

Calculation report

EN 13445 Ed. 2014 Issue 4

Project: HV Kralupy prelozka
Item: TV + CIRK SCCA
Customer: DIGITRONIC CZ s.r.o.
Drawing:
Revision:
Date: 18.10.2021

Internal design pressure	P	=	1.60 MPa
Internal design temperature	T	=	55.00 °C
Internal corrosion allowance	c	=	0 mm
External corrosion allowance	ce	=	0 mm
Joint efficiency	z	=	1.00
Minimum design temperature		=	0 °C

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Test pressure (MPa)

<i>Component</i>	<i>P</i>	<i>Static head (design)</i>	<i>Static head (test)</i>	<i>Stress ratio</i>	<i>1.25·P·f₀/f</i>	<i>1.43·P</i>
trubka DN40	1.60	0	0.0008	1,156	2.31	2.29
oblouk DN40, tvar 3D, R=57mm, typ A	1.60	0	0.0008	1,156	2.31	2.29

All pressures in MPa.

Item design pressure $P = 1.60$ MPa

Item maximum allowable design pressure (P_{max}) = 9.68 MPa (limited by trubka DN40)

Item lowest stress ratio = 1.156 (limited by trubka DN40)

Item test pressure = $P_t = \max[1.25 \cdot P_d \cdot (\text{Item } f_0/f); 1.43 \cdot P_d] = 2.31$ MPa

Maximum Pressures (MPa)

<i>Component</i>	<i>Internal, test</i>	<i>Internal</i>
trubka DN40	16.78	9.68
oblouk DN40, tvar 3D, R=57mm, typ A	16.78	9.68

All pressures in MPa.

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Bill of materials

Component	Dimensions	Material
trubka DN40	Id = 44.30 mm, Od = 48.30 mm, Tk = 2.00 mm, L = 400.00 mm	X6CrNiTi18-10 HOT.F. (EN 10216-5:2008) - Seamless tube ($t \leq 60.00$ mm) - No.: 1.4541
oblouk DN40, tvar 3D, R=57mm, typ A	Id = 44.30 mm, Od = 48.30 mm, Tk = 2.00 mm, L = 89.54 mm	X6CrNiTi18-10 HOT.F. (EN 10216-5:2008) - Seamless tube ($t \leq 60.00$ mm) - No.: 1.4541

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Material properties summary

X6CrNiTi18-10 HOT.F. (EN 10216-5:2008) - Seamless tube (t ≤ 60.00 mm) - No.: 1.4541

<i>Temp.</i>	<i>Allowable</i>	<i>Yield strength</i>	<i>Tensile strength</i>	<i>Elasticity</i>	<i>Thermal expansion</i>
Room	153.33 MPa	180.00 MPa	460.00 MPa	200 000.00 MPa	0.000016000 1/°C
Design	132.67 MPa	160.50 MPa	0 MPa	197 375.00 MPa	0.000016000 1/°C
Test	230.00 MPa				

Notes

Allowable stress calculation may vary upon component type or characteristics

Yield strength shown refers to 0.2% plastic strain

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Cylindrical shell - trubka DN40*According to: EN 13445 Ed. 2014 Issue 4, Part 3, Clause 7 and 8***Design data**

Internal design temperature	Ti =	55.00 °C
Internal design pressure	Pi =	1.60 MPa
Joint efficiency	z =	1.00

Material: X6CrNiTi18-10 HOT.F. (EN 10216-5:2008) - Seamless tube (t ≤ 60.00 mm)

Nominal design stress at internal design temperature	$f = \left(\frac{R_{p10/T}}{15} \right) =$	132.67 MPa
Nominal design stress at room temperature	$f = \max\left[\frac{R_{p10/T}}{15}; \min\left(\frac{R_{p10/T}}{12}; \frac{R_m/T}{3} \right) \right] =$	153.33 MPa
Nominal design stress in test condition	$f_{test} = \max\left(\frac{R_{p10/Ttest}}{105}; \frac{R_m/Ttest}{2} \right) =$	230.00 MPa

Geometry

Inside diameter	Di =	44.30 mm
Outside diameter	De =	48.30 mm
Length	L =	400.00 mm
Nominal thickness	en =	2.00 mm
Corrosion allowance	c =	0 mm
External corrosion allowance	ce =	0 mm
Undertolerance	δ =	0.30 mm

Internal pressure

Overpressure due to static head	Ph =	0 MPa
Calculation pressure	P=Pi+Ph =	1.60 MPa
Outside diameter	De'=De-2ce =	48.30 mm
Minimum required thickness	$e = \frac{P \cdot D_e'}{2 \cdot f \cdot z + P} + c + ce + \delta =$	0.59 mm

e/De ≤ 0,16 (0.01200 ≤ 0.16000): Ok**en ≥ e: Ok****Maximum allowable pressures (at the top of the vessel)**

Maximum allowable test pressure	=	16.78 MPa
Maximum allowable design pressure	=	9.68 MPa

Deformation according to EN13445-4 Clause 9

Ratio of deformation	$F = 50 \cdot en / (Di/2 + en/2) =$	4.320 %
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Hydrostatic test

Item or side minimum allowables ratio	Item f0/f =	1.15578
Coincident design pressure for the maximum pressure load case	Pd =	1.60 MPa
Test pressure as per EN13445-5 formula 10.2.3.3.1-1	Pt1 = 1.25 · Pd · (Item f0/f) =	2.31 MPa
Test pressure as per EN13445-5 formula 10.2.3.3.1-2	Pt2 = 1.43 · Pd =	2.29 MPa
Item or side hydrostatic test pressure	Pt=max(Pt1,Pt2) =	2.31 MPa
Overpressure due to static head in test condition	Pht =	0.0008 MPa
Calculation pressure	Pc=Pt+Pht =	2.31 MPa
Outside diameter	De'=De =	48.30 mm
Minimum required thickness	$e = \frac{P \cdot D_e'}{2 \cdot f \cdot z + P} + \delta =$	0.54 mm

e/De ≤ 0,16 (0.01100 ≤ 0.16000): Ok**en ≥ e: Ok**

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Elbow - oblouk DN40, tvar 3D, R=57mm, typ A*According to: EN 13445 Ed. 2014 Issue 4, Part 3, Clause 7 and 8, EN 13480-3: 2012***Design data**

Internal design temperature	Ti =	55.00 °C
Internal design pressure	Pi =	1.60 MPa
Joint efficiency	z =	1.00

Material: X6CrNiTi18-10 HOT.F. (EN 10216-5:2008) - Seamless tube (t ≤ 60.00 mm)

Nominal design stress at internal design temperature	$f = \left(\frac{R_{p10/T}}{15} \right) =$	132.67 MPa
Nominal design stress at room temperature	$f = \max\left[\frac{R_{p10/T}}{15}; \min\left(\frac{R_{p10/T}}{12}; \frac{R_m/T}{3} \right) \right] =$	153.33 MPa
Nominal design stress in test condition	$f_{test} = \max\left(\frac{R_{p10/Ttest}}{105}; \frac{R_m/Ttest}{2} \right) =$	230.00 MPa

Geometry

Inside diameter	Di =	44.30 mm
Outside diameter	De =	48.30 mm
Length	L =	89.54 mm
Nominal thickness	en =	2.00 mm
Corrosion allowance	c =	0 mm
External corrosion allowance	ce =	0 mm
Undertolerance	δ =	0.30 mm
Center-to-End radius	R =	57.00 mm

Internal pressure

Overpressure due to static head	Ph =	0 MPa
Calculation pressure	P=Pi+Ph =	1.60 MPa
Outside diameter	De'=De-2ce =	48.30 mm
Minimum required thickness	$e = \frac{P \cdot D_e'}{2f \cdot z + P} + c + ce + \delta =$	0.59 mm
e/De ≤ 0,16 (0.01200 ≤ 0.16000): Ok		
en ≥ e: Ok		

Minimum thickness according to EN 13480

Minimum required wall thickness for a straight pipe without allowances and tolerances	$e = \frac{PD_e}{2f \cdot z + P} =$	0.29 mm
Minimum required thickness without allowances and tolerances on the intrados	$e_{int} = e \frac{R/D_e - 0,25}{R/D_e - 0,5} =$	0.40 mm
Minimum required thickness without allowances and tolerances on the extrados	$e_{ext} = e \frac{R/D_e + 0,25}{R/D_e + 0,5} =$	0.25 mm
Minimum required thickness	$e_{min} = \max(e_{int}; e_{ext}) + c + ce + \delta =$	0.70 mm
en ≥ e,min: Ok		

Maximum allowable pressures (at the top of the vessel)

Maximum allowable test pressure	=	16.78 MPa
Maximum allowable design pressure	=	9.68 MPa

Deformation according to EN13445-4 Clause 9

Ratio of deformation	F=100·De/2R =	42.368 %
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Hydrostatic test

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Coincident design pressure for the maximum pressure load case	Pd =	1.60 MPa
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Test pressure as per EN13445-5 formula 10.2.3.3.1-2	Pt2 = 1.43·Pd =	2.29 MPa
Item or side hydrostatic test pressure	Pt=max(Pt1,Pt2) =	2.31 MPa
Overpressure due to static head in test condition	Pht =	0.0008 MPa
Calculation pressure	Pc=Pt+Pht =	2.31 MPa
Outside diameter	De'=De =	48.30 mm
Minimum required thickness	$e = \frac{P \cdot D_e'}{2 \cdot f \cdot z + P} + \delta$ =	0.54 mm
e/De ≤ 0,16 (0.01100 ≤ 0.16000): Ok		
en ≥ e: Ok		

Minimum thickness according to EN 13480

Minimum required wall thickness for a straight pipe without allowances and tolerances	$e = \frac{P D_e}{2 f \cdot z + P}$ =	0.24 mm
Minimum required thickness without allowances and tolerances on the intrados	$e_{int} = e \frac{R/D_e - 0,25}{R/D_e - 0,5}$ =	0.33 mm
Minimum required thickness without allowances and tolerances on the extrados	$e_{ext} = e \frac{R/D_e + 0,25}{R/D_e + 0,5}$ =	0.21 mm
Minimum required thickness	e,min = MAX(e,int; e,ext) + δ =	0.63 mm
en ≥ e,min: Ok		