



General recommendations for tubes

1. Steel types, mechanical properties, conditions

Steel types, mechanical properties and conditions of EO steel tubes

Steel type	Tensile strength R _m	Yield point ReH	Ductile yield A5 (longit.)	Condition
Fine grain E235N acc. to EN 10305-4 (St. 37.4 acc. to DIN 1630/DIN 2391 old designation)	340 N/mm ² min. 49,000 lb/in ²	235 N/mm ² min. 34,000 lb/in ²	25% min.	Seamless, cold drawn, normal annealed, DIN EN 10305-1 and -4

Steel types, mechanical properties and conditions of EO stainless steel tubes

Steel type	Tensile strength R _m	Yield point (1% proof stress)	Ductile yield A5 (longit.)	Condition
1.4571 X6CrNiMoTi17122	500 N/mm ² min. 72,500 lb/in ²	245 N/mm ² min. 35,500 lb/in ²	35% min.	Seamless, cold drawn free of scale, heat treated in accordance with DIN EN 10216-5 tab. 6

2. Tests and certifications

All tubes are subjected to a non-destructive leak test and marked accordingly as proof. This marking replaces a works certificate DIN EN 10204-2.2. Test class 1 DIN EN 10216-5 Table 7 applies for tubes made of 1.4571.

3. Recommended bend radius

A bend radius of 3x the external tube diameter is recommended for cold bending of tubes with tube benders or by hand.

4. Welding suitability and weldability

Tubes of E235N are weldable according to usual techniques. Types made of 1.4571 (stainless) are suitable for arc welding. The welding filler should be selected in accordance with DIN EN 1600 and DIN EN 12072 part 1 taking into account the type of application and the welding technique.

5. Approximate calculation of the flow resistance in straight tubelines

The flow resistance and thus the tubeline efficiency is influenced by the tube inside diameter, the volume flow (measured or calculated) and the properties of the medium. Laminar flow should be considered in order to keep losses in the system down to a minimum. The transition from laminar to turbulent flow, which brings an increase in the flow resistance is generally defined by the Reynolds number Re 2320. Since the transition cannot be pinpointed exactly, the transition range can only be determined by measuring. If, for simplified calculation, transition at Re 2320 and a "technically smooth" tube inner surface are assumed, the limit speeds $w_{crit.}$ and the laminar to turbulent flow volume flow $\dot{v}_{crit.}$ when transition takes place, can be estimated according to the following formulas:

$$w_{crit.} = \frac{2.32 \cdot v}{d_i} \text{ [m / s]}$$

$$\dot{v}_{crit.} = 0.109 \cdot d_i \cdot v \text{ [l / min]}$$

d_i = tube bore Ø in mm

v = kinematic viscosity in mm² / s.

For approximate calculation of the pressure drop in bar/1 m tube length, the following formulas can be used:

1. Laminar range:

$$\rho_v = \frac{0.32 \cdot w \cdot v \cdot \rho}{d_i^2 \cdot 10^3} = \frac{6.79 \cdot \dot{v} \cdot v \cdot \rho}{d_i^4 \cdot 10^3} \text{ [bar / 1 m]}$$

2. Turbulent range:

$$\rho_v = \frac{0.281 \cdot w^{1.75} \cdot v^{0.25} \cdot \rho}{d_i^{1.25} \cdot 10^3}$$

$$= \frac{59 \cdot \dot{v}^{1.75} \cdot v^{0.25} \cdot \rho}{d_i^{4.75} \cdot 10^3} \text{ [bar / 1 m]}$$

w = flow speed in m/s; v = kinetic viscosity in mm²/s;
 $\dot{v}$ = volume flow in l/min.; ρ = density of the medium in kg/m³; d_i = pipe internal diameter in mm.

Detailed calculations of the flow resistance require an exact knowledge of the tubeline system and the operating conditions. Refer to the relevant literature for other methods of calculations.



Tubes



Seamless EO steel tubes Material E235N (St. 37.4)

Tolerances DIN EN 10305-4

Order code		Tube O.D. (mm)	Tolerance	Wall thickness (mm)	Tube I.D. (mm)	Design pressure bar		Burst pressure bar	Weight kg/m
Phosphated and oiled	Cr(VI)- free					DIN 2413 I Static	DIN 2413 III Dynamic		
R04X0.5	R04X0.5CF	4	±0.08	0.50	3.0	313	273	1160	0.047
R04X1	R04X0.75CF	4		0.75	2.5	470	391	1820	0.063
	R04X1CF	4		1.00	2.0	627	500	2700	0.074
	R05X1CF	5	±0.08	1.00	3.0	501	416	2120	0.099
R06X1 R06X1.5	R06X0.75CF	6	±0.08	0.75	4.5	333	288	1150	0.103
	R06X1CF	6		1.00	4.0	444	372	1650	0.123
	R06X1.5CF	6		1.50	3.0	666	526	2550	0.166
	R06X2CF	6		2.00	2.0	692	662	>3500	0.197
	R06X2.25CF	6		2.25	1.5	757	725	>3500	0.208
R08X1 R08X1.5 R08X2	R08X1CF	8	±0.08	1.00	6.0	333	288	1175	0.173
	R08X1.5CF	8		1.50	5.0	499	412	1925	0.240
	R08X2CF	8		2.00	4.0	666	526	2500	0.296
	R08X2.5CF	8		2.50	3.0	658	630	2650	0.339
R10X1 R10X1.5 R10X2	R10X1CF	10	±0.08	1.00	8.0	282	248	900	0.222
	R10X1.5CF	10		1.50	7.0	423	357	1450	0.314
	R10X2CF	10		2.00	6.0	564	458	2025	0.395
	R10X2.5CF	10		2.50	5.0	705	551	2675	0.462
	R10X3CF	10		3.00	4.0	666	638	>3500	0.518
R12X1 R12X1.5 R12X2	R12X1CF	12	±0.08	1.00	10.0	235	209	750	0.271
	R12X1.5CF	12		1.50	9.0	353	303	1150	0.388
	R12X2CF	12		2.00	8.0	470	391	1600	0.493
	R12X2.5CF	12		2.50	7.0	588	474	2025	0.586
	R12X3CF	12		3.00	6.0	705	551	2600	0.666
	R12X3.5CF	12		3.50	5.0	651	624		0.734
R14X2 R14X3	R14X1.5CF	14	±0.08	1.50	11.0	302	264	975	0.462
	R14X2CF	14		2.00	10.0	403	342	1325	0.592
	R14X2.5CF	14		2.50	9.0	504	415	1650	0.709
	R14X3CF	14		3.00	8.0	604	485	2200	0.814
		14		3.50	7.0	705	551	2625	0.906
R15X1 R15X1.5 R15X2	R15X1CF	15	±0.08	1.00	13.0	188	170	575	0.345
	R15X1.5CF	15		1.50	12.0	282	248	950	0.499
	R15X2CF	15		2.00	11.0	376	321	1275	0.641
		15		3.00	9.0	564	458	2000	0.888
R16X1.5 R16X2 R16X2.5 R16X3	R16X1.5CF	16	±0.08	1.50	13.0	264	233	850	0.536
	R16X2CF	16		2.00	12.0	353	303	1175	0.691
	R16X2.5CF	16		2.50	11.0	441	370	1500	0.832
	R16X3CF	16		3.00	10.0	529	433	1850	0.962
R18X1 R18X1.5 R18X2 R18X2.5	R18X1CF	18	±0.08	1.00	16.0	157	143	450	0.419
	R18X1.5CF	18		1.50	15.0	235	209	700	0.610
	R18X2CF	18		2.00	14.0	313	273	975	0.789
	R18X2.5CF	18		2.50	13.0	392	333	1300	0.956
	R18X3CF	18		3.00	12.0	470	391	1575	1.111

Surface finish:

- Phosphated and oiled:
- Tubes with I.D. 1.5–5 mm: outside and inside oiled.
- Tubes from 6 mm I.D.: outside and inside phosphated and oiled.

• Cr(VI)-free:

These dimensions are externally thick coat passivated (thickness of coat 8–12 µm), inside oiled.

Calculation pressures:

Calculation pressures given are according to DIN 2413 part I for **static stress**

$$P = \frac{20 \cdot K \cdot s \cdot c}{S \cdot d_a} \text{ (bar)}$$

Material characteristic value $K = 235 \text{ N/mm}^2$ and DIN 2413 part III for **dynamic stress**

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

Material characteristic value $K = 226 \text{ N/mm}^2$ (permanent fatigue strength)

Safety correction value $S = 1.5$ for static and dynamic stress, $S = \text{wallthickness}$.

Factor c for consideration of wall thickness divergence for **static and dynamic stress** = 0.8 for tube O.D. 4 and 5; 0.85 for tube o.d. 6 and 8; 0.9 for larger tube O.D.





Tubes

Seamless EO steel tubes (Continued) Material E235N (St. 37.4)

Tolerances DIN EN 10305-4

Order code		Tube O.D. (mm)	Tolerance	Wall thickness (mm)	Tube I.D. (mm)	Design pressure bar		Burst pressure bar	Weight kg/m
Phosphated and oiled	Cr(VI)- free					DIN 2413 I Static	DIN 2413 III Dynamic		
R20X2 R20X2.5 R20X3	R20X1.5CF	20	±0.08	1.50	17.0	212	190	675	0.684
	R20X2CF	20		2.00	16.0	282	248	900	0.888
	R20X2.5CF	20		2.50	15.0	353	303	1100	1.079
	R20X3CF	20		3.00	14.0	423	357	1400	1.258
	R20X3.5CF	20		3.50	13.0	494	408	1650	1.424
	R20X4CF	20		4.00	12.0	564	458	2000	1.578
R22X1.5 R22X2 R22X2.5	R22X1.5CF	22	±0.08	1.50	19.0	192	173	550	0.758
	R22X2CF	22		2.00	18.0	256	227	775	0.986
	R22X2.5CF	22		2.50	17.0	320	278	1025	1.202
	R22X3CF	22		3.00	16.0	385	328	1175	1.406
R25X2 R25X2.5 R25X3 R25X4 R25X4.5	R25X2CF	25	±0.08	2.00	21.0	226	201	725	1.134
	R25X2.5CF	25		2.50	20.0	282	248	850	1.387
	R25X3CF	25		3.00	19.0	338	292	1025	1.628
	R25X4CF	25		4.00	17.0	451	378	1500	2.072
	R25X4.5CF	25		4.50	16.0	508	418	1625	2.275
R28X1.5 R28X2 R28X2.5 R28X3	R28X1.5CF	28	±0.08	1.50	25.0	151	138	425	0.980
	R28X2CF	28		2.00	24.0	201	181	600	1.282
	R28X2.5CF	28		2.50	23.0	252	223	750	1.572
	R28X3CF	28		3.00	22.0	302	264	900	1.850
R30X2.5 R30X3 R30X4 R30X5	R30X2CF	30	±0.08	2.00	26.0	188	170	575	1.381
	R30X2.5CF	30		2.50	25.0	235	209	725	1.695
	R30X3CF	30		3.00	24.0	282	248	850	1.998
	R30X4CF	30		4.00	22.0	376	321	1175	2.565
	R30X5CF	30		5.00	20.0	470	391	1600	3.083
R35X2 R35X2.5 R35X3	R35X2CF	35	±0.15	2.00	31.0	161	147	450	1.628
	R35X2.5CF	35		2.50	30.0	201	181	600	2.004
	R35X3CF	35		3.00	29.0	242	215	700	2.367
	R35X4CF	35		4.00	27.0	322	280	960	3.058
R38X3 R38X4 R38X5	R38X2.5CF	38	±0.15	2.50	33.0	186	168	550	2.189
	R38X3CF	38		3.00	32.0	223	199	675	2.589
	R38X4CF	38		4.00	30.0	297	260	900	3.354
	R38X5CF	38		5.00	28.0	371	318	1150	4.069
	R38X6CF	38		6.00	26.0	445	373	1425	4.735
	R38X7CF	38		7.00	24.0	519	427	1700	5.352
R42X2 R42X3 R42X4	R42X2CF	42	±0.2	2.00	38.0	134	123	375	1.973
	R42X3CF	42		3.00	36.0	201	181	575	2.885
	R42X4CF	42		4.00	34.0	269	237	850	3.749
R50X6		50	±0.2	6.00	38.0	338	292		6.511
R65X8		65	±0.3	8.00	49.0	347	299		11.246

Remarks:

Corrosion – additional allowances are not considered for the calculation of pressures. Tube with a diameter ratio of

$\frac{da}{d_{\text{imax}}} > 2$ are calculated for static stress in

accordance with DIN 2413 coverage III, but with $K = 235 \text{ N/mm}^2$.

When a specific factor of safety is required, calculations should be based upon the burst pressures shown in the above tables.

Temperature range: –40° up to 120°C without pressure reductions.

For increased temperatures:

control calculation according to DIN 2413 required (static application above 120 °C).

$$P = \frac{20 \cdot K \cdot s \cdot c}{S (da - s \cdot c)}$$

Material strength K for increased temperatures:

Temperature in °C	K (Nmm ²)
up to 200	185
up to 250	165

R



Tubes



Seamless EO stainless steel tubes Material-No.: 1.4571

Tolerances DIN EN 10305-1

Order code	Tube O.D. (mm)	Tolerance	Wall thickness (mm)	Tube I.D. (mm)	1.4571 Design pressure bar DIN 2413 I Static	1.4571 burst pressure bar	Weight kg/m
1.4571							
R04X171	4	±0.08	1.0	2	735		0.075
R06X171	6	±0.08	1.0	4	490	1850	0.125
R06X1.571	6	±0.08	1.5	3	735	2900	0.169
R08X171	8	±0.08	1.0	6	368	1300	0.175
R08X1.571	8		1.5	5	551	2050	0.244
R10X171	10		1.0	8	294	950	0.225
R10X1.571	10	±0.08	1.5	7	441	1750	0.319
R10X271	10		2.0	6	588	2400	0.401
R12X171	12		1.0	10	245	850	0.275
R12X1.571	12	±0.08	1.5	9	368	1400	0.394
R12X271	12		2.0	8	490	1900	0.501
R14X1.571	14		1.5	11	315	1200	0.469
R14X271	14	±0.08	2.0	10	420	1550	0.601
R14X2.571	14		2.5	9	525	2100	0.720
R15X171	15		1.0	13	196	675	0.351
R15X1.571	15	±0.08	1.5	12	294	1100	0.507
R15X271	15		2.0	11	392	1400	0.651
R16X1.571	16	±0.08	1.5	13	276	950	0.545
R16X271	16		2.0	12	368	1300	0.701
R16X2.571	16	±0.08	2.5	11	459	1850	0.845
R16X371	16		3.0	10	551	2400	0.977
R18X1.571	18	±0.08	1.5	15	245	800	0.620
R18X271	18		2.0	14	327	1150	0.801
R20X271	20		2.0	16	294	1050	0.901
R20X2.571	20	±0.08	2.5	15	368	1400	1.095
R20X371	20		3.0	14	441	1800	1.277
R22X1.571	22	±0.08	1.5	19	200	650	0.770
R22X271	22		2.0	18	267	900	1.002
R25X2.571	25	±0.08	2.5	20	294	1050	1.408
R25X371	25		3.0	19	353	1275	1.653
R28X1.571	28	±0.08	1.5	25	158	550	0.995
R28X271	28		2.0	24	210	700	1.302
R30X2.571	30	±0.08	2.5	25	245	850	1.722
R30X371	30	±0.08	3.0	24	294	1150	2.028
R30X471	30		4.0	22	392	1500	2.605
R35X271	35	±0.15	2.0	31	168	550	1.653
R38X471	38	±0.15	4.0	30	309	1150	3.405
R42X271	42	±0.2	2.0	38	140	475	2.003
R42X371	42		3.0	36	210	750	2.930



Seamless EO stainless steel tubes (continued) Material-No.: 1.4571

Calculation pressure:

Calculation pressures given are according to DIN 2413 part I for **static stress**

$$P = \frac{20 \cdot K \cdot s \cdot c}{S \cdot d_a} \text{ (bar)}$$

Material characteristic value $K = 245 \text{ N/mm}^2$ (1.4571)
(1% proof stress)

Safety factor $S = 1.5$

Factor c for consideration of wall thickness divergence:
0.9

For range of application for which a certain safety value compared to burst pressure is demanded for tubes of 1.4571 grade stainless steel, the measured burst pressures are contained in tube-tables.

Calculation pressures according to DIN EN 2413 part III for **dynamic stress** are not listed, because in DIN 17458 the permanent fatigue stress is not listed. Until standards will be available for gauge localization of permanent fatigue strength we recommend for calculations to use DIN EN 2413 part III with the following characteristic values: permanent fatigue strength $K=190 \text{ N/mm}^2$ for tubes of 1.4571; $S = 1.5$; $C = 0.9$.

Remarks:

Corrosion: additional allowances are not considered for the calculation of pressures.

Tubes with a diameter proportion $d_a/d_i \geq 1.35$ are calculated according to DIN 2413 III with above characteristic values.

Permissible temperature range and required

pressure reductions. This is based on calculated pressures at the elevated temperatures shown, taking into consideration the recommended reduction in proof stress (DIN EN 10216-5).

Temperature	-60° up to +20° C	50°C	100°C	200°C	300°C	400°C
Pressure reductions 1.4571 in %	—	5.5	11.5	21.5	29	34

Interpolation is acceptable for intermediate temperature levels.

Seamless EO steel tubes Material C-Steel

for hydraulic and pneumatic pressure lines.

SAE J 524. C-Steel.

Test according ASTM A 179-90 A/ASME SA 179.

Quality and leak tested.

Order code (With Tube O.D. and wall thickness Inch)	Tube O.D. (mm)	Tolerance	Wall thickness (mm)	Design pressure bar		burst pressure bar	Weight kg/m
				DIN 2413 I Static	DIN 2413 III Dynamic		
R1/4X0.049	6.35	±0.08	1.24	553	450	—	0.157
R3/8X0.049PHR	9.53	±0.08	1.24	368	316	—	0.254
R3/8X0.065PHR	9.53	±0.08	1.65	489	405	—	0.321
R1/2X0.049PHR	12.70	±0.08	1.24	276	243	—	0.352
R1/2X0.065PHR	12.70	±0.08	1.65	367	314	—	0.450
R5/8X0.083PHR	16.00	±0.08	2.11	374	320	—	0.716
R3/4X0.095PHR	19.05	±0.08	2.41	357	307	—	0.990
R3/4X0.109PHR	19.05	±0.08	2.67	410	347	—	1.112
R1X0.095PHR	25.40	±0.08	2.41	268	236	—	1.368
R1X0.120PHR	25.40	±0.08	3.05	338	292	—	1.680
R11/4X0.120PHR	31.75	±0.08	3.05	271	239	—	2.157
R11/2X0.156PHR	38.10	±0.15	3.96	293	257	—	3.336

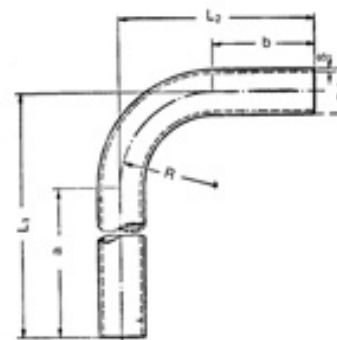
R


Tubes



Seamless EO tube bends 90° Material E235N (St. 37.4) and 1.4571

For minimum pressure loss



Order code		Tube O.D. D	Tolerance ±	Wall- thickness S	Tube I.D. mm	Bending radius R	Leg length		Length		Weight kg/piece
Cr(VI)-free	1.4571						a	b	L1	L2	
RB16X2CF	RB16X271	16	0.08	2.0	12	30	200	40	230	70	0.198
RB18X1.5CF	RB18X1.571	18	0.08	1.5	15	36	200	35	236	71	0.178
RB20X2CF	RB20X2.571	20	0.08	2.0	16	36	200	45	236	81	0.268
RB20X2.5CF		20	0.08	2.5	15	36	200	45	236	81	0.326
RB22X1.5CF	RB22X271	22	0.08	1.5	19	38	200	40	238	78	0.227
RB22X2CF		22	0.08	2.0	18	38	200	40	238	78	0.296
RB25X2CF	RB25X2.571	25	0.08	2.0	21	44	200	50	244	94	0.362
RB25X2.5CF		25	0.08	2.5	20	44	200	50	244	94	0.442
RB25X3CF		25	0.08	3.0	19	44	200	50	244	94	0.519
RB28X1.5CF	RB28X271	28	0.08	1.5	25	48	200	50	248	98	0.319
RB28X2CF		28	0.08	2.0	24	48	200	50	248	98	0.417
RB28X3CF		28	0.08	3.0	22	48	200	50	248	98	0.601
RB30X2.5CF	RB30X371	30	0.08	2.5	25	50	200	60	250	110	0.575
RB30X3CF		30	0.08	3.0	24	50	200	60	250	110	0.677
RB30X4CF		30	0.08	4.0	22	50	200	60	250	110	0.869
RB35X2CF	RB35X271	35	0.15	2.0	31	60	200	65	260	125	0.586
RB35X3CF		35	0.15	3.0	29	60	200	65	260	125	0.852
RB38X2.5CF	RB38X471	38	0.15	2.5	33	65	200	75	265	140	0.827
RB38X3CF		38	0.15	3.0	32	65	200	75	265	140	0.979
RB38X4CF		38	0.15	4.0	30	65	200	75	265	140	1.268
RB38X5CF		38	0.15	5.0	28	65	200	75	265	140	1.538
RB42X2CF	RB42X271	42	0.20	2.0	38	80	200	85	280	165	0.809
RB42X3CF		42	0.20	3.0	36	80	200	85	280	165	1.183
RB50X6*		50	0.20	6.0	38	180	150	150	330	330	3.496
RB65X8*		65	0.30	8.0	49	180	160	160	330	330	6.294

Tolerances for leg length a, b = ±2.5 mm

For tube bends, contrary to straight tubes of the same wall thickness there is a higher stress at the inside of the bend and a reduction of the fatigue strength, because of the out-of-round of tube. Details see DIN 2413 III section 4.7.

If the elbow end is cut off to a different length, a recalibration of the tube end may be necessary.

Tube bends material E235N (St. 37.4) are phosphated and oiled. (Yellow chromated on request.)

*phosphated and oiled

