

Flange Input Data Values

Description: BELLOW FLG.2 :

BELLOW FLG.2

Description of Flange Geometry (Type)		Integral Weld Neck
Description of Flange Analysis	Partial, Thickness	
Design Pressure	P	39.55 kgf/cm ²
Design Temperature		420 C
Internal Corrosion Allowance	ci	3.0000 mm
External Corrosion Allowance	ce	3.0000 mm
Use Corrosion Allowance in Thickness Calcs.		Yes
Flange Inside Diameter	B	559.600 mm
Flange Outside Diameter	A	820.000 mm
Flange Thickness	t	62.0000 mm
Thickness of Hub at Small End	go	48.0000 mm
Thickness of Hub at Large End	g1	48.0000 mm
Length of Hub	h	72.0000 mm
Flange Material		SA-336 F11
Flange Allowable Stress At Temperature	Sfo	1358.38 kgf/cm ²
Flange Allowable Stress At Ambient	Sfa	1406.14 kgf/cm ²
Bolt Material		SA-193 B16
Bolt Allowable Stress At Temperature	Sb	1757.68 kgf/cm ²
Bolt Allowable Stress At Ambient	Sa	1757.68 kgf/cm ²
Diameter of Bolt Circle	C	659.000 mm
Nominal Bolt Diameter	dB	20.0000 mm
Type of Threads		TEMA Metric
Number of Bolts		28
Flange Face Outside Diameter	Fod	779.000 mm
Flange Face Inside Diameter	Fid	719.000 mm
Flange Facing Sketch	9, Code	Sketch 6
Gasket Outside Diameter	Go	777.880 mm
Gasket Inside Diameter	Gi	720.720 mm
Gasket Factor	m	6.5000
Gasket Design Seating Stress	y	1827.98 kgf/cm ²
Column for Gasket Seating	1, Code	Column I
Gasket Thickness	tg	34.9300 mm
Flange Face Nubbin Width	w	19.8100 mm

ASME Code, Section VIII, Division 1, 2007

Hub Small End Required Thickness due to Internal Pressure:

$$\begin{aligned}
 &= (P*(D/2+Ca))/(S*E-0.6*P) \text{ per UG-27 (c)(1)} \\
 &= (39.55*(559.6000/2+3.0000))/(1358.38*1.00-0.6*39.55)+Ca \\
 &= 14.3805 \text{ mm}
 \end{aligned}$$

Distance to Full Face Gasket ID Centroid hg	-15.660 mm
Distance to Full Face Gasket OD Centroid h'g	30.540 mm

Corroded Flange Thickness, tc = T-Fcor	56.000 mm
Corroded Flange ID, Bcor = B+2*Fcor	565.600 mm
Corroded Large Hub, g1Cor = g1-Fcor	45.000 mm
Corroded Small Hub, g0Cor = go-Fcor	45.000 mm
Code R Dimension, R = ((C-Bcor)/2)-g1cor	4.700 mm

Basic Gasket Width, bo = Full Face	2.476 mm
Effective Gasket Width, b = (C-Gi) / 4	-15.430 mm

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Flange Calculations BELLOW FLG.2 Flng: 11 3:51a Dec 23,2008

Gasket Reaction Diameter, $G = C - 2 * HG$ 690.320 mm

Note: The gasket extends beyond the Bolt circle diameter, this flange will be designed as a full face flange per Taylor Forge bulletin 502.

Basic Flange and Bolt Loads:

Hydrostatic End Load due to Pressure [H]:

$$= 0.785 * G^2 * P_{eq}$$

$$= 0.785 * 690.3201^2 * 39.551$$

$$= 148028.219 \text{ kgf}$$

Contact Load on Gasket Surfaces [Hp]:

$$= 2 * b * P_i * G * m * P +$$

$$= 2 * -15.4300 * 3.1416 * 690.3201 * 6.5000 * 39.55$$

$$= -172053.328 \text{ kgf}$$

Full Face ID Gasket Compression [H'p]:

$$= H_p * h_g / h'_g$$

$$= (-172053 * -15.6601 / 30.5396)$$

$$= 88225.266 \text{ kgf}$$

Full Face ID Pressure Load [H'GY]:

$$= b * P_i * G * y * h_g / h'_g$$

$$= -15.4300 * 3.1416 * 690.3201 * 1827 * -15.6601 / 30.5396$$

$$= 313665.594 \text{ kgf}$$

Hydrostatic End Load at Flange ID [Hd]:

$$= P_i * B_{cor}^2 * P / 4$$

$$= 3.1416 * 565.6000^2 * 39.5507 / 4$$

$$= 99371.602 \text{ kgf}$$

Pressure Force on Flange Face [Ht]:

$$= H - H_d$$

$$= 148028 - 99371$$

$$= 48656.617 \text{ kgf}$$

Operating Bolt Load [Wm1]:

$$= \max(H + H_p + H'p, 0)$$

$$= \max(148028 + -172053 + 88225, 0)$$

$$= 64200.156 \text{ kgf}$$

Gasket Seating Bolt Load [Wm2]:

$$= y * b * P_i * G + y_{Part} * b_{Part} * l_p + H'GY$$

$$= 1827.98 * -15.4300 * 3.1416 * 690.320 + 0.00 * 0.0000 * 0.00 + 313665.59$$

$$= -298032.281 \text{ kgf}$$

$$= 0.000 \text{ kgf, Mating Flange Load Governs}$$

Required Bolt Area [Am]:

$$= \text{Maximum of } Wm1/S_b, Wm2/S_a$$

$$= \text{Maximum of } 64200 / 1757, 0 / 1757$$

$$= 36.526 \text{ cm}^2$$

Bolting Information for TEMA Metric Thread Series (Non Mandatory):

	Minimum	Actual	Maximum
Bolt Area, cm ²	36.526	60.774	
Radial distance bet. hub and bolts	31.750	1.700	
Radial distance bet. bolts and the edge	23.810	77.500	
Circumferential spacing between bolts	52.390	73.785	90.571

Min. Gasket Contact Width (Brownell Young) [Not an ASME Calc] [Nmin]:

$$= A_b * S_a / (y * P_i * (G_o + G_i))$$

$$= 60.774 * 1757.68 / (1827.98 * 3.14 * (777.880 + 720.72))$$

$$= 1.241 \text{ mm}$$

Flange Design Bolt Load, Gasket Seating [W]:

$$= S_b * A_b$$

$$= 1757.68 * 60.7743$$

$$= 106821.28 \text{ kgf}$$

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Gasket Seating Force [HG]:

$$= W - H$$

$$= 106821 - 148028$$

$$= -41206.93 \text{ kgf}$$

Moment Arm Calculations:

Distance to Gasket Load Reaction [hg]:

$$= (C - G_i) * (2 * G_i + C) / (6 * (G_i + C))$$

$$= (659.000 - 720.720) * (2 * 720.720 + 659.000) /$$

$$(6 * (720.720 + 659.000))$$

$$= -15.6601 \text{ mm}$$

Reverse Moment arm[h'g]:

$$= hg * h'g / (hg + h'g)$$

$$= -15.6601 * 30.5396 / (-15.6601 + 30.5396)$$

$$= -32.1416 \text{ mm}$$

Distance to Face Pressure Reaction [ht]:

$$= (R + g1Cor + hg) / 2.0$$

$$= (1.7000 + 45.0000 + -15.6601) / 2.0$$

$$= 15.5200 \text{ mm}$$

Distance to End Pressure Reaction [hd]:

$$= R + g1Cor$$

$$= 1.7000 + 45.0000$$

$$= 46.7000 \text{ mm}$$

Summary of Moments for Internal Pressure:

Loading	Force	Distance	Bolt Corr	Moment
End Pressure, Md	99372.	46.7000	1.0000	4641. kgf-m.
Face Pressure, Mt	48657.	15.5200	1.0000	755. kgf-m.
Gasket Load, Mg	0.	0.0000	1.0000	0. kgf-m.
Gasket Seating, Matm	106821.	-15.6601	1.0000	-1673. kgf-m.
Full Face Load, Mr	-41207.	-32.1416	1.0000	1324. kgf-m.

Total Moment for Operation, Mop 5396. kgf-m.
Total Moment for Gasket seating, Matm -1673. kgf-m.

Effective Hub Length, $h_0 = \sqrt{Bcor * goCor}$ 154.127 mm
Hub Ratio, $h/h_0 = HL / H_0$ 0.467
Thickness Ratio, $g1/g_0 = (g1Cor/goCor)$ 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 = 1.439
T = 1.737 U = 6.046
Y = 5.502 Z = 2.867
d = .29880E+07 mm³ e = 0.0059 mm⁻¹
Stress Factors ALPHA = 1.348
BETA = 1.464 GAMMA = 0.776
DELTA = 0.069 Lamda = 0.845

Longitudinal Hub Stress, Operating [SHo]:

$$= (f * Mop / Bcor) / (L * g1^2)$$

$$= (1.0000 * 5395 / 565.6000) / (0.8447 * 42.0000^2)$$

$$= 640.26 \text{ kgf/cm}^2$$

Radial Flange Stress, Operating [SRo]:

$$= (Beta * Mop / Bcor) / (L * t^2)$$

$$= (1.4639 * 5395 / 565.6000) / (0.8447 * 56.0000^2)$$

$$= 527.23 \text{ kgf/cm}^2$$

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Tangential Flange Stress, Operating [STo]:

$$= (Y * Mo / (t^2 * Bcor)) - Z * SRO$$

$$= (5.5016 * 5395 / (56.0000^2 * 565.6000)) - 2.8670 * 527$$

$$= 162.08 \text{ kgf/cm}^2$$

Average Flange Stress, Operating [SAo]:

$$= (SHo + \max(SRO, STo)) / 2$$

$$= (640 + \max(527, 162)) / 2$$

$$= 583.75 \text{ kgf/cm}^2$$

Bolt Stress, Operating [BSO]:

$$= (Wm1 / Ab)$$

$$= (64200 / 60.7743)$$

$$= 1056.37 \text{ kgf/cm}^2$$

Bolt Stress, Seating [BSa]:

$$= (Wm2 / Ab)$$

$$= (0 / 60.7743)$$

$$= 0.00 \text{ kgf/cm}^2$$

Radial Stress at Bolt Circle, Full Face Gaskets, Operating [SFO]:

$$= 6 * MR / (t^2 * (Pi * C - n * dB))$$

$$= 6 * 1324 /$$

$$(56.0000^2 * (3.1416 * 659.0000 - 28 * 20.0000))$$

$$= 167.78 \text{ kgf/cm}^2$$

Stress Computation Results:

	Operating		Gasket Seating	
	Actual	Allowed	Actual	Allowed
Longitudinal Hub	640.	2038.	0.	2109. kgf/cm ²
Radial Flange	527.	1358.	0.	1406. kgf/cm ²
Tangential Flange	162.	1358.	0.	1406. kgf/cm ²
Maximum Average	584.	1358.	0.	1406. kgf/cm ²
Bolting	1056.	1758.	0.	1758. kgf/cm ²
Full Faced Gasket	168.	1358.	0.	1406. kgf/cm ²

Minimum Required Flange Thickness

41.885 mm

Estimated M.A.W.P. (Operating)

65.8 kgf/cm²

Estimated Finished Weight of Flange at given Thk.

186.7 kgm

Estimated Unfinished Weight of Forging at given Thk

293.0 kgm

Minimum Design Metal Temperature Results:

Min Metal Temp. w/o impact per UCS-66

16 C

Min Metal Temp. at Rqd thickness (UCS 66.1)[rat 0.60]

-6 C

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