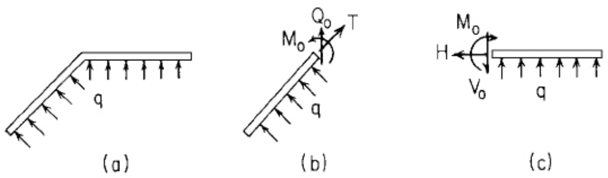
Buffer Tank 001

===== **INPUT** ===

Stresses at junction between conical and cylindrical shell due to an internal pressure.

Based upon chapter 13.4 within "Roarks Formulas for Stress and Strain", 7th Ed.

Cylindrical shell - mean radius [m] $R_{cyl} := \frac{3515}{2 \cdot 1000}$



Cylindrical shell - thickness [m] $t_{cyl} := 0.015$

Conical shell - thickness [m] $t_{con} := 0.018$

Youngs modulus at design temperature (EN 13445-3 Annex O) [N/m^2] $E := 2.02905 \cdot 10^{11}$

Half angle at the apex of the cone [rad] $\alpha := 75 \cdot \frac{\pi}{180}$

Poissons ratio [-] $\nu := 0.3$

1.5 bar design pressure + internal hydrostatic pressure
(ρ=1300 kg/m^3 ; g=9.81 m/s^2 ; h=4.841 m ; q=$\rho \cdot g \cdot h$) [N/m^2] $q := 2.1174 \cdot 10^5$

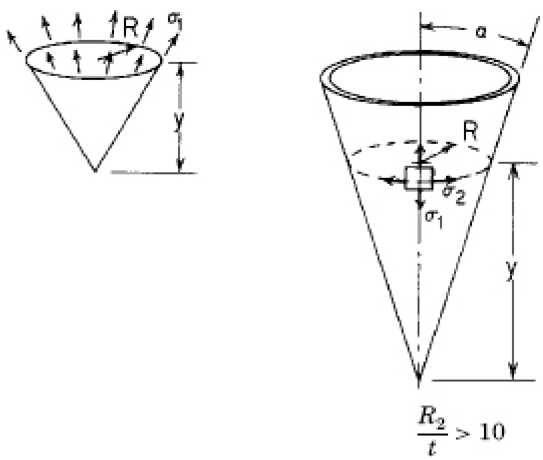
Design stress acc. EN13445-3, P265GH @ 143° C (t <= 16 mm) [N/m^2] $f_1 := 150.35 \cdot 10^6$

Design stress acc. EN13445-3, P265GH @ 143° C (t > 16 mm) [N/m^2] $f_2 := 144.92 \cdot 10^6$

===== **CALCULATION** ===

1/ Conical shell

A/ Table 13.1, case 2a



Meridional stress [N/m^2]

$$\sigma_1 := \frac{q \cdot R_{cyl}}{2 \cdot t_{con} \cdot \cos(\alpha)} \qquad \sigma_1 = 4 \times 10^7$$

Circumferential stress [N/m^2]

$$\sigma_2 := \frac{q \cdot R_{cyl}}{t_{con} \cdot \cos(\alpha)} \qquad \sigma_2 = 8 \times 10^7$$

Meridional bending stress [N/m^2] $\sigma_{1m} := 0$

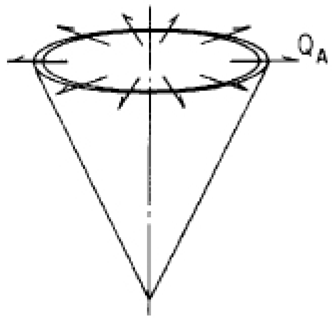
Circumferential bending stress [N/m^2] $\sigma_{2m} := 0$

Unit force [N/m] $T := \sigma_1 \cdot t_{con}$ $T = 718905.847621$

Radial displacement [m] $\Delta R := \frac{q \cdot R_{cyl}^2}{E \cdot t_{con} \cdot \cos(\alpha)} \cdot \left(1 - \frac{\nu}{2}\right)$ $\Delta R = 5.880998 \times 10^{-4}$

Rotation [rad] $\psi := \frac{3 \cdot q \cdot R_{cyl} \cdot \tan(\alpha)}{2 \cdot E \cdot t_{con} \cdot \cos(\alpha)}$ $\psi = 2.203817 \times 10^{-3}$

B/ Table 13.3, case 4a



Radius at cone-cylinder interaction [m] $R_A := R_{cyl}$

Calculation factors [-]

$$k_A := \frac{2}{\sin(\alpha)} \cdot \left[\frac{12 \cdot \left(1 - \nu^2\right) \cdot R_A^2}{t_{con}^2 \cdot \sec(\alpha)^2}\right]^{0.25}$$

$$\beta := \left[12 \cdot \left(1 - \nu^2\right)\right]^{0.5}$$

$$F_{1A} := 0 \qquad F_{2A} := 1 - \frac{2.652}{k_A} + \frac{3.516}{k_A^2} - \frac{2.610}{k_A^3} + \frac{0.038}{k_A^4} \qquad F_{4A} := 1 - \frac{3.359}{k_A} + \frac{5.641}{k_A^2} - \frac{9.737}{k_A^3} + \frac{14.716}{k_A^4}$$

$$F_{3A} := 0 \qquad F_{5A} := 1 - \frac{3.359}{k_A} + \frac{7.266}{k_A^2} - \frac{10.068}{k_A^3} + \frac{5.787}{k_A^4} \qquad F_{6A} := 1 - \frac{2.652}{k_A} + \frac{1.641}{k_A^2} - \frac{0.290}{k_A^3} - \frac{2.211}{k_A^4}$$

$$F_{7A} := F_{6A} \qquad F_{8A} := F_{5A} \qquad F_{9A} := F_{5A} + \frac{2 \cdot \sqrt{2} \cdot \nu}{k_A} \cdot F_{2A} \qquad F_{10A} := F_{6A} \qquad C_1 := F_{9A}$$

Radial displacement [m] $\Delta R_A := \frac{R_A \cdot \sin(\alpha)}{E \cdot t_{con}} \cdot \frac{k_A}{\sqrt{2} \cdot C_1} \cdot \left(F_{4A} - \frac{4 \cdot \nu^2}{k_A^2} \cdot F_{2A}\right)$ $\Delta R_A = 5.906062 \times 10^{-9}$

Rotation [rad] $\psi_A := \frac{R_A \cdot \beta}{E \cdot t_{con}^2 \cdot C_1} \cdot F_{10A}$ $\psi_A = 8.67419 \times 10^{-8}$

Coefficient for meridional force [-] $N_{1A} := \sin(\alpha)$

Coefficient for circumferential force [-] $N_{2A} := \sin(\alpha) \cdot \frac{k_A}{\sqrt{2} \cdot C_1} \cdot \left(F_{4A} + \frac{\sqrt{2} \cdot \nu}{k_A} \cdot F_{8A}\right)$

Meridional bending moment [Nm] $M_{1A} := 0$