



**EO<sup>®</sup> Ermeto Original  
Tubes**





## General recommendations for tubes

### 1. Steel types, mechanical properties, conditions

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

Steel type	Tensile strength Rm	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 <sup>2</sup> min. 49,000 lb/in <sup>2</sup>	235 N/mm <sup>2</sup> min. 34,000 lb/in <sup>2</sup>	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 Rm	Yield point (1 % proof stress)	Ductile yield A5 (longit.)	Condition
1.4571 X6CrNiMoTi17122	500 N/mm <sup>2</sup> min. 72,500 lb/in <sup>2</sup>	245 N/mm <sup>2</sup> min. 35,500 lb/in <sup>2</sup>	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:

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

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

$$d_i = \text{tube bore } \varnothing \text{ in mm}$$

$$\nu = \text{kinematic viscosity in mm}^2/\text{s}$$

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

#### 1. Laminar range:

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

#### 2. Turbulent range:

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

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

$w$  = flow speed in m/s;  $\nu$  = kinetic viscosity in mm<sup>2</sup>/s;  $\dot{v}$  = volume flow in l/min.;  $\rho$  = density of the medium in kg/m<sup>3</sup>;  $d_i$  = 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.



## 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
	R04X0.75CF	4		0.75	2.5	470	391	1820	0.063
R04X1	R04X1CF	4	±0.08	1.00	2.0	627	500	2700	0.074
	R05X1CF	5		1.00	3.0	501	416	2120	0.099
R06X1	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
R06X1.5	R06X1.5CF	6	±0.08	1.50	3.0	666	526	2550	0.166
	R06X2CF	6		2.00	2.0	692	662	>3500	0.197
R06X2.5	R06X2.5CF	6	±0.08	2.25	1.5	757	725	>3500	0.208
	R08X1CF	8		1.00	6.0	333	288	1175	0.173
R08X1.5	R08X1.5CF	8	±0.08	1.50	5.0	499	412	1925	0.240
	R08X2CF	8		2.00	4.0	666	526	2500	0.296
R08X2	R08X2.5CF	8	±0.08	2.50	3.0	658	630	2650	0.339
	R10X1CF	10		1.00	8.0	282	248	900	0.222
R10X1.5	R10X1.5CF	10	±0.08	1.50	7.0	423	357	1450	0.314
	R10X2CF	10		2.00	6.0	564	458	2025	0.395
R10X2	R10X2.5CF	10	±0.08	2.50	5.0	705	551	2675	0.462
	R10X3CF	10		3.00	4.0	666	638	>3500	0.518
R12X1	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
R12X2	R12X2CF	12	±0.08	2.00	8.0	470	391	1600	0.493
	R12X2.5CF	12		2.50	7.0	588	474	2025	0.586
R12X3	R12X3CF	12	±0.08	3.00	6.0	705	551	2600	0.666
	R12X3.5CF	12		3.50	5.0	651	624	2600	0.734
R14X2	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
R14X3	R14X2.5CF	14	±0.08	2.50	9.0	504	415	1650	0.709
	R14X3CF	14		3.00	8.0	604	485	2200	0.814
R15X1	R15X1.5CF	15	±0.08	3.00	7.0	705	551	2625	0.906
	R15X2CF	15		1.00	13.0	188	170	575	0.345
R15X1.5	R15X1.5CF	15	±0.08	1.50	12.0	282	248	950	0.499
	R15X2CF	15		2.00	11.0	376	321	1275	0.641
R15X2	R15X2CF	15	±0.08	3.00	9.0	564	458	2000	0.888
	R16X1.5CF	16		1.50	13.0	264	233	850	0.536
R16X2	R16X2CF	16	±0.08	2.00	12.0	353	303	1175	0.691
	R16X2.5CF	16		2.50	11.0	441	370	1500	0.832
R16X3	R16X3CF	16	±0.08	3.00	10.0	529	433	1850	0.962
	R18X1CF	18		1.00	16.0	157	143	450	0.419
R18X1.5	R18X1.5CF	18	±0.08	1.50	15.0	235	209	700	0.610
	R18X2CF	18		2.00	14.0	313	273	975	0.789
R18X2.5	R18X2.5CF	18	±0.08	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,  $s =$  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.

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

$\frac{d_a}{d_{i_{max}}} > 2$  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).

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

Material strength K for increased temperatures:

Temperature in °C	K (N/mm <sup>2</sup> )
up to 200	185
up to 250	165

**R**

**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 in %	1.4571	-	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.

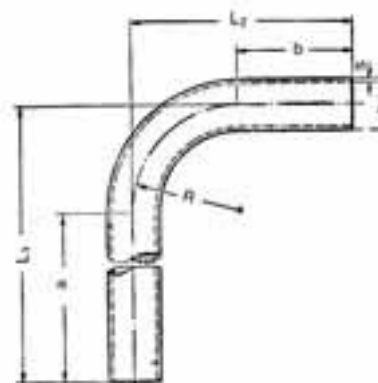
Test according ASTM A 179-90 A/ASME SA 179.

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		
<b>R1/4X0.049</b>	6.35	±0.08	1.24	553	450	-	0.157
<b>R3/8X0.049PHR</b>	9.53	±0.08	1.24	368	316	-	0.254
<b>R3/8X0.065PHR</b>	9.53	±0.08	1.65	489	405	-	0.321
<b>R1/2X0.049PHR</b>	12.70	±0.08	1.24	276	243	-	0.352
<b>R1/2X0.065PHR</b>	12.70	±0.08	1.65	367	314	-	0.450
<b>R5/8X0.083PHR</b>	16.00	±0.08	2.11	374	320	-	0.716
<b>R3/4X0.095PHR</b>	19.05	±0.08	2.41	357	307	-	0.990
<b>R3/4X0.109PHR</b>	19.05	±0.08	2.67	410	347	-	1.112
<b>R1X0.095PHR</b>	25.40	±0.08	2.41	268	236	-	1.368
<b>R1X0.120PHR</b>	25.40	±0.08	3.05	338	292	-	1.680
<b>R11/4X0.120PHR</b>	31.75	±0.08	3.05	271	239	-	2.157
<b>R11/2X0.156PHR</b>	38.10	±0.15	3.96	293	257	-	3.336

## 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	L <sub>1</sub>	L <sub>2</sub>	
<b>RB16X2CF</b>	<b>RB16X271</b>	16	0.08	2.0	12	30	200	40	230	70	0.198
<b>RB18X1.5CF</b>	<b>RB18X1.571</b>	18	0.08	1.5	15	36	200	35	236	71	0.178
<b>RB20X2CF</b>	<b>RB20X2.571</b>	20	0.08	2.0	16	36	200	45	236	81	0.268
<b>RB20X2.5CF</b>		20	0.08	2.5	15	36	200	45	236	81	0.326
<b>RB22X1.5CF</b>	<b>RB22X271</b>	22	0.08	1.5	19	38	200	40	238	78	0.227
<b>RB22X2CF</b>		22	0.08	2.0	18	38	200	40	238	78	0.296
<b>RB25X2CF</b>	<b>RB25X2.571</b>	25	0.08	2.0	21	44	200	50	244	94	0.362
<b>RB25X2.5CF</b>		25	0.08	2.5	20	44	200	50	244	94	0.442
<b>RB25X3CF</b>		25	0.08	3.0	19	44	200	50	244	94	0.519
<b>RB28X1.5CF</b>	<b>RB28X271</b>	28	0.08	1.5	25	48	200	50	248	98	0.319
<b>RB28X2CF</b>		28	0.08	2.0	24	48	200	50	248	98	0.417
<b>RB28X3CF</b>		28	0.08	3.0	22	48	200	50	248	98	0.601
<b>RB30X2.5CF</b>	<b>RB30X371</b>	30	0.08	2.5	25	50	200	60	250	110	0.575
<b>RB30X3CF</b>		30	0.08	3.0	24	50	200	60	250	110	0.677
<b>RB30X4CF</b>		30	0.08	4.0	22	50	200	60	250	110	0.869
<b>RB35X2CF</b>	<b>RB35X271</b>	35	0.15	2.0	31	60	200	65	260	125	0.586
<b>RB35X3CF</b>		35	0.15	3.0	29	60	200	65	260	125	0.852
<b>RB38X2.5CF</b>	<b>RB38X471</b>	38	0.15	2.5	33	65	200	75	265	140	0.827
<b>RB38X3CF</b>		38	0.15	3.0	32	65	200	75	265	140	0.979
<b>RB38X4CF</b>		38	0.15	4.0	30	65	200	75	265	140	1.268
<b>RB38X5CF</b>		38	0.15	5.0	28	65	200	75	265	140	1.538
<b>RB42X2CF</b>	<b>RB42X271</b>	42	0.20	2.0	38	80	200	85	280	165	0.809
<b>RB42X3CF</b>		42	0.20	3.0	36	80	200	85	280	165	1.183
<b>RB50X6*</b>		50	0.20	6.0	38	180	150	150	330	330	3.496
<b>RB65X8*</b>		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.

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

\*phosphated and oiled