Design Pressure : 2.5 MPa

Design Temperature : 200°C

Gasket Material : Asbestos with 1.6 mm thickness

Shell I.D. = 1.5 m

Allowable stress for shell and flange material = 100 MPa

" " " bolting Material = 138 MPa

Hub Thickness = 12 mm

Weld Joint Efficiency = 0.85

Dist. b/w gasket and outer shell surface = 6 mm

$m = 2.75$, $y = 25.5$ MPa

$$\frac{d_o}{d_i} = \sqrt{\frac{25.5 - 2.5 \times 2.75}{25.5 - 2.5 \times 2.75}} = 1.075$$

Let shell thickness be g_o

$$g_o = \frac{2.5\,(1.5 + g_o + 0.002)}{2 \times 100 \times 0.85 + 2.5} \Rightarrow g_o = 0.022\,m$$

$\therefore$ $g_o + 0.002 = 0.024$ m , next higher thickness is 0.025 m

Shell OD = $1.5 + 2 \times 0.025 = 1.55$ m

$d_i = 1.55 + 2 \times 0.006 = 1.562\ m$ ($\because$ gasket is 6 mm away from outer surface)

$\therefore\ d_o = 1.075 \times 1.562 = 1.679\ m$

Min. gasket width $= \dfrac{1.679 - 1.562}{2} = 0.0585$

$\therefore$ Gasket width of $0.058\ m$ is selected and $d_o = 1.678\ m$

Basic gasket seating width $= b_o = \dfrac{0.058}{2} = 29\ mm$

$\because\ b_o > 6.3\ mm,\ b = 2.5\sqrt{b_o} = 13.58\ mm$

$\therefore$ Diam. at locat^n of gasket load reaction $(G) = 1.678 - 2 \times 0.0135$

$= 1.651\ m\ (d_o - 2b)$

Load due to design pressure $= \dfrac{\pi G^2}{4} \cdot p = 5.35\ MN$

Load to keep joint tight $= \pi G (2b) mp$

$= \pi \times 1.651 \times 0.027 \times 0.85 \times 2.5$

$= 0.3\ MN$

Total Operating Load $= W_o = H_o + H_p = 5.35 + 0.3$

$= 5.65\ MN$

Bolt load under bolting up condition $= \pi G b y\ (W_g)$

$= \pi \times 1.651 \times 0.0135 \times 25.5$

$= 1.78\ MN$

Min. bolting Area $= \dfrac{5.65}{138} = 0.041\ m^2$

Selectⁿ of bolts :-

i) $M18 \times 2$:-

Root area $= \dfrac{\pi}{4}(18 - 2\times2)^2 \times 10^{-1} = 0.154 \times 10^{-3}\ m^2$

$n = \dfrac{0.041}{0.154 \times 10^{-3}} = 266.2$, Actual $n = 268$ (multiple of 4)

$$C_1 = 1.55 + 2(0.012 + 0.027) = 1.628 \text{ mm}$$

$$C_2 = \frac{268 \times 0.075}{\pi} = 6.4 \text{ mm}$$

Not Selected

Similarly computing for all the other bolts, we find that,

in case of M33 x 2

$\boxed{\text{Bolt circle diameter} = 1.668 \text{ m}}$

C from geometrical considerat^n's = 1.564 m

closest in this case, hence we use M33x2 bolts.

$$\text{min. no. of bolts} = \left(\frac{\pi}{4}(33 - 2\times 2)^2 \times 10^{-6}\right)^{-1} \times 0.041$$

$$= 62.07$$

∴ Actual no. of bolts = $\boxed{64 \text{ (multiple of 4)}}$

$\therefore$ Flange outside diameter = C + bolt diameter + t_c

$= 1.668 + 0.033 + 0.02$

$\boxed{= 1.721 \text{ m}}$