DIN 2445 Part-2 SEAMLESS STEEL TUBES FOR DYNAMIC LOADS SUPPLEMENT BASIS FOR CALUCULATION OF STRAIGHT TUBES

1. General information

During the operation of hydraulic installations, when the control valve is operated the pressure and velocity of the flow medium change. As the valve is switched on and off, the pressure changes with each working stroke for P A=0 to the maximum nominal pressure in each case. In addition, by reason of the changes in velocity, pressure surges arise which are superimposed on this pressure. The pipeline is dynamically stressed.

The calculation is carried out differently there for presses the working stroke of which is controlled by a valve or limited by a stop. The calculations with valve control, since it is only for these that generally valid assumptions arc possible.

In the case of presses limited by a stop, the load must be recalculated after a dimension is chosen to allow for the water contained in the press cylinder.

Tube o. d. mm	Wall thickness mm	Tube i. d. mm	Deign pressure's bar	Weight kg/m
4	0.5	3	313	0.043
4	0.75	2.5	409	0.063
4	1	2	522	0.074
5	0.75	3.5	376	0.083
5	1	3	432	0.099
6	0.75	4.5	333	0.103
6	1	4	389	0.123
6	1.5	3	549	0.166
6	2	2	692	0.197
6	2.25	1.5	757	0.208
8	1	6	333	0.173
8	1.5	5	431	0.240
8	2	4	549	0.296
8	2	4	549	0.296
8	2.5	3	658	0.339

Tube o. d. mm	Wall thickness mm	Tube i. d. mm	Deign pressure's bar	Weight kg/m
20	1.58	17	212	0.684
20	2	16	282	0.888
20	2.5	15	353	1.079
20	3	14	373	1.258
20	3.5	13	426	1.424
20	4	12	478	1.578
22	1	20	128	0.518
22	1.5	19	192	0.758
22	2	18	256	0.986
22	2.5	17	320	1.202
22	3	16	385	1.406
25	2	21	226	1.134
25	2.5	20	282	1.387
25	3	19	338	1.628
25	4	17	394	2.072
25	4.5	16	432	2.275
25	5	15	478	2.466

10	1	8	282	0.222
10	1.5	7	373	0.341
10	2	6	478	0.395
10	2.5	5	576	0.462
10	3	4	666	0.518
12	1	10	235	0.271
12	1.5	9	353	0.383
12	2	8	409	0.493
12	2.5	7	495	0.586
12	3	6	576	0.665
12	3.5	5	69	0.734
14	1	12	20	0.321
14	1.5	11	302	0.462
14	2	10	403	0.592
14	2.5	9	434	0.709
14	3	8	507	0.814
14	3.5	7	576	0.906
14	4	6	64	0.986
15	1	13	188	0.345
15	1.5	12	282	0.499
15	2	11	376	0.641
15	2.5	10	409	0.771
15	3	9	478	0.888
16	1	14	176	0.370
16	1.5	13	264	0.536
16	2	12	353	0.691
16	2.5	11	386	0.832
16	3	10	452	0.962
18	1	16	157	0.419

28	1.5	25	151	0.980
28	2	24	201	1.282
28	2.5	23	252	1.572
28	3	22	302	1.850
28	4	21	403	2.368
28	5	18	434	2.836
30	2	26	188	1.381
30	2.5	25	235	1.695
30	3	24	282	1.998
30	4	22	376	2.565
30	5	20	409	3.083
35	2	31	161	1.628
35	2.5	30	201	2.004
35	3	29	242	2.367
35	4	27	322	3.058
35	5	25	403	3.699
35	6	23	419	4.291
38	2.5	33	186	2.189
38	3	32	223	2.589
38	4	30	297	3.354
38	5	28	371	4.069
38	6	26	390	4.735
38	7	24	446	5.352
42	2	38	134	1.973
42	3	36	201	2.885
42	4	34	269	3.749
50	6	38	338	6.511
50	9	32	437	9.103
65	8	49	347	11.246

18	1.5	15	236	0.610	80	10	60	353	17.263
18	2	14	313	0.789					
18	2.5	13	392	0.956					
18	3	12	409	1.110					

2. Design pressures

The pumps and accumulators of a hydraulic installation are designed for a pressure, the nominal pressure, as specified in DIN 2401 Part 1. This is the design pressure of the installation pA. It is possible to calculate a pressure surge which brings about an increase in pressure. This calculated pressure p = pA + △ p is the maximum pressure in the installation.

The calculation of the continuous pulsating fatigue strength of the tubes was hased on the maximum pressure p.

When there are unusually long supply lines, the greater pressure surge fluctuates around the pressure permanently present in the installation. The fatigue strength of such tubes can be calculated from the amplitude of fluctuation p - p = 2 △ p.

Correlation of the pressures

All pressures are overpressures in bar

Nominal pressure of the installation (design pressure)	Alternation of pressure on which the calculation is based		Maximum applicable pressure (calculated pressure for)		Nominal pressure of pipeline components (e.g. flanges, fitted appliances
	For water hydraulic installations with l = 30 m w = 10 m/s Ts = 0.1 s	For oil hydraulic installations with l = 7 m w = 9 m/s Ts = 0.025 s	hot finished tubes according to DIN 2445 Part 1 for water hydraulic installations	precision steel tubes according to DIN 2445 Part 2 for oil hydraulic installations	
pA	± p		p		PN
64	-	45	-	-	125
100	60	45	160	145	160
160	60	45	220	205	250
250	60	45	310	295	320
320	60	45	380	365	400
400	60	45	460	445	500

3. Types of fluctuating stress

Various types of change in pressure arise in a hydraulic installation during operation. Pressure changes from 0to p occur in the control line, depending on the number of working strokes. A pressure change equal to the pressure surge around the installation pressure pA ± △ p also occurs as a multiple of the number of working strokes. It is mostly not possible to give more precise information as to the nature of the actual collectives stresses. The overall rise in pressure from 0 to p should therefore be taken into account in calculating pulsating fatigue strength.

4. Calculation assumptions

Sections 4.1 and 4.2 list calculation assumptions which are valid for most cases in practice. The values can be varied, although △ p cannot be made lager than the pressure change on which the calculation is based as shown in the Table.

4.1 Hot finished tubes for hydraulic installations according to DIN 2445 Part

Length of pipeline	l = 30 m
Rate of flow	w = 10m/s
Closing time of control element	Ts = 0.1 s
Number of working strokes	n > 2 · 10
Pressure propagation velocity	α = 1300 m/s
Density of water	Ω = 1000 kg/m³
Surge effect factor	Z = 2 • l / α • T5 = 2 • 30 / 1300 • 0.1 = 0,45
Pressure increase from pressure surge	△p = Z(Ω • α • w / 10) = 0,45 • (1000 • 1300 • 10 / 10)

4.2 Precision steel tubes for oil hydraulic installations according to DIN 2445 Part 2

Length of pipeline	l = 7 m
Rate of flow	w = 9 m/s
Closing time of control element	Ta = 0,025 s
Number of working strokes	n > 2 · 10
Pressure propagation velocity	α = 1300 m/s
Density of water	Ω = 880 kg/m³
Surge effect factor	Z = 2 • l / α • T5 = 2 • 7 / 1300 • 0,025 = 0,43
Pressure increase from pressure surge	△p = Z(Ω • α • w / 10) = 0,43 • (880 • 1300 • 9)/10 =4,45 N/mm² ~ 45 bar

5.Calculation

The tubes should be calculated in accordance with DIN 2431, June 1972 edition, scope Ⅲ for deformation and for fatigue failure over a given number of cycles or overall. The larger of the resulting tube wall thicknesses should be chosen.

5.1 Calculation for deformation

s= da・p / 2 • Ozul ＋ c1 P = Pa ＋ △P Ozul = K / S = y・K

Materials: St 35,4 and St 52.4

Yield strength in N/mm²

Range of application	Grade of steel	da ≤ 30 mm wall thickness		da>30mm wall thickness			
		≤3	>3	≤16	>16 ≤30	>30 ≤50	>50
Part	St 35.4	225	235	235	-	-	-
Part	St 52.4	-	355	355	345	335	315