	86
25	77
20	68
15	59
10	50
5	41
0	32
-5	23
-10	14
-15	5
-20	-4
-25	-13
-30	-22
-35	-31
-40	-40
-45	-49
-50	-58

Fahrenheit to Celsius

°F	°C
340	171
330	166
320	160
310	154
300	149
290	143
280	138
270	132
260	127
250	121
240	116
230	110
220	104
210	99
200	93
190	88
180	82
170	77
160	71
150	66
140	60
130	54
120	49
110	43
100	38
90	32
80	27
70	21
60	16
50	10
40	4
30	-1
20	-7
10	-12
0	-18
-10	-23
-20	-29
-30	-34
-40	-40
-50	-46
-60	-51

Pressure conversion table

bar to psi

bar	psi
1000	14505
800	11604
600	8703
500	7253
400	5802
250	3626
160	2321
100	1451
60	870
40	580
35	508
25	363
16	232
10	145
6	87
4	58
2.5	36
1.6	23
1	15

psi to bar

psi	bar
10000	689
9000	620
7000	483
6000	414
4000	276
3000	207
2500	172
1000	69
900	62
600	41
500	34
400	28
250	17
150	10.3
100	6.9
90	6.2
60	4.1
40	2.8
25	1.7
10	0.7

Examples

Temperature conversion

Initial value: 100
°C in °F: 212 °F
°F in °C: 37.78 °C

Pressure conversion

Initial value: 35
bar in psi: 507.675 psi
psi in bar: 2.41296 bar