



GEEVEHYDRAULICS B.V.

HYDRAULISCHE SLANGEN & KOMPONENTEN

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 E235 acc. to EN 10305-4 (St. 37.4 as per DIN 1630)	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 under inert gas, normal annealed, abbreviation NBK, DIN 2391C, Part 2

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
Abbreviation 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 17458 tab. 6
Abbreviation 1.4541 X6CrNiTi1810	500 N/mm ² min. 72,500 lb/in ²	235 N/mm ² min. 35,500 lb/in ²	35 % min.	

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 50 049-2.2. Test class 1 DIN 17458 Table 7 applies for tubes made of 1.4571 and 1.4541.

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 E235 are weldable according to usual techniques. Types made of 1.4571 and 1.4541 (stainless) are suitable for arc welding. The welding filler should be selected in accordance with DIN 8556 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:

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

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

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

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

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

1. Laminar range:

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

2. Turbulent range:

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

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

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.



Seamless EO steel tubes Material St. 37.4

Tolerances DIN 2391, part 1

Order Code		Chromium ⁶ -free	Tube O.D. (mm)	Tolerance	Wall thickness (mm)	Tube I.D. (mm)	Design pressure bar		Burst pressure bar	Weight kg/m
Phosphated and oiled	Zinc plated yellow						DIN 2413 I Static	DIN 2413 III Dynamic		
R04X0.5	R04X0.5VZ		4	±0.08	0.50	3.0	313	273	1160	0.047
	R04X0.75VZ		4		0.75	2.5	409	391	1820	0.063
R04X1	R04X1VZ		4	±0.08	1.00	2.0	522	500	2700	0.074
	R05X1VZ		R04X1CF		5	1.00	3.0	432	416	2120
R06X1 R06X1.5	R06X0.75VZ	R06X1CF	6	±0.08	0.75	4.5	333	288	1150	0.103
	R06X1VZ		6		1.00	4.0	389	372	1650	0.123
	R06X1.5VZ		6		1.50	3.0	549	526	2550	0.166
	R06X2VZ		6		2.00	2.0	692	662	>3500	0.197
	R06X2.25VZ		6		2.25	1.5	757	725	>3500	0.208
R08X1 R08X1.5 R08X2	R08X1VZ	R08X1CF R08X1.5CF	8	±0.08	1.00	6.0	333	288	1175	0.222
	R08X1.5VZ		8		1.50	5.0	431	412	1925	0.240
	R08X2VZ		8		2.00	4.0	549	526	2500	0.296
	R08X2.5VZ		8		2.50	3.0	658	630	2650	0.339
R10X1 R10X1.5 R10X2	R10X1VZ	R10X1CF R10X1.5CF	10	±0.08	1.00	8.0	282	248	900	0.222
	R10X1.5VZ		10		1.50	7.0	373	357	1450	0.314
	R10X2VZ		10		2.00	6.0	478	458	2025	0.395
	R10X2.5VZ		10		2.50	5.0	576	551	2675	0.462
	R10X3VZ		10		3.00	4.0	666	638	>3500	0.518
R12X1 R12X1.5 R12X2	R12X1VZ	R12X1CF R12X1.5CF R12X2CF	12	±0.08	1.00	10.0	235	209	750	0.271
	R12X1.5VZ		12		1.50	9.0	353	303	1150	0.388
	R12X2VZ		12		2.00	8.0	409	391	1600	0.493
	R12X2.5VZ		12		2.50	7.0	495	474	2025	0.586
	R12X3VZ		12		3.00	6.0	576	551	2600	0.666
	R12X3.5VZ		12		3.50	5.0	651	624		0.734
R14X2 R14X3	R14X1.5VZ		14	±0.08	1.50	11.0	302	264	975	0.462
	R14X2VZ		14		2.00	10.0	357	342	1325	0.592
	R14X2.5VZ		14		2.50	9.0	434	415	1650	0.709
	R14X3VZ		14		3.00	8.0	507	485	2200	0.814
			14		3.50	7.0	576	551	2625	0.906
R15X1 R15X1.5 R15X2 R15X3	R15X1VZ	R15X1.5CF	15	±0.08	1.00	13.0	188	170	575	0.345
	R15X1.5VZ		15		1.50	12.0	282	248	950	0.499
	R15X2VZ		15		2.00	11.0	336	321	1275	0.641
	R15X3		15		3.00	9.0	478	458	2000	0.888
R16X1.5 R16X2 R16X2.5 R16X3	R16X1.5VZ	R16X2CF	16	±0.08	1.50	13.0	264	233	850	0.536
	R16X2VZ		16		2.00	12.0	353	303	1175	0.691
	R16X2.5VZ		16		2.50	11.0	386	370	1500	0.832
	R16X3VZ		16		3.00	10.0	452	433	1850	0.962
R18X1 R18X1.5 R18X2 R18X2.5	R18X1VZ	R18X1.5CF	18	±0.08	1.00	16.0	157	143	450	0.419
	R18X1.5VZ		18		1.50	15.0	235	209	700	0.610
	R18X2VZ		18		2.00	14.0	313	273	975	0.789
	R18X2.5VZ		18		2.50	13.0	348	333	1300	0.956
	R18X3VZ		18		3.00	12.0	409	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.

- Zinc plated yellow:
These dimensions are externally zinc plated (coating 8–12 µm), inside oiled.
- Chromium⁶-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.
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 St. 37.4

Tolerances DIN 2391, part 1

Order Code		Chromium ⁶ -free	Tube O.D. (mm)	Tolerance	Wall thickness (mm)	Tube I.D. (mm)	Design pressure bar		Burst pressure bar	Weight kg/m
Phosphated and oiled	Zinc plated yellow						DIN 2413 I Static	DIN 2413 III Dynamic		
R20X2 R20X2.5 R20X3 R20X3.5	R20X1.4VZ	R20X2CF	20	±0.08	1.50	17	212	190	675	0.684
	R20X2VZ		20		2.00	16	282	248	900	0.888
	R20X2.5VZ		20		2.50	15	353	303	1100	1.079
	R20X3VZ		20		3.00	14	373	357	1400	1.258
	R20X3.5VZ		20		3.50	13	426	408	1650	1.424
	R20X4VZ		20		12	478	458	2000	1.578	
R22X1.5 R22X2 R22X2.5	R22X1.5VZ	R22X2CF	22	±0.08	1.50	19	192	173	550	0.758
	R22X2VZ		22		2.00	18	256	227	775	0.986
	R22X2.5VZ		22		2.50	17	320	278	1025	1.202
	R22X3VZ		22		3.00	16	343	328	1175	1.406
R25X2 R25X2.5 R25X3 R25X4 R25X4.5	R25X2VZ	R25X3CF	25	±0.08	2.00	21	226	201	725	1.134
	R25X2.5VZ		25		2.50	20	282	248	850	1.387
	R25X3VZ		25		3.00	19	338	292	1025	1.628
	R25X4VZ		25		4.00	17	394	378	1500	2.072
	R25X4.5VZ		25		4.50	16	437	418	1625	2.275
R28X1.5 R28X2 R28X2.5 R28X3	R28X1.5VZ	R28X2CF	28	±0.08	1.50	25	151	138	425	0.980
	R28X2VZ		28		2.00	24	201	181	600	1.282
	R28X2.5VZ		28		2.50	23	252	223	750	1.572
	R28X3VZ		28		3.00	22	302	264	900	1.850
R30X2.5 R30X3 R30X4 R30X5	R30X2VZ	R30X3CF	30	±0.08	2.00	26	188	170	575	1.381
	R30X2.5VZ		30		2.50	25	235	209	725	1.695
	R30X3VZ		30		3.00	24	282	248	850	1.998
	R30X4VZ		30		4.00	22	336	321	1175	2.565
	R30X5VZ		30		5.00	20	409	391	1600	3.083
R35X2 R35X2.5 R35X3	R35X2VZ	R35X2CF	35	±0.15	2.00	31	161	147	450	1.628
	R35X2.5VZ	R35X3CF	35		2.50	30	201	181	600	2.004
	R35X3VZ		35		3.00	29	242	215	700	2.367
	R35X4VZ		35		4.00	27	322	280	960	3.058
R38X2.5 R38X3 R38X4 R38X5	R38X2.5VZ	R38X4CF	38	±0.15	2.50	33	186	168	550	2.189
	R38X3VZ		38		3.00	32	223	199	675	2.589
	R38X4VZ		38		4.00	30	297	260	900	3.354
	R38X5VZ		38		5.00	28	332	318	1150	4.069
	R38X6VZ		38		6.00	26	390	373		4.735
	R38X7VZ		38		24	446	427	1700	5.352	
R42X2 R42X3 R42X4	R42X2VZ	R42X2CF	42	±0.2	2.00	38	134	123	375	1.973
	R42X3VZ	R42X3CF	42		3.00	36	201	181	575	2.885
	R42X4VZ		42		4.00	34	269	237	850	3.749
R50X6			50	±0.2	6.00	38	338	292		6.511
R65X8			65	±0.3	8.00	49	347	299		11.246

Remarks:

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

$$\frac{d_a}{d_{i_{max}}} \geq 1.35 \quad \text{are calculated for static stress in}$$

accordance with DIN 2413 coverage III, but with K = 235 N/mm².

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 II 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 ²)
up to 200	185
up to 250	165

**Seamless EO stainless steel tubes Material-No.: 1.4571/1.4541**

Tolerances DIN 2391, part 1

Order Code		Tube O.D. (mm)	Tolerance	Wall thickness (mm)	Tube I.D. (mm)	1.4571 Design pressure bar DIN 2413-I Static	1.4541 Design pressure bar DIN 2413-I Static	1.4571 burst pressure bar	Weight kg/m
1.4571	1.4541								
R04X171		4	±0.08	1.0	2	600	539		0.075
R06X171	R06X141	6	±0.08	1.0	4	426	383	1850	0.125
R06X1.571		6	±0.08	1.5	3	600	539	2900	0.169
R08X171	R08X141	8	±0.08	1.0	6	368	297	1300	0.175
R08X1.571		8		1.5	5	472	424	2050	0.244
R10X171	R10X141	10		1.0	8	294	242	950	0.225
R10X1.571	R10X1.541	10	±0.08	1.5	7	389	349	1750	0.319
R10X271		10		2.0	6	498	447	2400	0.401
R12X171	R12X141	12		1.0	10	245	205	850	0.275
R12X1.571	R12X1.541	12	±0.08	1.5	9	368	297	1400	0.394
R12X271		12		2.0	8	426	383	1900	0.501
R14X1.571		14		1.5	11	315	258	1200	0.469
R14X271		14	±0.08	2.0	10	420	334	1550	0.601
R14X2.571		14		2.5	9	452	406	2100	0.720
R15X171		15		1.0	13	196	166	675	0.351
R15X1.571	R15X1.541	15	±0.08	1.5	12	294	242	1100	0.507
R15X271		15		2.0	11	392	314	1400	0.651
R16X1.571		16	±0.08	1.5	13	276	228	950	0.545
R16X271	R16X241	16		2.0	12	368	297	1300	0.701
R16X2.571		16	±0.08	2.5	11	403	362	1850	0.845
R16X371		16		3.0	10	472	424	2400	0.977
R18X1.571	R18X1.541	18	±0.08	1.5	15	245	205	800	0.620
R18X271		18		2.0	14	327	267	1150	0.801
R20X271		20		2.0	16	294	242	1050	0.901
R20X2.571		20	±0.08	2.5	15	368	297	1400	1.095
R20X371		20		3.0	14	389	349	1800	1.277
R22X1.571		22	±0.08	1.5	19	200	170	650	0.770
R22X271		22		2.0	18	267	222	900	1.002
R25X2.571		25	±0.08	2.5	20	294	242	1050	1.408
R25X371		25		3.0	19	353	286	1275	1.653
R28X1.571		28	±0.08	1.5	25	158	135	550	0.995
R28X271		28		2.0	24	210	177	700	1.302
R30X2.571		30	±0.08	2.5	25	245	205	850	1.722
R30X371		30	±0.08	3.0	24	294	242	1150	2.028
R30X471		30		4.0	22	392	314	1500	2.605
R35X271		35	±0.15	2.0	31	168	143	550	1.653
R38X471		38	±0.15	4.0	30	309	254	1150	3.405
R42X271		42	±0.2	2.0	38	140	121	475	2.003
R42X371		42		3.0	36	210	177	750	2.930

Seamless EO stainless steel tubes (continued) Material-No.: 1.4571/1.4541

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),

$K=235 \text{ N/mm}^2$ (1.4541) (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. Burst pressure values for tubes of 1.4541 grade stainless steel are not available. Calculation pressures according to DIN 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 2413 part III with the following characteristic values:
 permanent fatigue strength $K=190 \text{ N/mm}^2$ for tubes of 1.4571 and 1.4541; $S=1.5$; $C=0.9$.

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 part 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 17458).

Temperature	-60° up to +20° C	50°C	100°C	200°C	300°C	400°C	
Pressure	1.4571	–	5.5	11.5	21.5	29	34
reductions in %	1.4541	–	4.5	11	20	29	33

Interpolation is acceptable for intermediate temperature levels.

Seamless EO steel tubes Material C-STEEL

for hydraulic and pneumatic pressure lines.

US Norm SAE J 524, C-Steel.

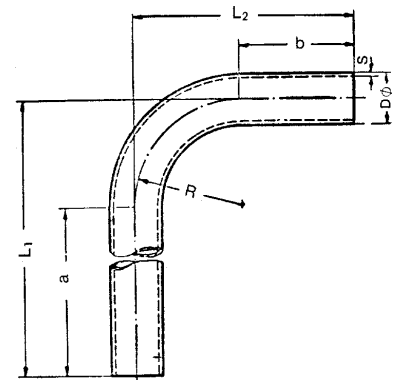
Test according ASTM A 179-90 A/ASME SA 179.

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
R3/8X0.049	9.53	±0.08	1.24	368	316	–	0.254
R3/8X0.065	9.53	±0.08	1.65	489	405	–	0.321
R1/2X0.049	12.70	±0.08	1.24	276	243	–	0.352
R1/2X0.065	12.70	±0.08	1.65	367	314	–	0.450
R5/8X0.083	16.00	±0.08	2.11	374	320	–	0.716
R3/4X0.095	19.05	±0.08	2.41	357	307	–	0.990
R3/4X0.104	19.05	±0.08	2.64	391	333	–	1.069
R3/4X0.109	19.05	±0.08	2.67	410	347	–	1.112
R1X0.095	25.40	±0.08	2.41	268	236	–	1.368
R1X0.120	25.40	±0.08	3.05	338	292	–	1.680
R11/4X0.120	31.75	±0.08	3.05	271	239	–	2.157
R11/2X0.156	38.10	±0.15	3.96	293	257	–	3.336

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

For minimum flow loss



Order Code		Tube O.D. D	Tolerance ±	Wall- thickness S	Tube I.D. mm	Bending radius R	Leg length		Length		Weight kg/piece
St.37.4	1.4571						a	b	L ₁	L ₂	
RB16X2VZ	RB16X271	16	0.08	2.0	12	30	200	40	230	70	0.198
RB18X1.5VZ	RB18X1.571	18	0.08	1.5	15	36	200	35	236	71	0.178
RB20X2VZ	RB20X2.571	20	0.08	2.0	16	36	200	45	236	81	0.268
RB20X2.5VZ		20	0.08	2.5	15	36	200	45	236	81	0.326
RB22X1.5VZ	RB22X271	22	0.08	1.5	19	38	200	40	238	78	0.227
RB22X2VZ		22	0.08	2.0	18	38	200	40	238	78	0.296
RB25X2VZ	RB25X2.571	25	0.08	2.0	21	44	200	50	244	94	0.362
RB25X2.5VZ		25	0.08	2.5	20	44	200	50	244	94	0.442
RB25X3VZ		25	0.08	3.0	19	44	200	50	244	94	0.519
RB28X1.5VZ	RB28X271	28	0.08	1.5	25	48	200	50	248	98	0.319
RB28X2VZ		28	0.08	2.0	24	48	200	50	248	98	0.417
RB28X3VZ		28	0.08	3.0	22	48	200	50	248	98	0.601
RB30X2.5VZ	RB30X371	30	0.08	2.5	25	50	200	60	250	110	0.575
RB30X3VZ		30	0.08	3.0	24	50	200	60	250	110	0.677
RB30X4VZ		30	0.08	4.0	22	50	200	60	250	110	0.869
RB35X2VZ	RB35X271	35	0.15	2.0	31	60	200	65	260	125	0.586
RB35X3VZ		35	0.15	3.0	29	60	200	65	260	125	0.852
RB38X2.5VZ	RB38X471	38	0.15	2.5	33	65	200	75	265	140	0.827
RB38X3VZ		38	0.15	3.0	32	65	200	75	265	140	0.979
RB38X4VZ		38	0.15	4.0	30	65	200	75	265	140	1.268
RB38X5VZ		38	0.15	5.0	28	65	200	75	265	140	1.538
RB42X2VZ	RB42X271	42	0.20	2.0	38	80	200	85	280	165	0.809
RB42X3VZ		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 section 4.7.

Tube bends material St. 37.4 are zink plated yellow.

*phosphated and oiled



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