Design Pressure = Max. Op. Press x 1.05 = P

Nominal Dia. = O.D. = D_o

Design Stress = f

Weld Joint Efficiency = J

Finding Vessel Thickness

Theoretical Thickness = $t_{th} = \dfrac{P D_o}{2fJ + P}$

Total Thickness = $t = t_{th} + t_c$ (2mm)

t_s = Next Standard thickness.

Calculating Head Thickness

$t_{flat} > t_{tori} > t_{ellip} > t_{hemis}$

Flat Head

$t_{th} = C D_i \sqrt{P/f}$

$D_i = D_o - 2t_s$

C: for flanged flat head butt-welded to shell

$t = 1.06 (t_{th} + 2)$ mm

1.06: 6% Allowance for

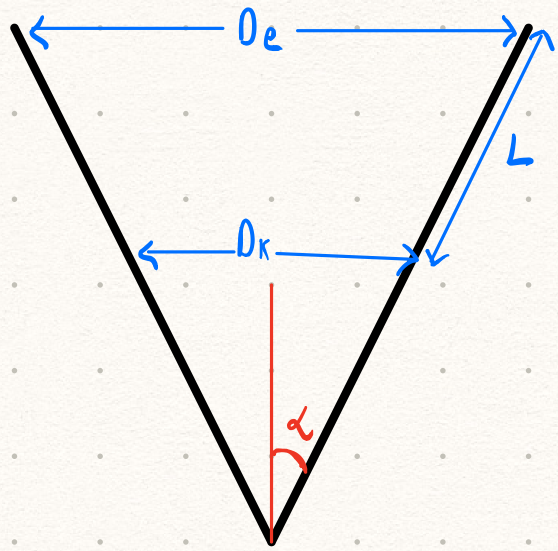
Next standard thickness

Conical Head

Near the junction

$$t_{th} = \frac{p D_o Z}{2 f J}$$ $\{Z = 2.05$ for 45° apex angle

$t_1 = (t_{th} + 2)$ mm
Next standard thickness



Away from junctⁿ

$$t_{th} = \frac{P D_K}{2fJ - P} \times \frac{1}{\cos\alpha}$$

Max. Internal Dia. of cone at 'L' dist.

$(D_o - 2t_s)$

$$L = \frac{1}{2}\left(\frac{D_o t_{th}}{\cos\alpha}\right)^{1/2}$$

$t_2 = (t_{th} + 2)$ mm
Next standard

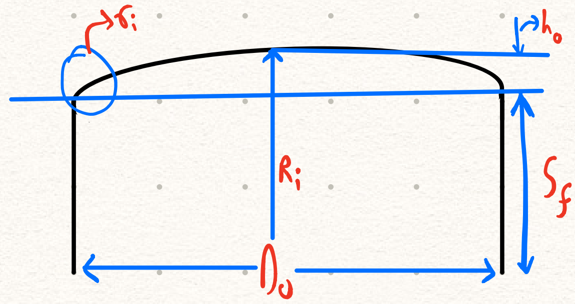
Ans = t_2 till 'L' mm & t_1 for the rest.
from base of cone

Tropospherical Head

R_i = Inner radii of curvature

$R_i = \boxed{R_o = D_o} =$ nominal dia of the shell

r_i = Inner rad. of curvature of Torous corner



$$t_{th} = \frac{P D_o C}{2 f J}$$

stress conc. factor

$$h_o = R_o - \left[\left(R_o - \frac{D_o}{2}\right)\left(R_o + \frac{D_o}{2} - 2 r_o\right)\right]^{1/2}$$

$r_o \rightarrow 0{\cdot}05 \times D_o$

h_E = effective ht. = least of $\left[h_o, \frac{D_o^2}{4R_o}, \sqrt{\frac{D_o r_o}{2}}\right]$

Find $\frac{h_E}{D_o}$ → Find $\frac{t_{th}}{D_o C}$ from the eq^n

From the table of C find the correct $\frac{h_E}{D_o}$ value using interpolat^n if necessary.

	t/D_o				
h_E/D_o	0.002	0.005	0.01	0.02	0.04
0.15	4.35	2.66	2.15	1.95	1.75
0.16	4.1	2.468	2.01	1.842	1.664
0.20	2.30	1.7	1.45	1.37	1.32

C Values

Now make table for t/D_oC Vs C

t/D_oC	0.00048	0.00202	0.00497	0.01085	0.02404
C	4.1	2.468	2.01	1.842	1.664

Interpolate to find the correct c value.

$$t_{th} = D_o \cdot C$$

$$t = (t_{th} + 2)\ \text{mm}$$

Next Standard

Ellipsoidal Head

Procedure same as torospherical

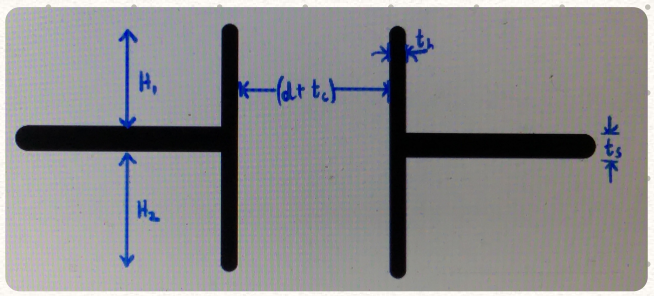
Just 2:1 Ellipsoid $\Rightarrow \frac{h_E}{D_o} = 0.25$

Hemispherical Head

$$\boxed{\frac{h_E}{D_o} = 0.5}$$

Calculat^n of Area Of Compensat^n

Given: D_o, P, f, J



Nozzle O.D. = d_o

H_1

t_c = 2mm → Corrosion Allowance

Find vessel thickness

$$t_r = \frac{P D_o}{2fJ + P} + t_c \ (2\,mm)$$

t_s = Next Standard

Nozzle thickness = $t_r' = \dfrac{P d_o}{2fJ + P} + t_c$ (2 mm)

t_n = Next standard

$$d = (d_o - 2t_n)$$

$$A = (d + 2t_c)t_r$$ (Area removed due to opening)

$$A' = A_s + A_n$$ (Area available for compensat^n)

A_s → Area available from shell

A_n → Area available from nozzle

$$A_s = (d + 2c)(t_s - t_r - t_c)$$

$$A_n = \underbrace{A_o + A_i}_{\boxed{\text{Inside}} + \text{Outside}}$$

Inside → $A_i = 0$ if inside protrussion is ignored

$$A_o = 2H_1(t_n - t_r' - t_c)$$

$$A_i = 2H_2(t_n - 2t_c)$$

$2t_c$ → Since it corrodes from 2 sides

→ $t_r' = 0$ for A_i since no press. diff. across the wall of nozzle.

Outside Nozzle Length

If actual nozzle length outside the vessel $> H_1$, then

$$H_1 = \sqrt{(d + t_c)(t_n - t_c)}$$ = Boundary Limit

otherwise $= H_1$

Inside Nozzle Length

If inside length of nozzle $> H_2$

$$H_2 = \sqrt{(d+2c)(t_n - 2t_c)}$$

If $A_s + A_n \geq A$ then no external reinforcement is necessary

If $A_s + A_n < A$

Then $A_r =$ Area of ring pad within boundary limit

$$= A - (A_s + A_n)$$

$$A_r = \{ \underbrace{2(d+t_c)}_{\text{Boundary Limit}} - \underbrace{(d+2t_n)}_{\text{OD of nozzle}} \} t_p$$

$t_n \rightarrow$ Actual Nozzle thickness

ID of Ring Pad: OD of nozzle

OD of Ring Pad: outer edge of boundary limit $2(d+t_c)$

Flange Calculation