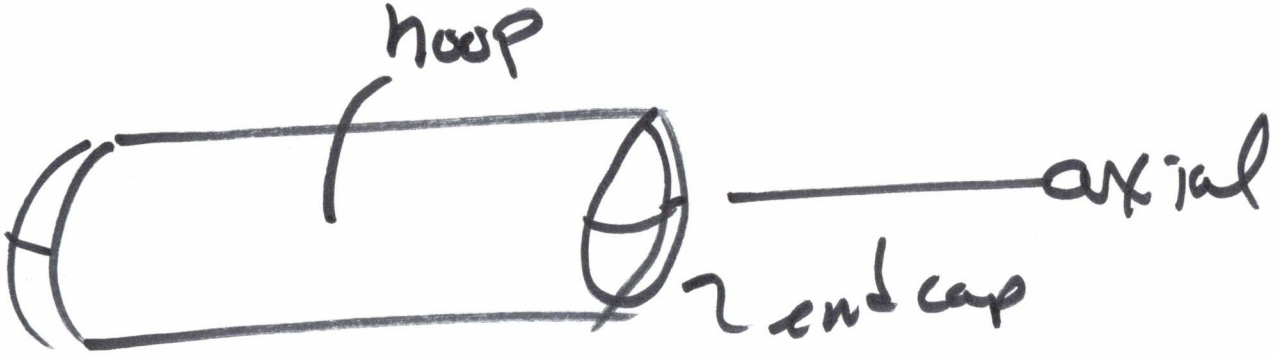
IX Pressure Vessels (Thin walled)

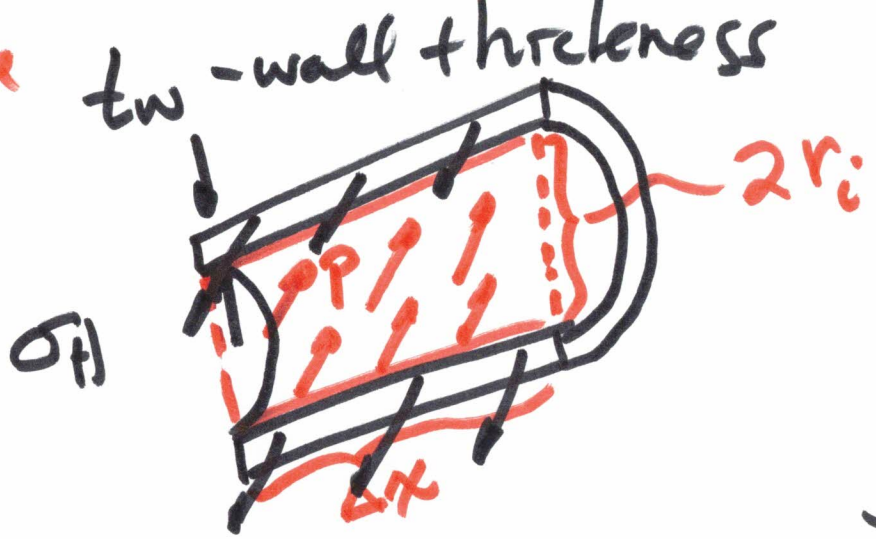
pipes, tanks fluid transport & storage

1. cylindrical pressure vessel



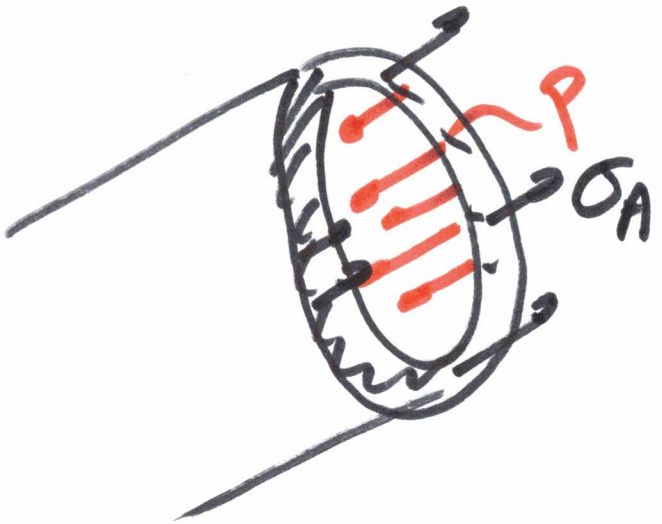
r_i - inside radius

t_w - wall thickness



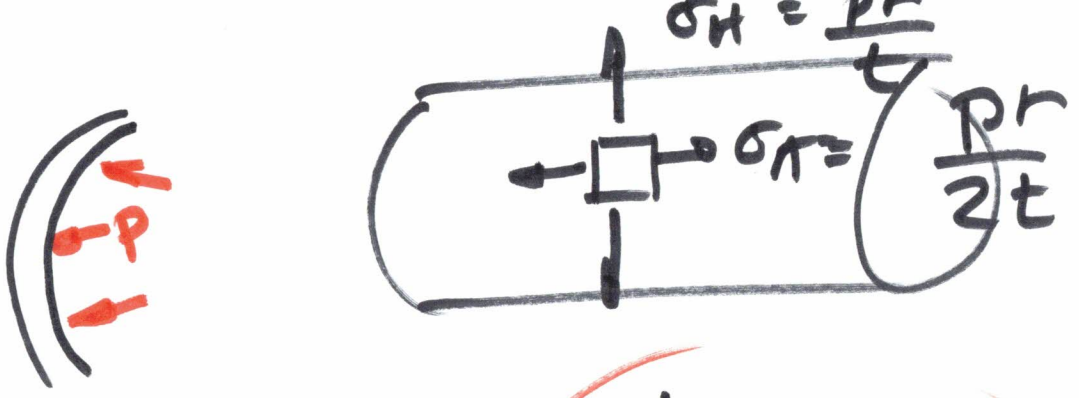
ΣF_x $P(\Delta x)2r_i - \sigma_H 2\Delta x t_w = 0$

$$\sigma_H = \frac{P r_i}{t_w}$$

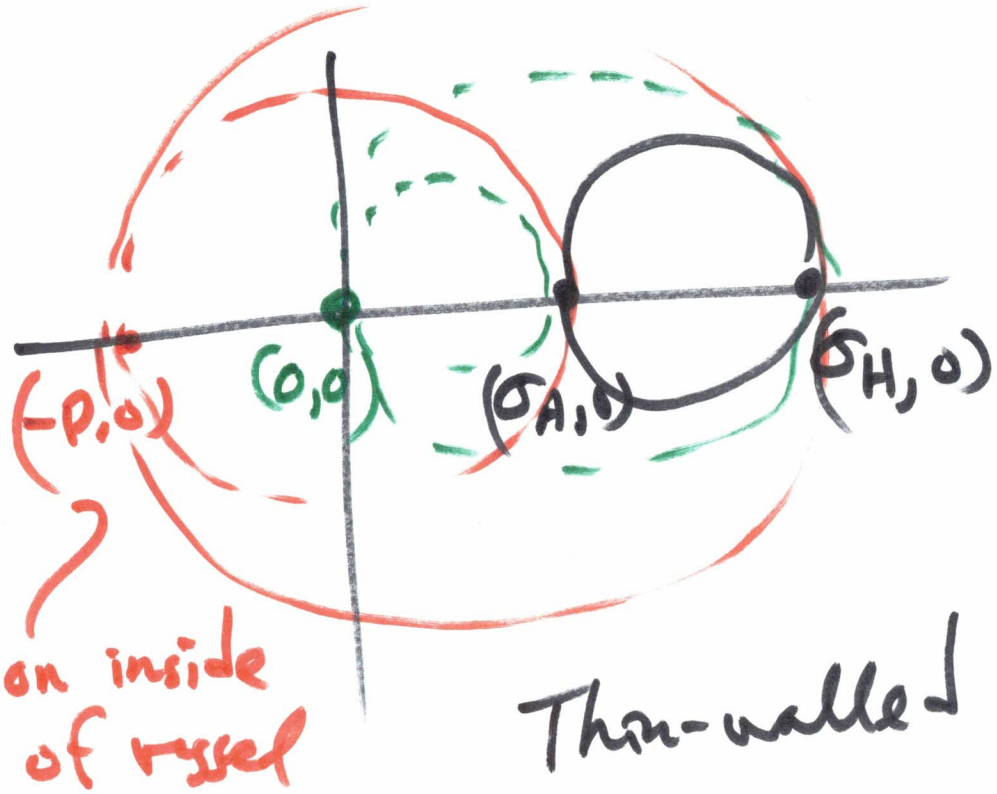


ΣF_t $P\pi r_i^2 - \sigma_A 2\pi r_i t_w = 0$

$$\sigma_A = \frac{P r_i}{2 t_w}$$



This is a principal stress state.



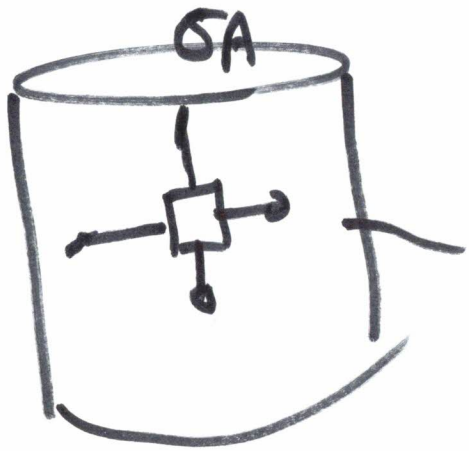
on inside of vessel

Thin-walled $\frac{t_w}{r_i} \leq 0.1$

EXAMPLE: soda can

$OD = 2.5$ in

$t_w = \frac{5}{1000}$ in



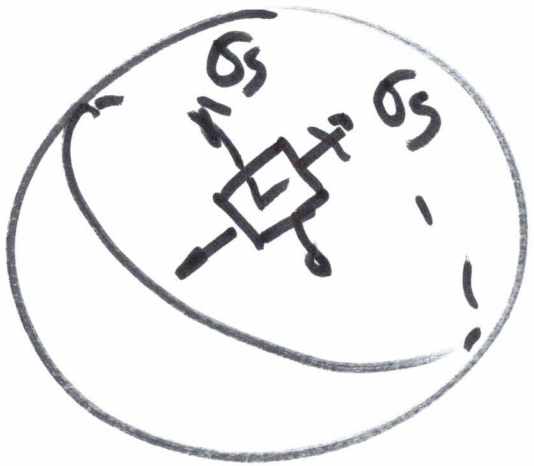
$$\sigma_H = \frac{pr}{t} = \frac{(50)(1.25)}{0.005} \text{ psi} = 12.5 \text{ ksi}$$

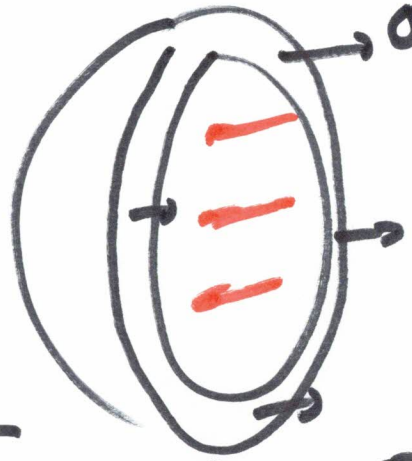
$$\sigma_A = \frac{pr}{2t} = 6.25 \text{ ksi}$$

outside $\tau_{MAX\ ABS} = \dfrac{12.5 \text{ ksi} - 0}{2}$

inside $\tau_{MAX\ ABS} = \dfrac{12.5 \times 10^3 - (-50)}{2}$ psi

2 Spherical





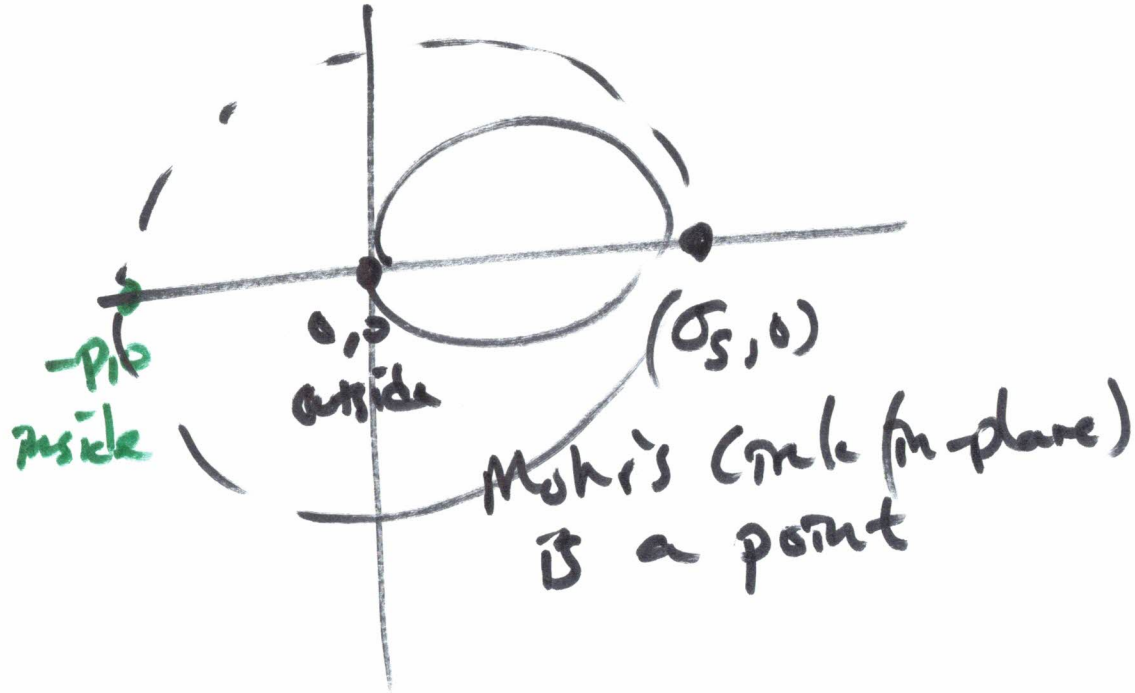
$$+\rightarrow \quad \Sigma F \quad p\pi r_i^2 - \sigma_s 2\pi r_i t_w = 0$$

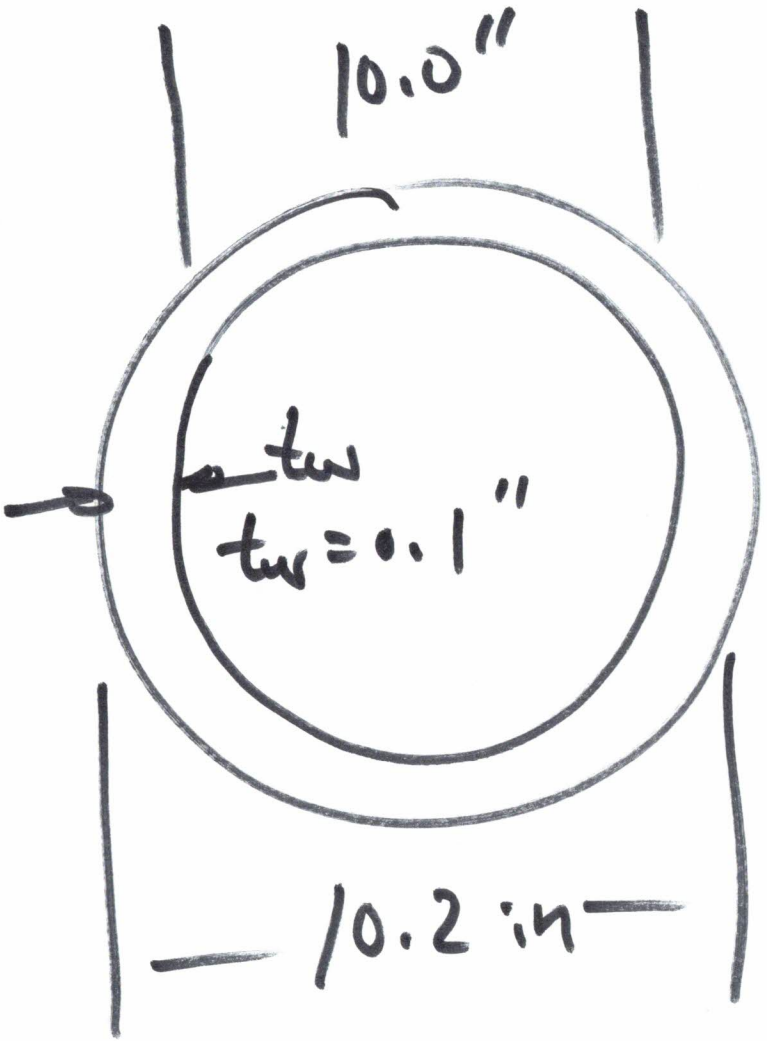
$$\sigma_s = \frac{p r_i}{2 t_w}$$

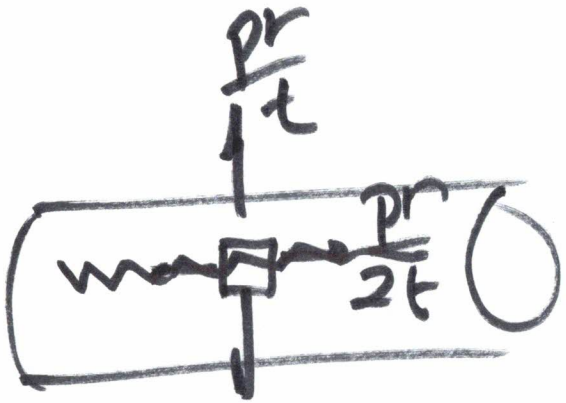
X: $(\sigma_s, 0)$

Y: $(\sigma_s, 0)$

C: $(\sigma_s, 0)$




10.0"
t_w
$t_w = 0.1$"
10.2 in


$\frac{pr}{t}$
$\frac{pr}{2t}$

B. Combined Loading

$$\sigma = \frac{P}{A}$$

$$\tau = \frac{T\, d/2}{J_P}$$

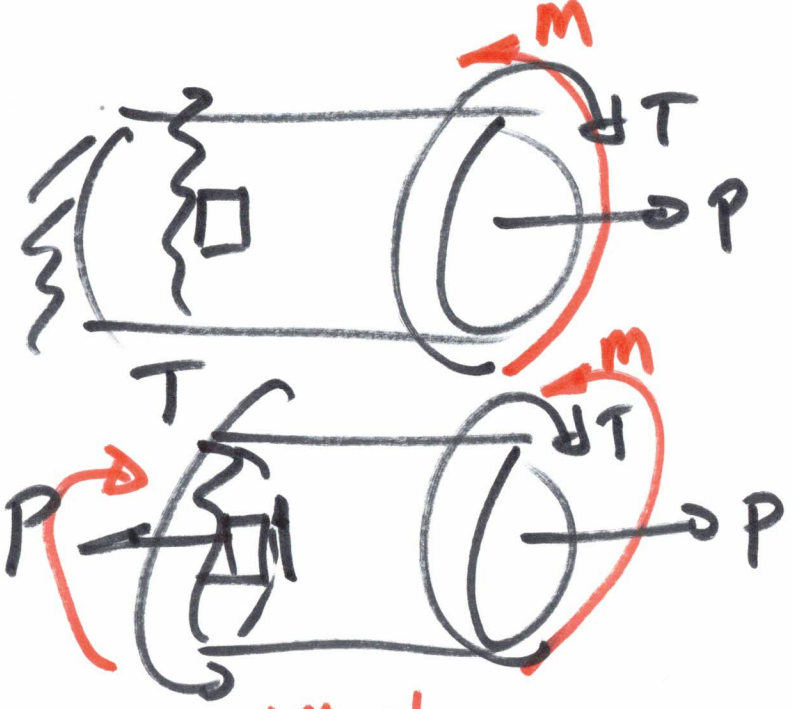
$$\sigma = \frac{-My}{I}$$

$$\tau = \frac{VQ}{It}$$

$$\sigma_S = \sigma_A = \frac{pr}{2t}$$

$$\sigma_H = \frac{pr}{t}$$

As long as the material is linear elastic (does not yield) we can superimpose the stress states.



$$\sigma = \left| \frac{M y}{I} \right|$$

$$\tau = \frac{T d_h}{I_p}$$