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Layout

Input values:	*1.234*	or	1.234
Calculated values:	***1.234***	or	**1.234**
Critical values:	*1.234*	or	1.234
Estimated values:	*1.234*	or	1.234

Summary

Strength Calculation Software	Program System ATLAS	Version	**8.33.8**
Developed by Lauterbach Verfahrenstechnik GmbH			
Certified per DIN EN ISO 9001:2015	Certificate Number 01 100 044763		

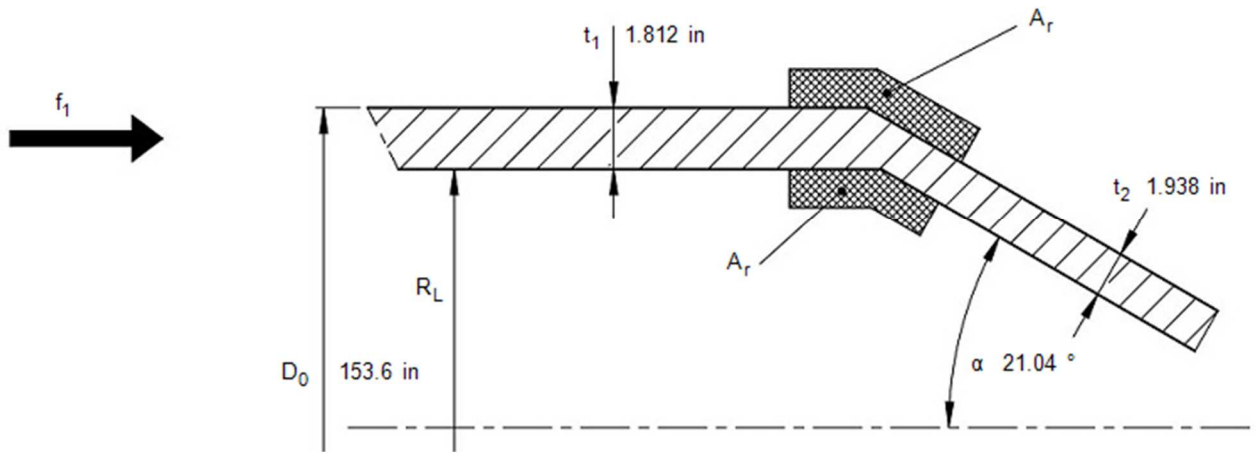
	LV Soft				ASME		Diff [%]
Example E4.3.7 - Conical transition Without a knuckle (large End)							
Required cylinder thickness t	37.48	mm	1.48	in	1.48	in	**0.08%**
Required cone thickness tr	39.93	mm	1.57	in	1.57	in	**0.08%**
Example E4.3.7 - Conical transition Without a knuckle (Smal End)				in			
Required cylinder thickness t	23.78	mm	0.94	in	0.94	in	**0.07%**
Required cone thickness tr	25.25	mm	0.99	in	0.99	in	**0.07%**
Required area Ars	2,055.00	mm^2	3.19	in^2	3.24	in^2	**1.57%**
Required area Aes	5,081.53	mm^2	7.88	in^2	6.28	in^2	**25.48%**
Example E4.3.8 - Conical transition With a knuckle							
Required knuckle thickness t	17.20	mm	0.68	in	0.68	in	**0.07%**
Required cone thickness tr	24.74	mm	0.97	in	0.97	in	**0.08%**

Equations for Aes und Ael in Appendices 1-5 and 1-8 have been changed in Edition 2021!
Results have to be adapted accordingly. Basis is PTB 4-2013!

E4.3.7 Large End - Cone-to-cylinder junction at large end under internal pressure - ASME BPVC VIII-1 UG-32 & Appendix-1: 2021

Cone-to-cylinder junction (wide end)

Type of reinforcing ring			
(0 = no, 1 = at the cylinder, 2 = at the cone)		0	
Without stiffener			
Design pressure	p_D	356	psi
Hydrostatic head	D_p	0	psi
Calculation pressure	p_0	**356**	psi
Calculation temperature	T_0	300	°F
Axial load based on circumference (for compression negative)	f_1	0	lbf/in



Cylinder

Outside diameter		D_0	153.6	in
Final wall thickness		t_1	1.812	in
Material	K02700-SA-516-70-Class:-Size:			
Wall thickness allowance		c_1	0	in
Allowance (corrosion)		c_2	0.125	in
Thickness without allowances		t_s	**1.687**	in
Inside radius	(= $D_0/2-t_s$)	R_L	**75.12**	in
Allowable stress		S_s	20015	psi
Modulus of elasticity		E_s	2.829e+7	psi
Weld joint efficiency (or Cast Quality Factor)		E_1	1	

Cone

Half-apex angle (≤30°)		α	21.04	°
Final wall thickness		t_2	1.938	in
Material	K02700-SA-516-70-Class:-Size:			
Wall thickness allowance		c_1	0	in
Allowance (corrosion)		c_2	0.125	in
Effective thickness		t_c	**1.813**	in
Allowable stress		S_c	20015	psi
Modulus of elasticity		E_c	2.829e+7	psi
Weld joint efficiency (or Cast Quality Factor)		E_2	1	

Results

Geometrical conditions
valid

Strength condition
Wall thickness acceptable

Factor				k	**1**	
Ratio			P_0/S_sE_1		**0.01779**	
Angle α	(Reinforcement required if Δ <	21.04 °	)	Δ	**43.56**	°
Effective load				Q_L	**13371**	lbf/in
Required thickness cylinder (UG-27)				t	**1.351**	in
with allowances	(t_1	1.812 in	≥t+)	t+	**1.476**	in
Required thickness cone (UG-32)				t_r	**1.447**	in
with allowances	(t_2	1.938 in	≥t_r+)	t_r+	**1.572**	in
Required cross sectional area				A_{rL}	**0**	in²
Available cross section				A_{eL}	**8.209**	in²
Required area of reinforcement				A_r	**0**	in²
Available area of reinforcement			$b_v \cdot t_v$	A_v	**0**	in²
Maximum distance from the connection point of the						
complete reinforcing area			$\sqrt{[R_L \cdot t_s]}$		**11.26**	in
centroid of reinforcing area			$0.25 \cdot \sqrt{[R_L \cdot t_s]}$		**2.815**	in

Equations

$cos(\alpha) = cos(\alpha) \Leftrightarrow cos(21.04°) = 0.9333$

$tan(\alpha) = tan(\alpha) \Leftrightarrow tan(21.04°) = 0.3846$

$$Q_L = P_0 \cdot \frac{R_L}{2} + f_1 = 24.55\ \text{bar} \cdot \frac{1908\ \text{mm}}{2} + 0\ \text{N/mm} = 2342\ \text{N/mm}$$

$$A_{rL} = \frac{k \cdot Q_L \cdot R_L}{S_s \cdot E_1} \cdot \left[1 - \frac{D_{el}}{\alpha}\right] \cdot \tan(\alpha) = \frac{1 \cdot 2342\ \text{N/mm} \cdot 1908\ \text{mm}}{138\ \text{N/mm}^2 \cdot 1} \cdot \left[1 - \frac{43.56°}{21.04°}\right] \cdot 0.3846 = 0\ \text{mm}^2$$

$$t = \frac{P_0 \cdot R_L}{S_s \cdot E_1 - 0.6 \cdot P_0} = \frac{24.55\ \text{bar} \cdot 1908\ \text{mm}}{138\ \text{N/mm}^2 \cdot 1 - 0.6 \cdot 24.55\ \text{bar}} = 34.3\ \text{mm}$$

$$t_r = \frac{P_0 \cdot \frac{R_L}{\cos(\alpha)}}{S_c \cdot E_2 - 0.6 \cdot P_0} = \frac{24.55\ \text{bar} \cdot \frac{1908\ \text{mm}}{0.9333}}{138\ \text{N/mm}^2 \cdot 1 - 0.6 \cdot 24.55\ \text{bar}} = 36.75\ \text{mm}$$

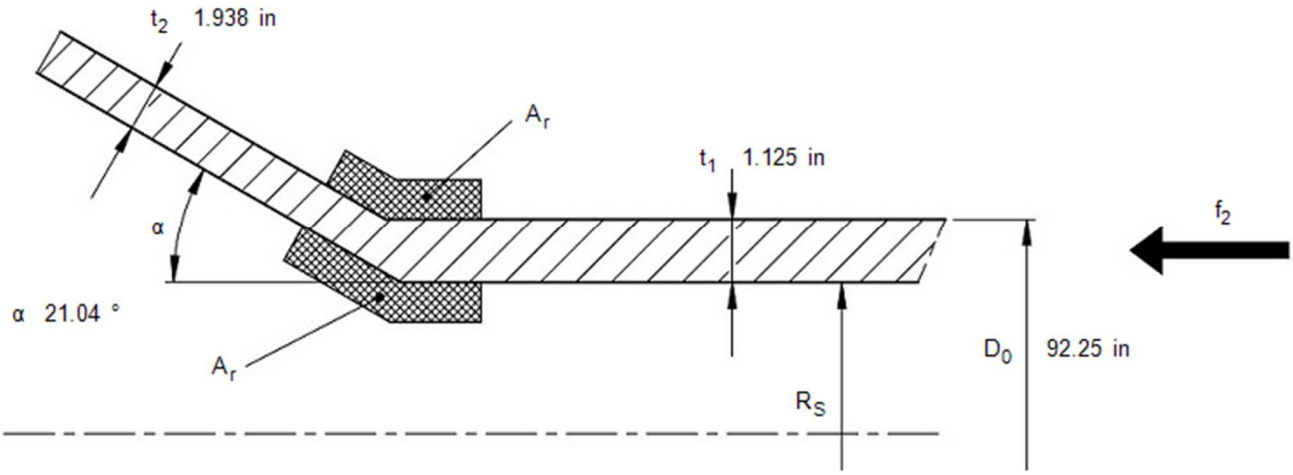
$$A_{eL} = (t_s - t) \cdot \sqrt{R_L \cdot t_s} + (t_c - t_r) \cdot \sqrt{R_L \cdot \frac{t_c}{\cos(\alpha)}} =$$

$$(42.86\ \text{mm} - 34.3\ \text{mm}) \cdot \sqrt{1908\ \text{mm} \cdot 42.86\ \text{mm}} + (46.04\ \text{mm} - 36.75\ \text{mm}) \cdot \sqrt{1908\ \text{mm} \cdot \frac{46.04\ \text{mm}}{0.9333}} = 5296\ \text{mm}^2$$

E4.3.7 Small End - Cone-to-cylinder junction at small end under internal pressure - ASME BPVC VIII-1 UG-32 & Appendix-1: 2021

Cone-to-cylinder junction (small end)

Type of reinforcing ring			
(0 = no, 1 = at the cylinder, 2 = at the cone)		0	
Without stiffener			
Design pressure	p_D	356	psi
Hydrostatic head	D_p	0	psi
Calculation pressure	p_0	**356**	psi
Calculation temperature	T_0	300	°F
Axial load based on circumference (for compression negative)	f_2	396.9	lbf/in



Cylinder

Outside diameter		D_0	92.25	in
Final wall thickness		t_1	1.125	in
Material	K02700-SA-516-70-Class:-Size:			
Wall thickness allowance		c_1	0	in
Allowance (corrosion)		c_2	0.125	in
Effective thickness		t_s	**1**	in
Inside radius	(= $D_0/2-t_s$)	R_S	**45.12**	in
Allowable stress		S_s	20015	psi
Modulus of elasticity		E_s	2.829e+7	psi
Weld joint efficiency (or Cast Quality Factor)		E_1	1	

Cone

Half-apex angle (≤30°)		α	21.04	°
Final wall thickness		t_2	1.938	in
Material	K02700-SA-516-70-Class:-Size:			
Wall thickness allowance		c_1	0	in
Allowance (corrosion)		c_2	0.125	in
Thickness without allowances		t_c	**1.813**	in
Allowable stress		S_c	20015	psi
Modulus of elasticity		E_c	2.829e+7	psi
Weld joint efficiency (or Cast Quality Factor)		E_2	1	

Results

Geometrical conditions
valid

Strength condition
Wall thickness acceptable

Factor			k	**1**	
Ratio		P_0/S_sE_1		**0.01779**	
Angle			Δ	**11.87**	°
Effective load			Q_S	**8429**	lbf/in
Required thickness cylinder (UG-27)			t	**0.8113**	in
with allowances	(t_1 1.125 in	≥t+)	t+	**0.9363**	in
Required thickness cone (UG-32)			t_r	**0.8692**	in
with allowances	(t_2 1.938 in	≥t_r+)	t_r+	**0.9942**	in
Required cross sectional area			A_{rS}	**3.185**	in²
Available cross section			A_{eS}	**7.876**	in²
Required area of reinforcement			A_r	**0**	in²
Available area of reinforcement		$b_v \cdot t_v$	A_v	**0**	in²
Maximum distance from the connection point of the					
complete reinforcing area		$\sqrt{[R_L \cdot t_s]}$		**9.044**	in
centroid of reinforcing area		$0.25 \cdot \sqrt{[R_L \cdot t_s]}$		**2.261**	in

Equations

$$cos(\alpha) = cos(\alpha) \Leftrightarrow cos(21.04°) = 0.9333$$

$$tan(\alpha) = tan(\alpha) \Leftrightarrow tan(21.04°) = 0.3846$$

$$QS = P0 \cdot \frac{RS}{2} + f2 = 24.55\ \text{bar} \cdot \frac{1146\ \text{mm}}{2} + 69.5\ \text{N/mm} = 1476\ \text{N/mm}$$

$$ArS = \frac{k \cdot QS \cdot RS}{SS \cdot E1} \cdot \left[1 - \frac{Del}{\alpha}\right] \cdot tan(\alpha) = \frac{1 \cdot 1476\ \text{N/mm} \cdot 1146\ \text{mm}}{138\ \text{N/mm}^2 \cdot 1} \cdot \left[1 - \frac{11.87°}{21.04°}\right] \cdot 0.3846 = 2055\ \text{mm}^2$$

$$t = \frac{P0 \cdot RS}{Ss \cdot E1 - 0.6 \cdot P0} = \frac{24.55\ \text{bar} \cdot 1146\ \text{mm}}{138\ \text{N/mm}^2 \cdot 1 - 0.6 \cdot 24.55\ \text{bar}} = 20.61\ \text{mm}$$

$$tr = \frac{P0 \cdot \frac{RS}{(cos(\alpha))}}{Sc \cdot E2 - 0.6 \cdot P0} = \frac{24.55\ \text{bar} \cdot \frac{1146\ \text{mm}}{0.9333}}{138\ \text{N/mm}^2 \cdot 1 - 0.6 \cdot 24.55\ \text{bar}} = 22.08\ \text{mm}$$

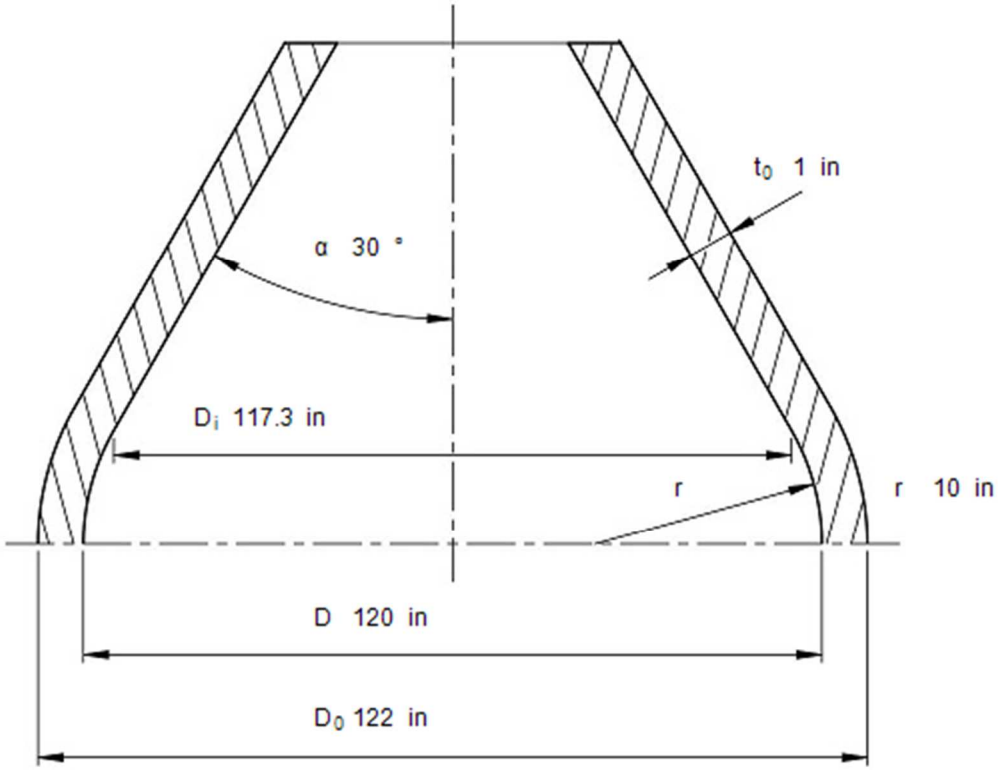
$$AeS = 0.78 \cdot \sqrt{RS \cdot ts} \cdot \left[(ts - t) + \frac{(tc - tr)}{cos(\alpha)}\right] =$$

$$0.78 \cdot \sqrt{1146\ \text{mm} \cdot 25.4\ \text{mm}} \cdot \left[(25.4\ \text{mm} - 20.61\ \text{mm}) + \frac{(46.04\ \text{mm} - 22.08\ \text{mm})}{0.9333}\right] = 5082\ \text{mm}^2$$

E4.3.8 - Cone with knuckle under internal pressure - ASME BPVC VIII-1 UG-32 & Appendix-1: 2021

Toriconical sections

Design pressure	p_D	285.4	psi
Hydrostatic head	D_p	0	psi
Calculation pressure	p_0	**285.4**	psi
Calculation temperature	T_0	300	°F
Final wall thickness	t_e	1	in
Wall thickness allowance	c_1	0	in
Allowance (corrosion)	c_2	0	in
Effective thickness without allowances	t_0	**1**	in



Outside diameter of cylindrical shell		D_0	122	in
Inside diameter of cylindrical shell	(= D_0-2t_0)	D	**120**	in
Semi-apex angle		α	30	°
Knuckle radius (≥0.06·D_0, ≥3·t_e)		r	10	in
Weld joint efficiency (or Cast Quality Factor)		E	1	

Material K02700-SA-516-70-Class:-Size:

Allowable stress	S	**20015**	psi

Calculation

Largest inside diameter of cone		D_i	**117.3**	in
Equivalent radius		L	**67.74**	in
Ratio		L/r	**6.774**	
Factor		M	**1.401**	
Required knuckle thickness		t	**0.6773**	in
Allowable inside pressure of knuckle		P	**421**	psi
Calculation diameter of cone		D_1	**117.3**	in
Required cone thickness at D_1		t_1	**0.9741**	in
Allowable inside pressure of cone		P_1	**292.9**	psi
Remark				
Required thickness incl. allowances	$t+c_1+c_2$	t+	**0.9741**	in
Allowable excess pressure	Min(P, P_1)	P_m	**292.9**	psi
Allowable excess pressure without hydr. Head		MAWP	**292.9**	psi

Geometrical conditions

valid

Strength condition

Wall thickness acceptable

Equations knuckle

$$cos(\alpha)=cos(\alpha) \Leftrightarrow cos(30°)=0.866$$

$$D_i = D-2 \cdot r \cdot (1-\cos(\alpha))=3048\ \text{mm}-2 \cdot 254\ \text{mm} \cdot (1-0.866)=2980\ \text{mm}$$

$$L=\frac{D_i}{2 \cdot \cos(\alpha)}=\frac{2980\ \text{mm}}{2 \cdot 0.866}=1720\ \text{mm}$$

$$t=\frac{P_0 \cdot L \cdot M}{2 \cdot S \cdot E-0.2 \cdot P_0}=\frac{19.68\ \text{bar} \cdot 1720\ \text{mm} \cdot 1.401}{2 \cdot 138\ \text{N/mm}^2 \cdot 1-0.2 \cdot 19.68\ \text{bar}}=17.2\ \text{mm}$$

$$P=\frac{2 \cdot S \cdot E \cdot t_0}{L \cdot M+0.2 \cdot t_0}=\frac{2 \cdot 138\ \text{N/mm}^2 \cdot 1 \cdot 25.4\ \text{mm}}{1720\ \text{mm} \cdot 1.401+0.2 \cdot 25.4\ \text{mm}}=2.903\ \text{MPa}$$

Equations cone

$$t_1=\frac{P_0 \cdot D_1}{2 \cdot \cos(\alpha) \cdot (S \cdot E-0.6 \cdot P_0)}=\frac{19.68\ \text{bar} \cdot 2980\ \text{mm}}{2 \cdot 0.866 \cdot (138\ \text{N/mm}^2 \cdot 1-0.6 \cdot 19.68\ \text{bar})}=24.74\ \text{mm}$$

$$P=\frac{2 \cdot S \cdot E \cdot t_0 \cdot \cos(\alpha)}{D_1+1.2 \cdot t_0 \cdot \cos(\alpha)}=\frac{2 \cdot 138\ \text{N/mm}^2 \cdot 1 \cdot 25.4\ \text{mm} \cdot 0.866}{2980\ \text{mm}+1.2 \cdot 25.4\ \text{mm} \cdot 0.866}=2.019\ \text{MPa}$$