Failure Modes of Simple Pressure Vessles

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$$MPa := 1 \cdot 10^6 \, Pa \qquad GPa := 1 \cdot 10^9 \, Pa$$

$$\rho := 1000 \frac{kg}{m^3} \qquad D2P(depth) := \rho \cdot g \cdot depth$$

This fucntion converts a depth to Pressure

$E := 190 \, GPa$ — Youngs Modulus

$Y := 205 \, MPa$ — Yield Stress

$\nu := 0.33$ — Poisson's Ratio

THESE MATERIAL VALUES ARE FOR 302/304/316 STAINLESS STEEL

## Cylinder Failure Modes

$$TD_{yield}(press) := \frac{1}{2} \cdot \left(1 - \sqrt{1 - \frac{2 \cdot press}{Y}} \right)$$

This function returns the Thickness to Diameter (outer) ratio of a cylinder that will cause yielding at the inner surface for a given pressure. To prevent yielding the T/D shoud be larger than this value. (Roark, p638 Table 32 Formula's for thick walled pressure vessel case 1c).

$$TD_{buckle}(press) := \left[press \cdot \left(\frac{1 - \nu^2}{2 \cdot E} \right) \right]^{\frac{1}{3}}$$

This function returns the Thickness to Diameter (outer) ratio of a cylinder for buckling. To prevent buckling T/D should be larger than this value.

$TD_{yield}(D2P(Depth))$

$TD_{buckle}(D2P(Depth))$
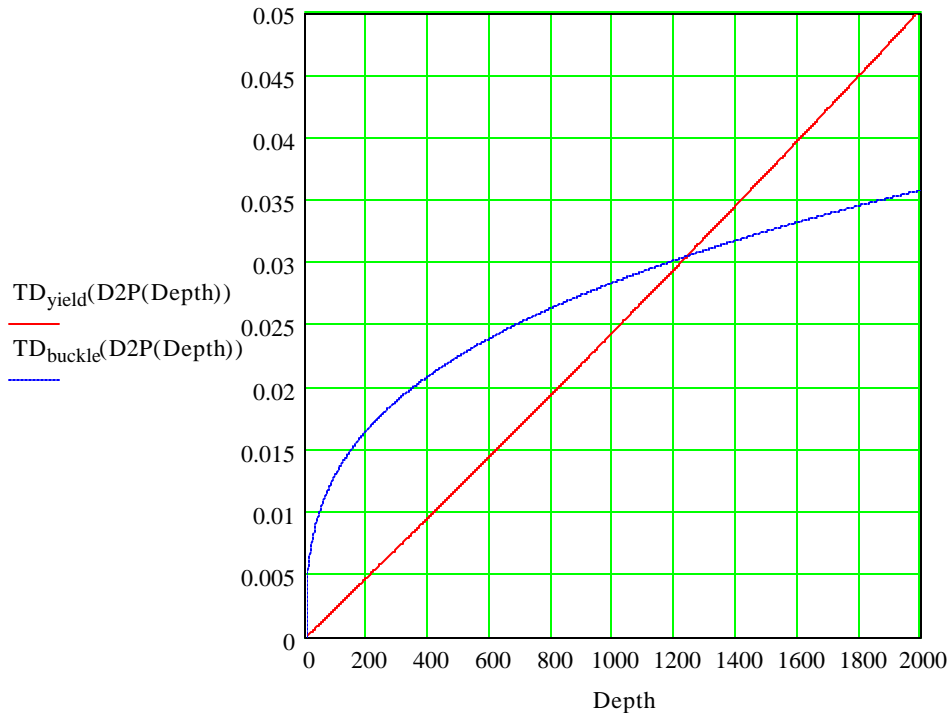
Depth

Above is the composite curve for above material. To prevent failure value to Thickness/Diameter (Outer) should be greater than both those shown here for a given depth.

End Plate Failure Modes

$$TD_{endplate}(press) := \frac{1}{2} \cdot \sqrt{\frac{3 \cdot \left(\dfrac{3}{\nu} + 1\right)}{\dfrac{8}{\nu}} \cdot \frac{press}{Y}}$$

This fuction calculates the Thickness to Diameter (INNER) ratio for an endplate simply supported around its edge that will cause yield failure for a given pressure applied to one side. (Roark pp428 Table 24 Formulas for flat circular plates of constant thickness Case 10a)

$TD_{endplate}(D2P(Depth))$
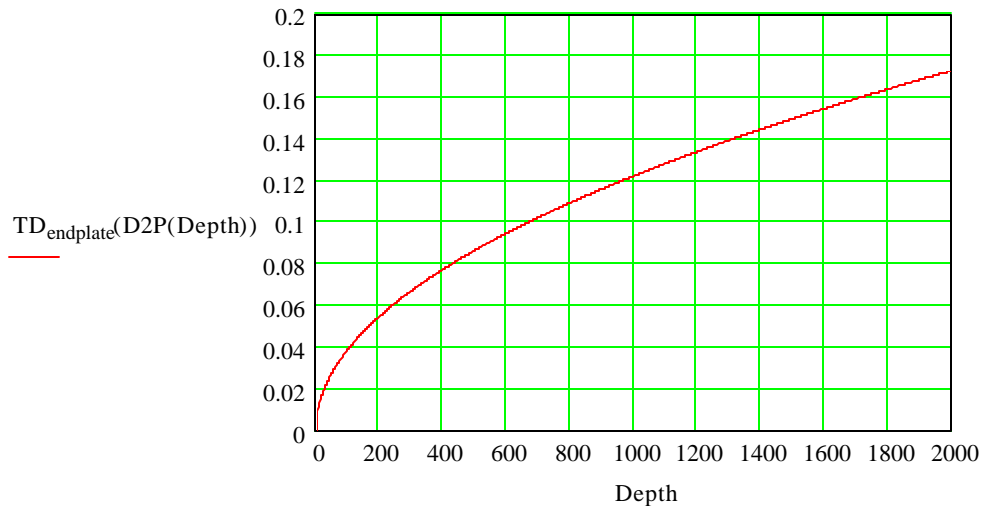
To prevent failure by yielding the Thickness/Diameter (inner) ratio should be geater than that shown above. Note: This curve is for a simply supported endplate. If the edges are clamped case 10b of Table 24 in roark should be used.

References:

Woods Hole Oceanographic Institute Technical Memorandum 3-81
Failure Curves of Cylindrical/Spherical Pressure Vessels and Flat End Caps.
By Arnold G. Sharp, August 1981

Roark's Formulas for Stress and Strain, 6th Edition
By Warren C. Young 1989 McGraw-Hill

Mark's Standard Handbook for Mechanical Enineers, pp6-36

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