

Input Echo, App Y Flange Item 1, Description: brida fondo

Description of Flange Geometry (Type)	Integral Weld Neck		
Design Pressure	P	15.40	bars
Design Temperature		25.00	C
Corrosion Allowance	FCOR	0.0000	mm.
Flange Inside Diameter	B	1360.0000	mm.
Flange Outside Diameter	A	1480.0000	mm.
Flange Thickness	T	40.0000	mm.
Thickness of Hub at Small End	G0	15.0000	mm.
Thickness of Hub at Large End	G1	15.0000	mm.
Length of Hub	HL	10.0000	mm.
Flange Material		SA-240 316Ti	
Flange Material UNS Number		S31635	
Flange Allowable Stress At Temperature	SFO	137.90	N./mm ²
Flange Allowable Stress At Ambient	SFA	137.90	N./mm ²
Bolt Material		SA-574	
Bolt Allowable Stress At Temperature	SBO	233.05	N./mm ²
Bolt Allowable Stress At Ambient	SBA	233.05	N./mm ²
Diameter of Bolt Circle	C	1430.0000	mm.
Nominal Bolt Diameter	DB	14.9356	mm.
Type of Threads	Special,	Root Area	
Root Area of a Single Bolt		1.7520	cm ²
Number of Bolts		125	
Gasket Outside Diameter	GOD	1378.0000	mm.
Gasket Inside Diameter	GID	1368.0000	mm.
Gasket Factor, m,	M	2.1100	
Gasket Design Seating Stress	Y	65.00	N./mm ²
Elastic Modulus of Bolt Material at Des. Temp		201062681	KPa.
Elastic Modulus of Flange Material at Des. Temp		194857530	KPa.

FLANGE ANALYSIS of Identical Flange Pairs Per Appendix Y

Corroded Flange ID,	BCOR = B+2.0*FCOR	1360.000	mm.
Corroded Large Hub,	G1COR = G1-FCOR	15.000	mm.
Corroded Small Hub,	G0COR = G0-FCOR	15.000	mm.
Code R Dimension,	R = (C-B)/2.0 - G1	20.000	mm.
Gasket Contact Width,	N = (GOD-GID) / 2	5.000	mm.
Basic Gasket Width,	B0 = N / 2.0	2.500	mm.
Effective Gasket Width,	BE = B0	2.500	mm.
Gasket Reaction Diameter,	G = (GOD+GID) / 2.0	1373.000	mm.
Radial Contact Dist.,	hcmax = (A - C) / 2	25.000	mm.

Basic Flange and Bolt loads:

Hydrostatic End Load due to Pressure:

$$H = 0.785 * G * G * PEQ$$

$$H = 0.7854 * 1373.0000 * 1373.0000 * 15.4000$$

$$H = 232514. \text{ Kgf}$$

Contact Load on Gasket Surfaces:

$$HP = 2 * BE * PI * G * M * P$$

$$HP = 2 * 2.5000 * 3.1416 * 1373.0000 * 0.0000 * 15.40$$

$$HP = 0. \text{ Kgf}$$

Hydrostatic End Load at Flange ID:

$$HD = 0.785 * Bcor * Bcor * P$$

$$HD = 0.785 * 1360.0000 * 1360.0000 * 15.4000$$

$$HD = 228131. \text{ Kgf}$$

Pressure Force on Flange Face:

$$HT = H - HD$$

$$HT = 232513 - 228131$$

$$HT = 4382. \text{ Kgf}$$

Operating Bolt Load:

$$WM1 = H + HP + HPP$$

$$WM1 = (232513 + 0 + 0)$$

$$WM1 = 232514. \text{ Kgf}$$

Gasket Seating Bolt Load:

$$WM2 = Y * BE * PI * G + Ypart * BEpart * GLPG + HPGY$$

$$WM2 = 0.00 * 2.5000 * 3.141 * 1373.000 + 0.00 * 0.0000 * 0.00$$

$$WM2 = 0. \text{ Kgf}$$

Required Bolt Area:

$$AM = \text{Maximum of } WM1/SBO, WM2/SBA$$

$$AM = \text{Maximum of } 232513 / 233, 0 / 233$$

$$AM = 97.8421 \text{ cm}^2$$

Bolting Information for User Defined Bolts:

Total Area of Bolts, AB 219.000 cm²

Flange Design Bolt Load, Gasket Seating:

$$W = SBA * (AM + AB) / 2.0$$

$$W = 233.05 * (97.8421 + 219.0000) / 2.0$$

$$W = 376474.22 \text{ Kgf}$$

Gasket Seating Force:

$$HG = WM1 - H$$

$$HG = 232513 - 232513$$

$$HG = 0.00 \text{ Kgf}$$

MOMENT ARM CALCULATIONS:

Distance to Hub Large End:

$$R = (C - BCOR) / 2 - G1COR$$

$$R = (1430.000 - 1360.000) / 2 - 15.000$$

$$R = 20.0000 \text{ mm.}$$

Distance to Gasket Load Reaction:

$$DHG = (C - G) / 2.0$$

$$DHG = (1430.0000 - 1373.0000) / 2.0$$

$$DHG = 28.5000 \text{ mm.}$$

Distance to Face Pressure Reaction:

$$\begin{aligned} DHT &= (R + G1COR + DHG) / 2.0 \\ DHT &= (20.0000 + 15.0000 + 28.5000) / 2.0 \\ DHT &= 31.7500 \text{ mm.} \end{aligned}$$

Distance to End Pressure Reaction:

$$\begin{aligned} DHD &= R + (G1COR / 2.0) \\ DHD &= 20.0000 + (15.0000 / 2.0) \\ DHD &= 27.5000 \text{ mm.} \end{aligned}$$

SUMMARY OF MOMENTS FOR INTERNAL PRESSURE:

LOADING		Force	Distance	Bolt Corr	Moment
End Pressure,	MD	228131.	27.5000	1.0000	6274. Kg-m.
Face Pressure,	MT	4382.	31.7500	1.0000	139. Kg-m.
Gasket Load,	MG	0.	28.5000	1.0000	0. Kg-m.
Gasket Seating,	MA	376474.	28.5000	1.0000	10730. Kg-m.

TOTAL MOMENT FOR OPERATION, RMO 6413. Kg-m.
 TOTAL MOMENT FOR GASKET SEATING, RMA 10730. Kg-m.

Effective Hub Length, H0 = SQRT(BCOR*G0COR) 142.829 mm.
 Hub Ratio, HRAT = HL / H0 0.070
 Thickness Ratio, GRAT = (G1COR/G0COR) 1.000

Flange Factors for Integral Flange:

Factor F per 2-7.2 0.909
 Factor V per 2-7.3 0.550
 Factor f per 2-7.6 1.000

Factors from Figure 2-7.1 K = 1.088
 T = 1.881 U = 25.130
 Y = 22.868 Z = 11.854

Stress Analysis of a Class 1 Assembly

Compute the Factor: F'

$$\begin{aligned} &= g0^2 * (h0 + F * T) / V \\ &= 15.0000^2 * (142.8286 + 0.9089 * 40.0000) / 0.5501 \\ &= 4.4724 \end{aligned}$$

Factor: Js

$$\begin{aligned} &= 1/B1 * (2*hd/\beta + hc/a) + pi*rb \\ &= 1/1375.000(2*27.500/1.0200+25.0000/1.0582)+3.14159*0.005685 \\ &= 0.0743 \end{aligned}$$

Factor: Jp

$$\begin{aligned} &= 1/B1 * (hd/\beta + hc/a) + pi*rb \\ &= 1/1375.000(27.500/1.0200+25.0000/1.0582)+3.14159*0.005685 \\ &= 0.0546 \end{aligned}$$

Flange Moment due to Flange-Hub Interaction: Ms

$$= -(J_p * F' * M_p) / (t^3 + J_s * F')$$

$$= -(0.0546 * 4.4724 * 6412.87) / (40.0000 + 0.0743 * 4.4724)$$

$$= -369.8710 \text{ Kg-m.}$$

Slope of the Flange at the ID times E (Elastic Modulus): Ethetab

$$= 5.46 / (\pi * t^3) * (J_s * M_s + J_p * M_p)$$

$$= 5.46 / (3.14159 * 40.0000^3) * (0.0743 * -369.9 + 0.0546 * 6412.87)$$

$$= 86010. \text{ KPa.}$$

Contact Force between Flanges at hc: Hc

$$= (M_p + M_s) / h_c$$

$$= (6412.87 + -369.87) / 25.0000$$

$$= 241715. \text{ Kg}$$

Operating Bolt Load: Wml

$$= H + H_g + H_c$$

$$= 232513.55 + 0.00 + 241715.05$$

$$= 474229. \text{ Kg}$$

Operating Bolt Stress: Sigtab

$$= W_{ml} / A_b$$

$$= 474228.59 / 219.0000$$

$$= 212.3598 \text{ N./mm}^2$$

Design Prestress in the Bolts: Si

$$= \text{Sigtab} - 1.159 * h_c^2 * (M_p + M_s) / (a * t^3 * l * r_e * B_1)$$

$$= 212 - 1.159 * 25.000^2 * (6043) / (1.058 * 40.0000^3 * 94.936 * 94.936)$$

$$= 207.3493 \text{ N./mm}^2$$

Radial Flange Stress at the Bolt Circle: Sr

$$= 6 * (M_p + M_s) / (t^2 * (\pi * C - n * D))$$

$$= 6 * (6412 + -369) / (40.0000^2 * (\pi * 1430.0000 - 125 * 18.1106))$$

$$= 99.7152 \text{ N./mm}^2$$

Radial Flange Stress at the Inside Diameter: SRid

$$= -((2 * F * t) / (h_0 + F * t) + 6) * M_s / (\pi * B_1 * t^2)$$

$$= -((2 * 0.909 * 40.000) / (142.829 + 0.909 * 40.000) + 6) * -369 / (\pi * -369.871)$$

$$= -2.9359 \text{ N./mm}^2$$

Tangential Flange Stress at the Inside Diameter: STid

$$= (t * \text{Ethetab} / B_1) + ((2 * F * t * Z) / (h_0 + F * t) - 1.8) * M_s / (\pi * B_1 * t^2)$$

$$= (40.0000 * 86009.59 / 1375.0000)$$

$$+ ((2 * 0.9089 * 40.0000 * 11.8545) / (142.8286 + 0.9089 * 40.0000) - 1.8) * -369.87 / (\pi * 1375.000 * 40.0000^2)$$

$$= 0.9223 \text{ N./mm}^2$$

Longitudinal Hub Stress: Sh

$$= (h_0 * \text{Ethetab} * f) / ((0.91 * (g_1 / g_0)^2 * B_1 * V))$$

$$= (142.8286 * 86009.6 * 0.909) / ((0.91 * (15.0000 / 15.0000)^2 * 1375.0000 * 1375.0000)$$

$$= 16.2228 \text{ N./mm}^2$$

Summary of Flange Stresses :

	Actual	Allowable
Radial Flange Stress at the Bolt Circle	99.72	137.90 N./mm ²
Tangential Flange Stress at the ID	0.92	137.90 N./mm ²
Radial Flange Stress at the ID	-2.94	137.90 N./mm ²
Longitudinal Hub Stress	16.22	206.85 N./mm ²
Average of Sh and Sr	6.64	137.90 N./mm ²
Average of Sh and St	8.57	137.90 N./mm ²
Bolt Stress	212.36	233.05 N./mm ²

Results for Required Thickness and M.A.W.P.

Minimum Required Flange Thickness	33.4095 mm.
Estimated M.A.W.P.	16.90 bars

Input Echo, App Y Flange Item 2, Description: brida virola

Description of Flange Geometry (Type)	Integral Weld Neck		
Design Pressure	P	15.40	bars
Design Temperature		25.00	C
Corrosion Allowance	FCOR	0.0000	mm.
Flange Inside Diameter	B	1360.0000	mm.
Flange Outside Diameter	A	1480.0000	mm.
Flange Thickness	T	40.0000	mm.
Thickness of Hub at Small End	G0	10.0000	mm.
Thickness of Hub at Large End	G1	10.0000	mm.
Length of Hub	HL	10.0000	mm.
Flange Material		SA-240 316Ti	
Flange Material UNS Number		S31635	
Flange Allowable Stress At Temperature	SFO	137.90	N./mm ²
Flange Allowable Stress At Ambient	SFA	137.90	N./mm ²
Bolt Material		SA-574	
Bolt Allowable Stress At Temperature	SBO	233.05	N./mm ²
Bolt Allowable Stress At Ambient	SBA	233.05	N./mm ²
Diameter of Bolt Circle	C	1430.0000	mm.
Nominal Bolt Diameter	DB	14.9356	mm.
Type of Threads	Special,	Root Area	
Root Area of a Single Bolt		1.7520	cm ²
Number of Bolts		125	
Gasket Outside Diameter	GOD	1378.0000	mm.
Gasket Inside Diameter	GID	1368.0000	mm.
Gasket Factor, m,	M	2.1100	
Gasket Design Seating Stress	Y	65.00	N./mm ²
Elastic Modulus of Bolt Material at Des. Temp		201062681	KPa.
Elastic Modulus of Flange Material at Des. Temp		194857530	KPa.

FLANGE ANALYSIS of Identical Flange Pairs Per Appendix Y

Corroded Flange ID,	BCOR = B+2.0*FCOR	1360.000	mm.
Corroded Large Hub,	G1COR = G1-FCOR	10.000	mm.
Corroded Small Hub,	G0COR = G0-FCOR	10.000	mm.
Code R Dimension,	R = (C-B)/2.0 - G1	25.000	mm.
Gasket Contact Width,	N = (GOD-GID) / 2	5.000	mm.
Basic Gasket Width,	B0 = N / 2.0	2.500	mm.
Effective Gasket Width,	BE = B0	2.500	mm.
Gasket Reaction Diameter,	G = (GOD+GID) / 2.0	1373.000	mm.
Radial Contact Dist.,	hmax = (A - C) / 2	25.000	mm.

Basic Flange and Bolt loads:

Hydrostatic End Load due to Pressure:

$$H = 0.785 * G * G * PEQ$$

$$H = 0.7854 * 1373.0000 * 1373.0000 * 15.4000$$

$$H = 232514. \text{ Kgf}$$

Contact Load on Gasket Surfaces:

$$HP = 2 * BE * PI * G * M * P$$

$$HP = 2 * 2.5000 * 3.1416 * 1373.0000 * 0.0000 * 15.40$$

$$HP = 0. \text{ Kgf}$$

Hydrostatic End Load at Flange ID:

$$HD = 0.785 * Bcor * Bcor * P$$

$$HD = 0.785 * 1360.0000 * 1360.0000 * 15.4000$$

$$HD = 228131. \text{ Kgf}$$

Pressure Force on Flange Face:

$$HT = H - HD$$

$$HT = 232513 - 228131$$

$$HT = 4382. \text{ Kgf}$$

Operating Bolt Load:

$$WM1 = H + HP + HPP$$

$$WM1 = (232513 + 0 + 0)$$

$$WM1 = 232514. \text{ Kgf}$$

Gasket Seating Bolt Load:

$$WM2 = Y * BE * PI * G + Ypart * BEpart * GLPG + HPGY$$

$$WM2 = 0.00 * 2.5000 * 3.141 * 1373.000 + 0.00 * 0.0000 * 0.00$$

$$WM2 = 0. \text{ Kgf}$$

Required Bolt Area:

$$AM = \text{Maximum of } WM1/SBO, WM2/SBA$$

$$AM = \text{Maximum of } 232513 / 233, 0 / 233$$

$$AM = 97.8421 \text{ cm}^2$$

Bolting Information for User Defined Bolts:

Total Area of Bolts, AB 219.000 cm²

Flange Design Bolt Load, Gasket Seating:

$$W = SBA * (AM + AB) / 2.0$$

$$W = 233.05 * (97.8421 + 219.0000) / 2.0$$

$$W = 376474.22 \text{ Kgf}$$

Gasket Seating Force:

$$HG = WM1 - H$$

$$HG = 232513 - 232513$$

$$HG = 0.00 \text{ Kgf}$$

MOMENT ARM CALCULATIONS:

Distance to Hub Large End:

$$R = (C - BCOR) / 2 - G1COR$$

$$R = (1430.000 - 1360.000) / 2 - 10.000$$

$$R = 25.0000 \text{ mm.}$$

Distance to Gasket Load Reaction:

$$DHG = (C - G) / 2.0$$

$$DHG = (1430.0000 - 1373.0000) / 2.0$$

$$DHG = 28.5000 \text{ mm.}$$

Distance to Face Pressure Reaction:

$$\begin{aligned} \text{DHT} &= (R + \text{G1COR} + \text{DHG}) / 2.0 \\ \text{DHT} &= (25.0000 + 10.0000 + 28.5000) / 2.0 \\ \text{DHT} &= 31.7500 \text{ mm.} \end{aligned}$$

Distance to End Pressure Reaction:

$$\begin{aligned} \text{DHD} &= R + (\text{G1COR} / 2.0) \\ \text{DHD} &= 25.0000 + (10.0000 / 2.0) \\ \text{DHD} &= 30.0000 \text{ mm.} \end{aligned}$$

SUMMARY OF MOMENTS FOR INTERNAL PRESSURE:

LOADING		Force	Distance	Bolt Corr	Moment
End Pressure,	MD	228131.	30.0000	1.0000	6844. Kg-m.
Face Pressure,	MT	4382.	31.7500	1.0000	139. Kg-m.
Gasket Load,	MG	0.	28.5000	1.0000	0. Kg-m.
Gasket Seating,	MA	376474.	28.5000	1.0000	10730. Kg-m.

TOTAL MOMENT FOR OPERATION, RMO 6983. Kg-m.
 TOTAL MOMENT FOR GASKET SEATING, RMA 10730. Kg-m.

Effective Hub Length, H0 = SQRT(BCOR*G0COR) 116.619 mm.
 Hub Ratio, HRAT = HL / H0 0.086
 Thickness Ratio, GRAT = (G1COR/G0COR) 1.000

Flange Factors for Integral Flange:

Factor F per 2-7.2 0.909
 Factor V per 2-7.3 0.550
 Factor f per 2-7.6 1.000

Factors from Figure 2-7.1 K = 1.088
 T = 1.881 U = 25.130
 Y = 22.868 Z = 11.854

Stress Analysis of a Class 1 Assembly

Compute the Factor: F'

$$\begin{aligned} &= g0^2 * (h0 + F * T) / V \\ &= 10.0000^2 * (116.6190 + 0.9089 * 40.0000) / 0.5501 \\ &= 1.6970 \end{aligned}$$

Factor: Js

$$\begin{aligned} &= 1/B1 * (2*hd/\beta + hc/a) + pi*rb \\ &= 1/1370.000(2*30.000/1.0219+25.0000/1.0620)+3.14159*0.005685 \\ &= 0.0779 \end{aligned}$$

Factor: Jp

$$\begin{aligned} &= 1/B1 * (hd/\beta + hc/a) + pi*rb \\ &= 1/1370.000(30.000/1.0219+25.0000/1.0620)+3.14159*0.005685 \\ &= 0.0565 \end{aligned}$$

Flange Moment due to Flange-Hub Interaction: Ms

$$= -(J_p * F' * M_p) / (t^3 + J_s * F')$$

$$= -(0.0565 * 1.6970 * 6983.21) / (40.0000 + 0.0779 * 1.6970)$$

$$= -165.7339 \text{ Kg-m.}$$

Slope of the Flange at the ID times E (Elastic Modulus): Ethetab

$$= 5.46 / (\pi * t^3) * (J_s * M_s + J_p * M_p)$$

$$= 5.46 / (3.14159 * 40.0000^3) * (0.0779 * -165.7 + 0.0565 * 6983.21)$$

$$= 101571. \text{ KPa.}$$

Contact Force between Flanges at hc: Hc

$$= (M_p + M_s) / h_c$$

$$= (6983.21 + -165.73) / 25.0000$$

$$= 272693. \text{ Kgf}$$

Operating Bolt Load: Wml

$$= H + H_g + H_c$$

$$= 232513.55 + 0.00 + 272693.47$$

$$= 505207. \text{ Kgf}$$

Operating Bolt Stress: Sigtab

$$= W_{ml} / A_b$$

$$= 505207.03 / 219.0000$$

$$= 226.2320 \text{ N./mm}^2$$

Design Prestress in the Bolts: Si

$$= \text{Sigtab} - 1.159 * h_c^2 * (M_p + M_s) / (a * t^3 * l * r_e * B_1)$$

$$= 226 - 1.159 * 25.000^2 * (6817) / (1.062 * 40.0000^3 * 94.936 * 94.936)$$

$$= 220.5793 \text{ N./mm}^2$$

Radial Flange Stress at the Bolt Circle: Sr

$$= 6 * (M_p + M_s) / (t^2 * (\pi * C - n * D))$$

$$= 6 * (6983 + -165) / (40.0000^2 * (\pi * 1430.0000 - 125 * 18.1106))$$

$$= 112.4948 \text{ N./mm}^2$$

Radial Flange Stress at the Inside Diameter: SRid

$$= -((2 * F * t) / (h_0 + F * t) + 6) * M_s / (\pi * B_1 * t^2)$$

$$= -((2 * 0.909 * 40.000) / (116.619 + 0.909 * 40.000) + 6) * -165 / (\pi * -165.734)$$

$$= -1.3039 \text{ N./mm}^2$$

Tangential Flange Stress at the Inside Diameter: STid

$$= (t * E_{thetab} / B_1) + ((2 * F * t * Z) / (h_0 + F * t) - 1.8) * M_s / (\pi * B_1 * t^2)$$

$$= (40.0000 * 101571.12 / 1370.0000)$$

$$+ ((2 * 0.9089 * 40.0000 * 11.8545) / (116.6190 + 0.9089 * 40.0000) - 1.8) * -165.73 / (\pi * 1370.000 * 40.0000^2)$$

$$= 2.0607 \text{ N./mm}^2$$

Longitudinal Hub Stress: Sh

$$= (h_0 * E_{thetab} * f) / ((0.91 * (g_1 / g_0)^2 * B_1 * V))$$

$$= (116.6190 * 101571.1 * 0.909) / ((0.91 * (10.0000 / 10.0000)^2 * 1370.0000 * 1370.0000)$$

$$= 15.6995 \text{ N./mm}^2$$

Summary of Flange Stresses :

	Actual	Allowable
Radial Flange Stress at the Bolt Circle	112.49	137.90 N./mm ²
Tangential Flange Stress at the ID	2.06	137.90 N./mm ²
Radial Flange Stress at the ID	-1.30	137.90 N./mm ²
Longitudinal Hub Stress	15.70	206.85 N./mm ²
Average of Sh and Sr	7.20	137.90 N./mm ²
Average of Sh and St	8.88	137.90 N./mm ²
Bolt Stress	226.23	233.05 N./mm ²

Results for Required Thickness and M.A.W.P.

Minimum Required Flange Thickness	35.9854 mm.
Estimated M.A.W.P.	15.86 bars

PVElite 5.00 Licensee:

FileName : Appy REV 02_02_12 caso tornillo 233 MPa----- Page 11
Vessel Results Summary Item: 1 11:13p Feb 1,2013

Appendix Y Results For : brida fondo

Minimum Required Flange Thickness	33.4095	mm.
Estimated M.A.W.P.	16.90	bars

Appendix Y Results For : brida virola

Minimum Required Flange Thickness	35.9854	mm.
Estimated M.A.W.P.	15.86	bars

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Table of Contents

Y Flg Analysis	: brida fondo		1
Y Flg Analysis	: brida virola		6
Vessel Results	Summary		11