

Chapter 1

48)

Required force = 18000 lb

Diameter = 2.50 in

Pressure = ?

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

$$= \frac{18000 \text{ lb}}{\frac{\pi (2.5 \text{ in})^2}{4}}$$

$$= 3666.9 \text{ lb/in}^2 = \boxed{3666.93 \text{ Psi}}$$

58)

58) Find ΔP for a 1% decrease in volume for mercury

$$\begin{aligned} \Delta V &= 1\% \\ E_m &= 3540000 \text{ PSI} \quad \text{or} \quad 24750 \text{ MPa} \\ E &= \frac{-\Delta P}{(\Delta V)/V} \Rightarrow \Delta P = -E[\Delta V/V] \\ \Rightarrow \Delta P &= (-24750 \text{ MPa}) \cdot \left[\frac{1}{100} \right] \end{aligned}$$

$$\Rightarrow \Delta P = 247.5 \text{ MPa} \quad \text{or} \quad 35400 \text{ PSI}$$

63)

$$63) d_i = 0.5" \quad L = 42" \quad E_{mo} = \frac{189000 \text{ PSI}}{1303 \text{ MPa}}$$

Find Stiffness for a linear actuator filled with machine oil w/ the above dimensions (lb/in)



$$\left\{ \Delta P = -E \cdot \left[\frac{\Delta V}{V} \right] \right\}$$

$$\Rightarrow \Delta P = -E_{mo} \cdot \left[\frac{\pi r^2 1"}{\pi r^2 42"} \right]$$

$$\pi \cdot \left(\frac{0.5}{2} \right)^2 \cdot 1 = 0.196 \text{ in}^2$$

$$\pi \cdot \left(\frac{0.5}{2} \right)^2 \cdot 42 = 8.247 \text{ in}^2$$

$$\Rightarrow \Delta p = 189000 \text{ PSI} \cdot \left[\frac{0.196 \text{ in}^2}{8.247 \text{ in}^2} \right] = 4500 \text{ PSI}$$

* It takes 4500 lbs/in^2 to move the linear actuator 1", therefore to find the required lbs necessary we should multiply by the area that pressure is acting over

$$\Rightarrow 4500 \text{ PSI} \cdot \left(\pi \left(\frac{0.5}{2} \right)^2 \right) = 883.57 \text{ lbs}$$

$$\Rightarrow \boxed{883.57 \frac{\text{lbs}}{\text{in}}}$$

76)

$$1.00 \text{ lb force} = 0.0319 \text{ slug} \cdot 32.2 \text{ ft/s}^2 = 0.454 \text{ lbf} = 4.448 \text{ N}$$

92)

$$92) \quad d = 150 \text{ mm} \quad W_e = 2.25 \text{ N} \\ h = 200 \text{ mm} \quad W_f = 35.4 \text{ N}$$

$$\text{Volume of oil} = \pi \cdot \left(\frac{150}{2}\right)^2 \cdot 200 = 3534291.7 \text{ mm}^3$$

$$W_{\text{oil}} = W_f - W_e = 35.4 - 2.25 = 33.15 \text{ N}$$

$$\gamma_{\text{oil}} = \frac{W_{\text{oil}}}{V_{\text{oil}}} = \frac{33.15 \text{ N}}{3534291.7 \text{ mm}^3} = 9.38 \cdot 10^{-6} \frac{\text{N}}{\text{mm}^3}$$

$$SG = \frac{\gamma}{1000 \frac{\text{kg}}{\text{m}^3}} \Rightarrow SG = \frac{3.765 \cdot 10^{-5} \frac{\text{kg}}{\text{m}^3}}{1000 \frac{\text{kg}}{\text{m}^3}} =$$

$$\Rightarrow 9.38 \cdot 10^{-6} \frac{\text{N}}{\text{mm}^3} \cdot (39.37) = 3.69 \cdot 10^{-4} \frac{\text{N}}{\text{m}^3}$$

$$3.69 \cdot 10^{-4} \frac{\text{N}}{\text{m}^3} \cdot \left(\frac{1}{4.448}\right) = 8.3 \cdot 10^{-5} \frac{\text{lb}}{\text{m}^3}$$

$$8.3 \cdot 10^{-5} \cdot \left(\frac{1}{2.205}\right) = 3.765 \cdot 10^{-5} \frac{\text{kg}}{\text{m}^3}$$

$$SG_{\text{oil}} = 3.765 \cdot 10^{-8}$$

107)

$$\text{Alcohol } S_g = 0.79$$

- Calculate density in slugs/ft^3 and g/cm^3

$$S_g = \frac{\rho_s}{\rho_{w@4^\circ\text{C}}}$$

$$\rho_{w@4^\circ\text{C}} = 1000 \text{ kg/m}^3 = 1 \text{ g/cm}^3$$

$$\rho_{w@4^\circ\text{C}} = 1.94 \text{ slugs/ft}^3$$

Density in slugs/ft^3

$$\rho_{\text{alcohol}} = 0.79 \times 1.94 \text{ slugs/ft}^3$$

$$\boxed{= 1.53 \text{ slugs/ft}^3}$$

Density in g/cm^3

$$\rho_{\text{alcohol}} = 0.79 \times 1 \text{ g/cm}^3$$

$$\boxed{= 0.79 \text{ g/cm}^3}$$

Chapter 2

17)

KETCHUP, PAINT, SHAMPOO, TOOTH PASTE

18)

$$6.25 \cdot 10^{-4} \frac{\text{N} \cdot \text{s}}{\text{m}^2}$$

27)

Dynamic viscosity of hydrogen at 40°F

$$1.75 \times 10^{-7} \text{ lb} \cdot \text{s} / \text{ft}^2$$

35)

SAE 30 oil @ 210°F = $2.2 \times 10^{-4} \text{ lb} \cdot \text{s} / \text{ft}^2$

61)

Steel bar

Diameter 1.6 mm

$S_g = 0.94$

$\gamma_{\text{sp}} = 77 \text{ kN/m}^3$

fall through 250 mm in 10.4 s

Viscosity of oil = ?

$\gamma_f = S_g \times \gamma_{\text{water}} @ 4^\circ\text{C}$

$= 0.94 \times 9.81 \text{ kN/m}^3$

$= 9.2214 \text{ kN/m}^3$

$\gamma_b = 77 \text{ kN/m}^3$

$V = \left(\frac{250}{1000}\right) \text{ m} / 10.4 \text{ s}$

$\eta = \frac{(\gamma_b - \gamma_f) D^2}{18 V}$

$= \frac{(77 \text{ kN/m}^3 - 9.2214 \text{ kN/m}^3) \times \left(\frac{1.6}{1000}\right)^2}{18 \times \left(\frac{250}{1000}\right) \text{ m} / 10.4 \text{ s}}$

$= \frac{4.01 \times 10^{-4} \text{ kN} \cdot \text{s} / \text{m}^2}{1}$

$= 0.401 \text{ N} \cdot \text{s} / \text{m}^2$ $\text{N/m}^2 = \text{Pa}$

$\boxed{\eta = 0.401 \text{ Pa} \cdot \text{s}}$