Suppor Design of Tall vessels

Vessel Height (H) = 25m

Max. Operating Pressure (P_0) = 2 MPa

Design Pressure = $(1.05) P_0$

= 2.1 MPa

t_a = 28 mm

Corrodded Shell Thickness = 25 mm

Vessel ID = 2m

γ_s = 7.7×10^9 N/m²

$W_{min} = \pi (D_i + t_a) t_a H \gamma_s$

$= \pi (2 + 28 \times 10^{-3})(28 \times 10^{-3})(25)(7.7 \times 10^4)$

$= 343.404$ kN

W_t = Weight of water = $\frac{\pi D_i^2}{4} \times h_{shell} \times g \times \rho_w$

$= \frac{\pi}{4} \times 2^2 \times 25 \times 9.81 \times 1000$

$= 770.475$ kN

$W_{max} = W_{min} + W_t$

$= 343.404 + 770.475$

$= 1113.879$ kN

Scanned with CamScanner

$$T_{min} = 6.35 \times 10^{-5} \times \left(\frac{H}{D}\right)^{3/2} \times \left(\frac{W_{min}}{t}\right)^{1/2}$$

$$= 6.35 \times 10^{-5} \times \left(\frac{25+5}{2}\right)^{3/2} \left(\frac{334.404}{0.026}\right)^{1/2}$$

$$= 0.418\ s < 0.5\ s$$

Since $T_{min} < 0.5s$, $k_1 = 1$

$$T_{max} = 6.35 \times 10^{-5} \times \left(\frac{H}{D}\right)^{3/2} \times \left(\frac{W_{max}}{t}\right)^{1/2}$$

$$= 6.35 \times 10^{-5} \times \left(\frac{25+5}{2}\right)^{3/2} \times \left(\frac{1113.879}{0.026}\right)^{1/2}$$

$$= 0.764\ s > 0.5\ s$$

Since $T_{max} > 0.5s$, $k_2 = 2$

$$P_w = k_1 k_2 P_w H D$$

$$P_{w(min)} = 0.7 \times 1 \times (0.05 \times 150^2) \times \overset{D_i}{2} \times 30$$
$$= 47.25\ kN$$

$$P_{w(max)} = 0.7 \times 2 \times (0.05 \times 150^2) \times 2.056 \times 30$$
$$= 97.15\ kN$$

$$N_{w(min)} = P_{w(min)} \times \frac{h}{2}$$

$$= 47.25 \times \frac{30}{2} = 708.75 \text{ kNm}$$

$$N_{w(max)} = P_{w(max)} \times \frac{h}{2}$$

$$= 97.15 \times \frac{30}{2} = 1457.25 \text{ kNm}$$

$$\sigma_{zwm(min)} = \frac{4 M_{w(min)}}{\pi D^2 t} = \frac{4 \times 708.75}{\pi \times 2^2 \times t}$$

$$= \frac{225.602}{t} \text{ kPa}$$

$$\sigma_{z\,wm(max)} = \frac{4 M_{w(max)}}{\pi D^2 t} = \frac{4 \times 1457.25}{\pi \times 2^2 \times t}$$

$$= \frac{463.86}{t} \text{ kPa}$$

$$\sigma_{z(min)} = \frac{W_{min}}{\pi D_o t} = \frac{343.404}{\pi \times 2 \times t}$$

$$= \frac{54.65}{t} \text{ kPa}$$

$$\sigma_{z(max)} = \frac{W_{max}}{\pi D_o t} = \frac{1113.879}{\pi \times 2 \times t}$$

$$= \frac{177.28}{t} \text{ kPa}$$

$$\sigma_{zsm\,(max)} = \frac{4M_s}{\pi D^2 t} = \frac{362 \cdot 8}{t} \text{ kPa}$$

Max Tensile Strength

$$\sigma_z = \sigma_{zwm\,(max)} + \sigma_{zsm\,(max)} - \sigma_{zw\,(min)}$$

$$= \frac{463 \cdot 86}{t} + \frac{362 \cdot 8}{t} - \frac{54 \cdot 65}{t} \quad - (1)$$

WKT, $\sigma_z = fJ$

$$= 0 \cdot 85 \times 100 \times 10^3$$

$$= 85 \times 10^3 \text{ kPa} \quad - (2)$$

From (1) and (2)

$$\frac{463 \cdot 86}{t} + \frac{362 \cdot 8}{t} - \frac{54 \cdot 65}{t} = 85 \times 10^3$$

$$\frac{772 \cdot 01}{t} = 85 \times 10^3$$

$$\Rightarrow t = 9 \cdot 083 \text{ mm}$$

Maximum Compressible stress

$$\sigma_z = \sigma_{zwm(max)} + \sigma_{zsm(max)} + \sigma_{zw(max)}$$

$$= \frac{463.86}{t} + \frac{362.8}{t} + \frac{177.28}{t}$$

WKT, $\sigma_z = \frac{0.125\, E t}{D_o}$

$$= \frac{0.125 \times 2 \times 10^5 \times t \times 10^6}{2}$$

$$\frac{463.86}{t} + \frac{362.8}{t} + \frac{177.28}{t} = 0.125 \times 10^{11}$$

$$\therefore t = 8.461 \text{ mm}$$

$\therefore$ Skirt Thickness = 9.08[illegible] mm

Actual skirt thickness = (9.088 + 2) mm
= 11.083 mm

Standard skirt Thickness (near highest) available is 12mm