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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	**10.0.92**
Developed by Lauterbach Verfahrenstechnik GmbH			
Certified per DIn EN ISO 9001:2015	Certificate Number 01 100 044763		

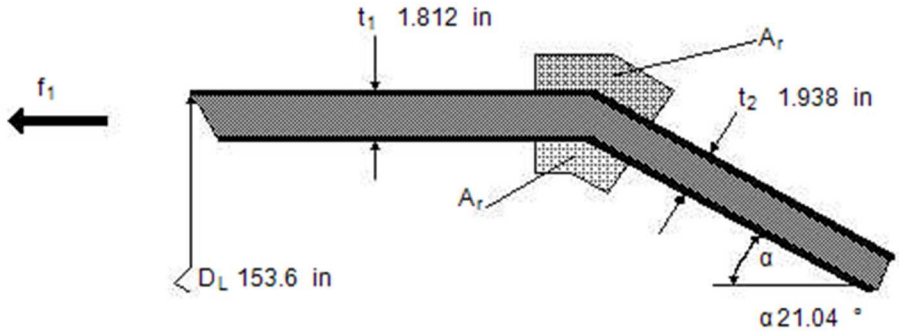
		LV Soft				ASME		Diff [%]
Example E4.4.7 - Conical transition Without a knuckle (large End)								
	Required area ArL	1008.88	mm^2	1.56	in^2	1.56	in^2	**0.10%**
	Required area AeL	13064.03	mm^2	20.25	in^2	20.38	in^2	**0.64%**
Large End/Line-of-support	Required moment of inertia Is	33871336.00	mm^4	81.38	in^4	81.85	in^4	**0.57%**
	Required moment of inertia I's	43504464.00	mm^5	104.52	in^5	105.12	in^5	**0.57%**
Example E4.4.7 - Conical transition Without a knuckle (Small End)								
	Required area ArS	715.96	mm^2	1.11	in^2	1.11	in^2	**0.08%**
	Required area AeS	8001.92	mm^2	13.12	in^2	13.12	in^2	**0.01%**
Small End/Line-of-support	Required moment of inertia Is	6975754.00	mm^4	16.76	in^4	16.76	in^4	**0.02%**
	Required moment of inertia I's	8959684.00	mm^4	21.53	in^4	21.53	in^4	**0.02%**
Example E4.4.8 - Conical transition With a knuckle								
Large End/Line-of-support	Required moment of inertia Is	5850143.00	mm^4	14.06	in^4	13.82	in^4	**1.70%**
	Required moment of inertia I's	7513945.00	mm^4	18.05	in^4	17.75	in^4	**1.70%**

E4.4.7 Large End - Formed heads pressure under external pressure - ASME BPVC VIII-1 UG-33 & Appendix-1: 2021

Area at the wide end of a cone-cylinder-juncture without knuckle acc. App.1-8

Type of stiffener No stiffener

External design pressure	p_D	14.7	psi
Hydrostatic head	D_p	0	psi
Calculation pressure	p_0	**14.7**	psi
Calculation temperature	T_0	300	°F
Axial additional load as line load (positive for tension) e.g. wind load, dead weight, traffic load, etc. but no loads resulting from internal / external pressure	f_1	497.1	lbf/in



Cylinder

Final wall thickness	t_1	1.812	in
Wall thickness allowance	c_1	0	in
Allowance (corrosion)	c_2	0.125	in
Final thickness without allowances	t_s	**1.687**	in
Outside diameter	D_L	153.6	in
Tip radius (=D_L/2)	R_L	**76.81**	in
Required thickness without allowances (UG-28)	t_{1r}	0.9549	in
Required thickness with allowances (UG-28)	t_{1r+}	**1.08**	in
Joint efficiency factor	E_1	1	
Material K02700-SA-516-70-Class:-Size:			
Allowable stress	S_s	20015	psi
Modulus of elasticity	E_s	2.9e+7	psi

Cone

Final wall thickness	t_2	1.938	in
Wall thickness allowance	c_1	0	in
Allowance (corrosion)	c_2	**0.125**	in
Final thickness without allowances	t_c	**1.813**	in
Half apex angle (≤ 60°)	α	21.04	°
Required thickness without allowances (UG-33)	t_{2r}	***0.3639***	in
Required thickness with allowances (UG-33)	t_{2r+}	***0.4889***	in
Joint efficiency factor	E_2	1	
Material K02700-SA-516-70-Class:-Size:			
Allowable stress	S_c	20015	psi
Modulus of elasticity	E_c	2.9e+7	psi

Stiffening ring

Material K02700-SA-516-70-Class:-Size:			
Actual cross section of the stiffener	A_r	34	in²
Allowable stress	S_r	20015	psi
Modulus of elasticity	E_r	2.9e+7	psi

Results

Factor (≥ 1)	k	**1**	
Ratio	P_0/S_sE_1	**7.344e-4**	
Angle	D_{el}	**2.818**	°
Effective load	Q_L	**1062**	lbf/in
Cross sectional area	A_{rL}	**1.564**	in²
Effective area	A_{eL}	**20.25**	in²
Required cross section of reinforcement	A_{req}	**0**	in²

Remark **Stiffening required acc. App. 1-8 (b)**

Equations

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

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

$$Q_L=P_0\cdot\frac{R_L}{2}+f_1=1.014\text{ bar}\cdot\frac{1951\text{ mm}}{2}+87.06\text{ N/mm}=185.9\text{ N/mm}$$

(1)

$$A_{rL}=\frac{k\cdot Q_L\cdot R_L\cdot\tan(\alpha)}{S_s\cdot E_1}\cdot\left(1-\frac{P_0\cdot R_L-Q_L}{4\cdot Q_L}\cdot\frac{D_{el}}{\alpha}\right)=$$

$$\frac{1\cdot 185.9\text{ N/mm}\cdot 1951\text{ mm}\cdot 0.3846}{138\text{ N/mm}^2\cdot 1}\cdot\left(1-\frac{1.014\text{ bar}\cdot 1951\text{ mm}-185.9\text{ N/mm}}{4\cdot 185.9\text{ N/mm}}\cdot\frac{2.818°}{21.04°}\right)=1009\text{ mm}^2$$

(2)

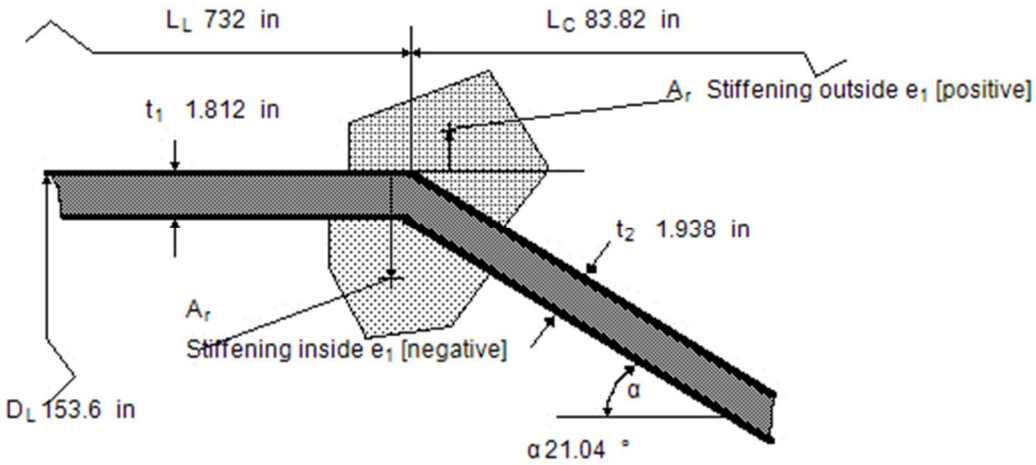
$$A_{eL}=0.55\cdot\sqrt{(D_L\cdot t_s)}\cdot\left(\frac{t_s+t_c}{\cos(\alpha)}\right)=$$

$$0.55\cdot\sqrt{(3902\text{ mm}\cdot 42.86\text{ mm})}\cdot\left(\frac{42.86\text{ mm}+46.04\text{ mm}}{0.9333}\right)=13064\text{ mm}^2$$

E4.4.7 Large End/Line-of-support - Formed heads pressure under external pressure - ASME BPVC VIII-1 UG-33 & Appendix-1: 2021

Moment of inertia at the wide end of a cone-cylinder-juncture under external pressure acc. App. 1-8 (Line-of-support)

External design pressure	p_D	14.7	psi
Hydrostatic head	D_p	0	psi
Calculation pressure	p_0	**14.7**	psi
Calculation temperature	T_0	300	°F
Axial additional load as line load (positive for tension) e.g. wind load, dead weight, traffic load, etc. but no loads resulting from internal / external pressure	f_1	497.1	lbf/in



Cylinder

Design wall thickness	t_1	1.812	in
Wall thickness allowance	c_1	0	in
Allowance (corrosion)	c_2	0.125	in
Final thickness without allowances	t_s	**1.687**	in
Required thickness without allowances (UG-28)	t_{1r}	0.9549	in
Required thickness with allowances (UG-28)	t_{1r+}	**1.08**	in
Outside diameter	D_L	153.6	in
Tip radius ($=D_L/2$)	R_L	**76.81**	in
Buckling length	L_L	732	in

Cone

Design wall thickness	t_2	1.938	in
Wall thickness allowance	c_1	0	in
Allowance (corrosion)	c_2	**0.125**	in
Final thickness without allowances	t_c	**1.813**	in
Required thickness without allowances (UG-33)	t_{2r}	0.3639	in
Required thickness with allowances (UG-33)	t_{2r+}	0.4889	in
Half apex angle (≤ 60°)	α	21.04	°
Buckling length	L_C	83.82	in

Stiffening ring

Material K02700-SA-516-70-Class:-Size:			
Spec. Min. Yield	S_y	2.9e+7	psi
Applicable material chart	Fig	CS-2	
Radial distance between the centroid of the stiffening ring and the outer surface of the cylinder	e_1		in
Cross sectional area	A_r	0	in²
Moment of inertia	I_r		in^4

Results

Equivalent length	M	**393.8**	in
Effective load	F_L	**5980**	lbf/in
Reference area	A_{TL}	**693.6**	in²
Factor	B	**993.4**	psi
Factor (see material chart)	A	**6.96e-5**	
Required moment of inertia	I_s	**81.38**	in^4
Required moment of inertia	I'_s	**104.5**	in^4
Length of support	$0.55\cdot\sqrt{(D\cdot t_s)}$	**8.856**	in
Available moment of inertia	I'		in^4
Remark			

Equations

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

$sin(\alpha)=sin(\alpha)=sin(21.04°)=0.359$

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

$R_S=R_L-L_C\cdot\sin(\alpha)=1951\text{ mm}-2129\text{ mm}\cdot 0.359=1172\text{ mm}$

App. 1-8 b-3) Step 1

$$M=\frac{-R_L\cdot\tan(\alpha)}{2}+\frac{L_L}{2}+\frac{RL^2-RS^2}{3\cdot R_L\cdot\tan(\alpha)}=$$

$$\frac{-1951\text{ mm}\cdot 0.3846}{2}+\frac{18593\text{ mm}}{2}+\frac{(1951\text{ mm})^2-(1172\text{ mm})^2}{3\cdot 1951\text{ mm}\cdot 0.3846}=10002\text{ mm}$$

App. 1-8 b-3) Step 1

$$F_L=P_0\cdot M+f_1\cdot\tan(\alpha)=$$

$1.014\text{ bar}\cdot 10002\text{ mm}+87.06\text{ N/mm}\cdot 0.3846=1047\text{ N/mm}$

App. 1-8 a)

$$A_{TL}=L_L\cdot\frac{t_s}{2}+L_C\cdot\frac{t_c}{2}+A_s=$$

$$18593\text{ mm}\cdot\frac{42.86\text{ mm}}{2}+2129\text{ mm}\cdot\frac{46.04\text{ mm}}{2}+0\text{ mm²}=447474\text{ mm²}$$

App. 1-8 b-3) Step 1

$$B=\frac{3}{4}\cdot\frac{F_L\cdot D_L}{A_{TL}}=\frac{3}{4}\cdot\frac{1047\text{ N/mm}\cdot 3902\text{ mm}}{447474\text{ mm²}}=6.849\text{ N/mm²}$$

App. 1-8 b-3) Step 6

$$I_s=A\cdot D_L^2\cdot\frac{A_{TL}}{14}=6.96e\text{-}5\cdot(3902\text{ mm})^2\cdot\frac{447474\text{ mm²}}{14}=3.387e+7\text{ mm^4}$$

App. 1-8 b-3) Step 6

$$I'_s=A\cdot D_L^2\cdot\frac{A_{TL}}{10.9}=6.96e\text{-}5\cdot(3902\text{ mm})^2\cdot\frac{447474\text{ mm²}}{10.9}=4.35e+7\text{ mm^4}$$

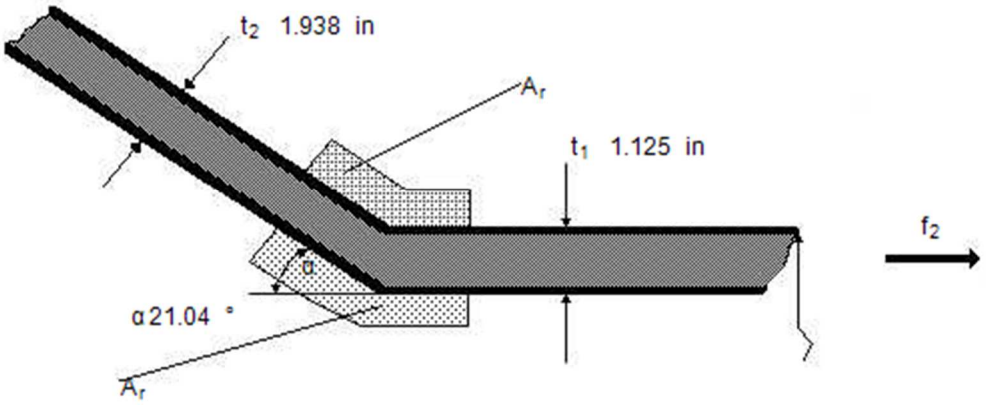
$$0.55\cdot\sqrt{(D\cdot t_s)}=0.55\cdot\sqrt{(3902\text{ mm}\cdot 42.86\text{ mm})}=224.9\text{ mm}$$

E4.4.7 Small End - Formed heads pressure under external pressure - ASME BPVC VIII-1 UG-33 & Appendix-1: 2021

Area at the small end of a cone-cylinder-juncture without knuckle

Type of stiffener No stiffener

External design pressure	p_D	14.7	psi
Hydrostatic head	D_p	0	psi
Calculation pressure	p_0	**14.7**	psi
Calculation temperature	T_0	300	°F
Axial additional load as line load (positive for tension) e.g. wind load, dead weight, traffic load, etc. but no loads resulting from internal / external pressure	f_2	913	lbf/in



Cylinder

Final wall thickness	t_1	1.125	in
Wall thickness allowance	c_1	0	in
Allowance (corrosion)	c_2	0.125	in
Final thickness without allowances	t_s	**1**	in
Outside diameter	D_S	92.25	in
Tip radius (=D_S/2)	R_S	**46.12**	in
Required thickness without allowances (UG-28)	t_{1r}	0.6718	in
Required thickness with allowances (UG-28)	t_{1r+}	**0.7968**	in
Joint efficiency factor	E_1	1	
Material K02700-SA-516-70-Class:-Size:			
Allowable stress	S_s	20015	psi
Modulus of elasticity	E_s	2.9e+7	psi

Cone

Final wall thickness	t_2	1.938	in
Wall thickness allowance	c_1	0	in
Allowance (corrosion)	c_2	0.125	in
Final thickness without allowances	t_c	**1.813**	in
Semi aperture angle (≤ 60°)	α	21.04	°
Required thickness without allowances (UG-33)	t_{2r}	***0.3639***	in
Required thickness with allowances (UG-33)	t_{2r+}	**0.4889**	in
Joint efficiency factor	E_2	1	
Material K02700-SA-516-70-Class:-Size:			
Allowable stress	S_c	20015	psi
Modulus of elasticity	E_c	2.9e+7	psi

Stiffening ring

Material			
Actual cross section of the stiffener	A_r		in²
Allowable stress	S_r		psi
Modulus of elasticity	E_r		psi

Results

Factor	k	**1**	≥ 1
Effective load	Q_S	**1252**	lbf/in
Cross sectional area	A_{rS}	**1.11**	in²
Effective area	A_{eS}	**12.4**	in²
Required cross section of the stiffener	A_{req}	**0**	in²
Remark			

Equations

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

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

$$Q_S=P_0\cdot\frac{R_S}{2}+f_2=1.014\text{ bar}\cdot\frac{1172\text{ mm}}{2}+159.9\text{ N/mm}=219.3\text{ N/mm}$$

(3)

$$A_{rS}=\frac{k\cdot Q_S\cdot R_S\cdot\tan(\alpha)}{S_s\cdot E_1}=\frac{1\cdot 219.3\text{ N/mm}\cdot 1172\text{ mm}\cdot 0.3846}{138\text{ N/mm}^2\cdot 1}=716\text{ mm}^2$$

(4)

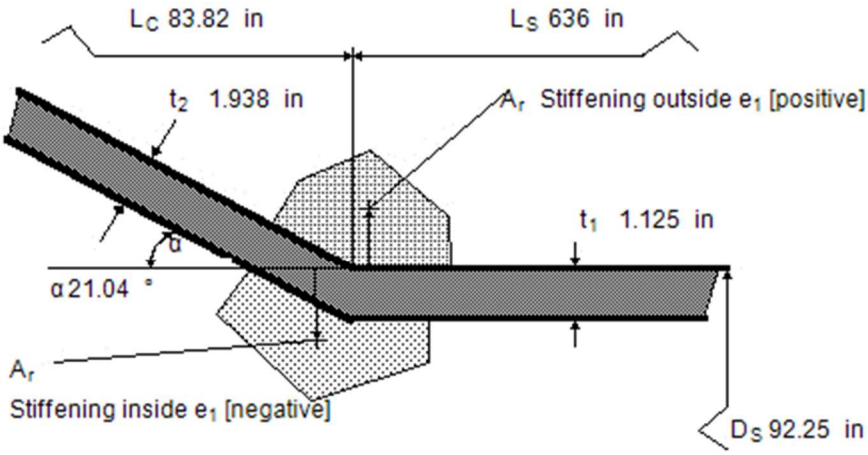
$$A_{eS}=0.55\cdot\sqrt{D_S\cdot t_s}\cdot\left[\frac{t_s-t+(t_c-t_r)}{\cos(\alpha)}\right]=$$

$$0.55\cdot\sqrt{2343\text{ mm}\cdot 25.4\text{ mm}}\cdot\left[\frac{25.4\text{ mm}-17.06\text{ mm}+(46.05\text{ mm}-9.242\text{ mm})}{0.9333}\right]=8002\text{ mm}^2$$

E4.4.7 Small End/Line-of-support - Formed heads pressure under external pressure - ASME BPVC VIII-1 UG-33 & Appendix-1: 2021

Moment of inertia at the small end of a cone-cylinder-juncture under external pressure acc. App.1-8 (Line-of-support)

External design pressure	p_D	14.7	psi
Hydrostatic head	D_p	0	psi
Calculation pressure	p_0	**14.7**	psi
Calculation temperature	T_0	300	°F
Axial additional load as line load (positive for tension) e.g. wind load, dead weight, traffic load, etc. but no loads resulting from internal / external pressure	f_2	913	lbf/in



Cylinder

Final wall thickness	t_1	1.125	in
Wall thickness allowance	c_1	0	in
Allowance (corrosion)	c_2	0.125	in
Final thickness without allowances	t_s	**1**	in
Required thickness without allowances (UG-28)	t_{1r}	0.6718	in
Required thickness with allowances (UG-28)	t_{1r+}	**0.7968**	in
Outside diameter	D_S	92.25	in
Tip radius (=D_S/2)	R_S	**46.12**	in
Buckling length	L_S	636	in

Cone

Final wall thickness	t_2	1.938	in
Wall thickness allowance	c_1	0	in
Allowance (corrosion)	c_2	0.125	in
Final thickness without allowances	t_c	**1.813**	in
Required thickness without allowances (UG-33)	t_{2r}	0.3639	in
Required thickness with allowances (UG-33)	t_{2r+}	**0.4889**	in
Semi-apex angle (≤ 60°)	α	21.04	°
Buckling length	L_C	83.82	in

Stiffening ring

Material K02700-SA-516-70-Class:-Size:			
Spec. Min. Yield	S_y	2.9e+7	psi
Applicable material chart	Fig	CS-2	
Radial distance between the centroid of the stiffening ring and the outer surface of the cylinder	e_1		in
Cross sectional area	A_r	0	in²
Moment of inertia	I_r		in^4

Results

Equivalent length	N	**362.3**	in
Effective load	F_S	**5677**	lbf/in
Reference area	A_{TS}	**394**	in²
Factor	B	**997**	psi
Factor (see material chart)	A	**6.998e-5**	
Required moment of inertia	I_s	**16.76**	in^4
Required moment of inertia	I'_s	**21.53**	in^4
Length of support	$0.55\cdot\sqrt{(D\cdot t_s)}$	**5.283**	in
Available moment of inertia	I'		in^4
Remark			

Equations

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

$sin(\alpha)=sin(\alpha)=sin(21.04°)=0.359$

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

$$R_S=R_L-L_C\cdot\sin(\alpha)=1952\text{ mm}-2129\text{ mm}\cdot 0.359=1172\text{ mm}$$

$$N=\frac{R_S\cdot\tan(\alpha)}{2}+\frac{L_S}{2}+\frac{RL^2-RS^2}{6\cdot R_S\cdot\tan(\alpha)}=$$

$$\frac{1172\text{ mm}\cdot 0.3846}{2}+\frac{16154\text{ mm}}{2}+\frac{(1952\text{ mm})^2-(1172\text{ mm})^2}{6\cdot 1172\text{ mm}\cdot 0.3846}=9203\text{ mm}$$

$$994.3\text{ N/mm}=1.014\text{ bar}\cdot 9203\text{ mm}+159.9\text{ N/mm}\cdot 0.3846$$

$$A_{TS}=L_S\cdot\frac{t_s}{2}+L_C\cdot\frac{t_c}{2}+A_S=16154\text{ mm}\cdot\frac{25.4\text{ mm}}{2}+2129\text{ mm}\cdot\frac{46.05\text{ mm}}{2}+0\text{ mm²}=254182\text{ mm²}$$

$$B=\frac{3}{4}\cdot\frac{F_S\cdot D_S}{AT_S}=\frac{3}{4}\cdot\frac{994.3\text{ N/mm}\cdot 2343\text{ mm}}{254182\text{ mm²}}=6.874\text{ N/mm²}$$

$$I_s=\frac{A\cdot DS^2\cdot A_{TS}}{14}=\frac{6.998\text{e-}5\cdot(2343\text{ mm})^2\cdot 254182\text{ mm²}}{14}=6975754\text{ mm^4}$$

$$I'_s=\frac{A\cdot DS^2\cdot A_{TS}}{10.9}=\frac{6.998\text{e-}5\cdot(2343\text{ mm})^2\cdot 254182\text{ mm²}}{10.9}=8959684\text{ mm^4}$$

$$0.55\cdot\sqrt{(D\cdot t_s)}=0.55\cdot\sqrt{(D\cdot 25.4\text{ mm})}=134.2\text{ mm}$$

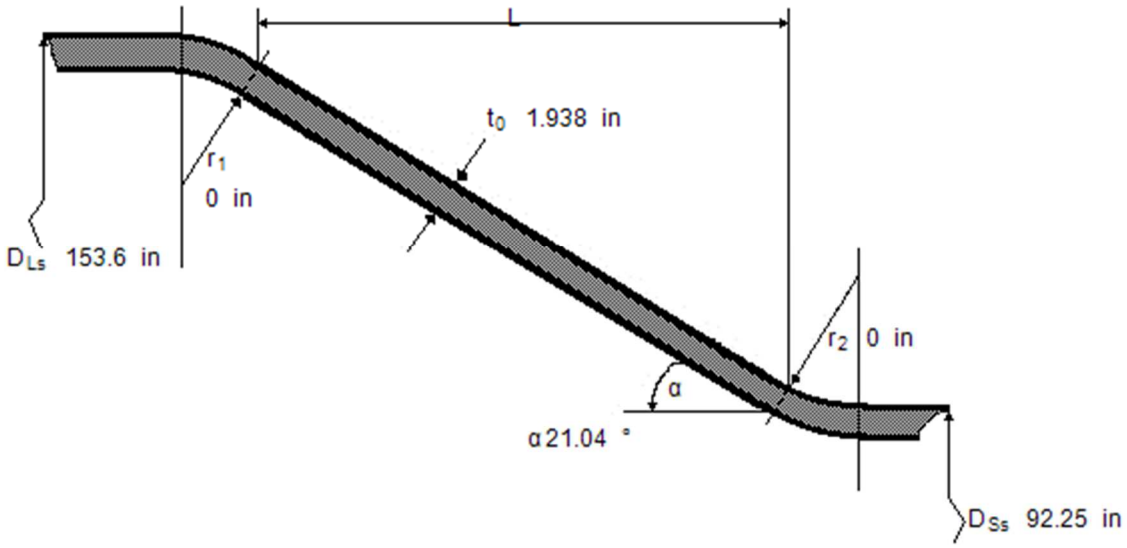
E4.4.8 Large and Small End - Formed heads pressure under external pressure - ASME BPVC VIII-1 UG-33 & Appendix-1: 2021

Conical shells under external pressure acc. UG-33(f)

External design pressure	p_D	14.7	psi
Hydrostatic head	D_p	0	psi
Calculation pressure	p_0	**14.7**	psi
Calculation temperature	T_0	300	°F

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

Spec. Min. Yield	S_y	37710	psi
Allowable stress	S_0	20015	psi
Applicable material chart	Fig	CS-2	
Modulus of elasticity	E	2.9e+7	psi



Cone wall thickness with allowances	t_0	1.938	in
Wall thickness allowance	c_1	0	in
Allowance (corrosion)	c_2	0.125	in
Cone wall thickness without allowances	t	**1.813**	in

Is a cylinder connected, which does not act as line of support?			N	(Y/N)
Outside diameter	(wide end)	D_{Ls}	153.6	in
Knuckle radius	(wide end)	r_1	0	in
Outside diameter	(small end)	D_{Ss}	92.25	in
Knuckle radius	(small end)	r_2	0	in
Half apex angle (≤ 60°)		α	21.04	°

Proof for cross-section area according to App. 1-8 required for cone-connection without knuckle

Results

Effective thickness	$t_e = t \cdot \cos(\alpha)$	t_e	**1.692**	in
Axial length of the cone		L	**79.79**	in
Design length		L_e	**63.85**	in
Ratio		L_e/D_L	**0.4156**	
Ratio		D_L/t_e	**90.81**	
Factor according to fig. 5-UGO-28.0		A	**0.004054**	
Factor (see material chart)		B	**16850**	psi
Factor	$2 \cdot \text{Min}(S_0;.9 \cdot B)$	S	**31589**	psi
Allowable external pressure	(for t0)	P	**247.4**	psi
Allowable pressure without hydrostatic head		MEP	**247.4**	psi
Required thickness	(for P0)	t	***0.3664***	in
Required thickness incl. allowances		$t+c_1+c_2$	***0.4914***	in

Remark

Equations

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

$$sin(\alpha) = sin(\alpha) = sin(21.04°) = 0.359$$

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

$$D_L = D_{Ls} - r_1 \cdot (1 - \cos(\alpha)) = 3902\ \text{mm} - 0\ \text{mm} \cdot (1 - 0.9333) = 3902\ \text{mm}$$

$$D_S = D_{Ss} + r_2 \cdot (1 - \cos(\alpha)) = 2343\ \text{mm} + 0\ \text{mm} \cdot (1 - 0.9333) = 2343\ \text{mm}$$

$$L = \frac{(D_L - D_S)}{2} \cdot \tan(\alpha) = \frac{(3902\ \text{mm} - 2343\ \text{mm})}{2} \cdot 0.3846 = 2027\ \text{mm}$$

$$L_1 = r_1 \cdot \sin(\alpha) = 0\ \text{mm} \cdot 0.359 = 0\ \text{mm}$$

$$L_2 = r_2 \cdot \left(\frac{D_{Ss}}{D_{Ls}}\right) \cdot \sin(\alpha) = 0\ \text{mm} \cdot 0.6005 \cdot 0.359 = 0\ \text{mm}$$

$$L_3 = \frac{L}{2} \cdot \frac{(D_L + D_S)}{D_{Ls}} = \frac{2027\ \text{mm}}{2} \cdot \frac{(3902\ \text{mm} + 2343\ \text{mm})}{3902\ \text{mm}} = 1622\ \text{mm}$$

$$L_e = L_1 + L_2 + L_3 = 0\ \text{mm} + 0\ \text{mm} + 1622\ \text{mm} = 1622\ \text{mm}$$

1) for $D_L/t_0 \geq 10$

UG-33 f-a) Step 6

$$Pa(B) = \frac{4 \cdot B}{3 \cdot \left(\frac{D_L}{t_0}\right)} = \frac{4 \cdot 116.2\ \text{N/mm}^2}{3 \cdot 90.81} = 1.706\ \text{N/mm}^2$$

UG-33 f-a) Step 7

$$Pa(E) = \frac{2 \cdot A \cdot E}{3 \cdot \left(\frac{D_L}{t_0}\right)} = \frac{2 \cdot 0.004054 \cdot 199948\ \text{N/mm}^2}{3 \cdot 90.81} = 5.951\ \text{N/mm}^2$$

2) for $D_L/t_0 < 10$

UG-33 f-b) Step 2

$$P_{a1}=\left[\frac{2.167}{\frac{D_L}{t_0}}-0.0833\right]\cdot B=\left[\frac{2.167}{90.81}-0.0833\right]\cdot 116.2\ \text{N/mm²}=-6.905\ \text{N/mm²}$$

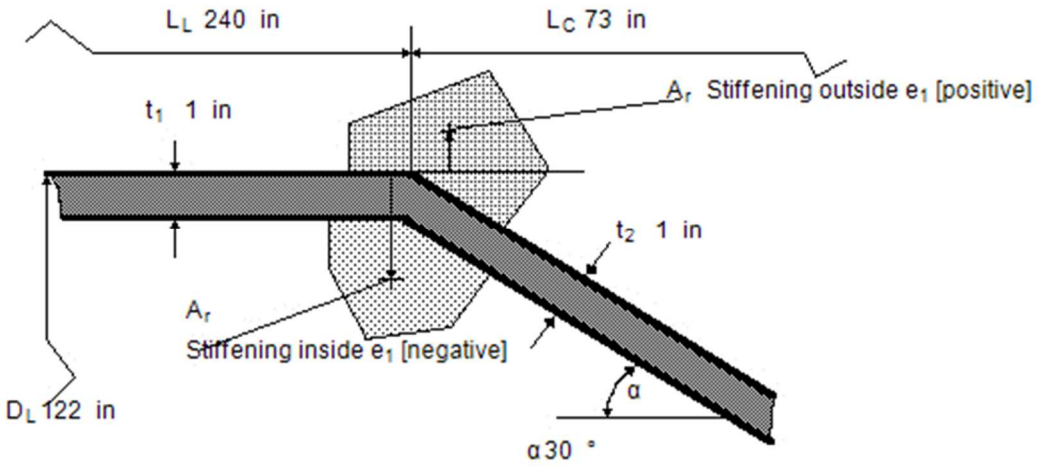
UG-33 f-b) Step 3

$$P_{a2}=\frac{2\cdot S}{\frac{D_L}{t_0}}\cdot\left[1-\frac{2\cdot S}{\frac{D_L}{t_0}}\right]=\frac{2\cdot 217.8\ \text{N/mm²}}{90.81}\cdot\left[1-\frac{2\cdot 217.8\ \text{N/mm²}}{90.81}\right]=4.744\ \text{N/mm²}$$

E4.4.8 Large End/Line-of-support - Formed heads pressure under external pressure - ASME BPVC VIII-1 UG-33 & Appendix-1: 2021

Moment of inertia at the wide end of a cone-cylinder-juncture under external pressure acc. App. 1-8 (Line-of-support)

External design pressure	p_D	14.7	psi
Hydrostatic head	D_p	0	psi
Calculation pressure	p_0	**14.7**	psi
Calculation temperature	T_0	300	°F
Axial additional load as line load (positive for tension) e.g. wind load, dead weight, traffic load, etc. but no loads resulting from internal / external pressure	f_1	145	lbf/in



Cylinder

Design wall thickness	t_1	1	in
Wall thickness allowance	c_1	0	in
Allowance (corrosion)	c_2	0	in
Final thickness without allowances	t_s	**1**	in
Required thickness without allowances (UG-28)	t_{1r}	0.5205	in
Required thickness with allowances (UG-28)	t_{1r+}	**0.5205**	in
Outside diameter	D_L	122	in
Tip radius (=D_L/2)	R_L	**61**	in
Buckling length	L_L	240	in

Cone

Design wall thickness	t_2	1	in
Wall thickness allowance	c_1	0	in
Allowance (corrosion)	c_2	0	in
Final thickness without allowances	t_c	**1**	in

Required thickness without allowances (UG-33)	t_{2r}	0.3358	in
Required thickness with allowances (UG-33)	t_{2r+}	**0.3358**	in
Half apex angle (≤ 60°)	α	30	°
Buckling length	L_C	73	in

Stiffening ring

Material K02700-SA-516-70-Class:-Size:			
Spec. Min. Yield	S_y	2.9e+7	psi
Applicable material chart	Fig	CS-2	
Radial distance between the centroid of the stiffening ring and the outer surface of the cylinder	e_1	0	in
Cross sectional area	A_r	0	in²
Moment of inertia	I_r	0	in^4

Results

Equivalent length	M	**134.7**	in
Effective load	F_L	**2064**	lbf/in
Reference area	A_{TL}	**156.5**	in²
Factor	B	**1207**	psi
Factor (see material chart)	A	**8.447e-5**	
Required moment of inertia	I_s	**14.06**	in^4
Required moment of inertia	I'_s	**18.05**	in^4
Length of support	$0.55\cdot\sqrt{(D\cdot t_s)}$	**6.075**	in
Available moment of inertia	I'	**18.15**	in^4

Remark **Stiffening required**

Equations

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

$sin(\alpha)=sin(\alpha)=sin(30°)=0.5$

$tan(\alpha)=tan(\alpha)=tan(30°)=0.5774$

$$R_S=R_L-L_C\cdot\sin(\alpha)=1549\text{ mm}-1854\text{ mm}\cdot 0.5=445\text{ mm}$$

App. 1-8 b-3) Step 1

$$M=\frac{-R_L\cdot\tan(\alpha)}{2}+\frac{L_L}{2}+\frac{RL^2-RS^2}{3\cdot R_L\cdot\tan(\alpha)}=$$

$$\frac{-1549\text{ mm}\cdot 0.5774}{2}+\frac{6096\text{ mm}}{2}+\frac{(1549\text{ mm})^2-(445\text{ mm})^2}{3\cdot 1549\text{ mm}\cdot 0.5774}=3421\text{ mm}$$

App. 1-8 b-3) Step 1

$$F_L=P_0\cdot M+f_1\cdot\tan(\alpha)=$$

$$1.014\text{ bar}\cdot 3421\text{ mm}+25.39\text{ N/mm}\cdot 0.5774=361.4\text{ N/mm}$$

App. 1-8 a)

$$A_{TL}=L_L\cdot\frac{t_s}{2}+L_C\cdot\frac{t_c}{2}+A_s=$$

$$6096\text{ mm}\cdot\frac{25.4\text{ mm}}{2}+1854\text{ mm}\cdot\frac{25.4\text{ mm}}{2}+0\text{ mm}^2=100968\text{ mm}^2$$

App. 1-8 b-3) Step 1

$$B=\frac{3}{4}\cdot\frac{F_L\cdot D_L}{A_{TL}}=\frac{3}{4}\cdot\frac{361.4\text{ N/mm}\cdot 3099\text{ mm}}{100968\text{ mm}^2}=8.32\text{ N/mm}^2$$

App. 1-8 b-3) Step 6

$$I_s=A\cdot D_L^2\cdot\frac{A_{TL}}{14}=8.447\text{e-}5\cdot(3099\text{ mm})^2\cdot\frac{100968\text{ mm}^2}{14}=5850143\text{ mm^4}$$

App. 1-8 b-3) Step 6

$$I'_s = A \cdot D_L^2 \cdot \frac{A_{TL}}{10.9} = 8.447\text{e-}5 \cdot (3099\ \text{mm})^2 \cdot \frac{100968\ \text{mm}^2}{10.9} = 7513945\ \text{mm\^4}$$

$$0.55 \cdot \sqrt{(D \cdot t_s)} = 0.55 \cdot \sqrt{(3099\ \text{mm} \cdot 25.4\ \text{mm})} = 154.3\ \text{mm}$$