MET330 HW1.1

Gavin Cotton, Trey Ward, Naftaly Gichunga, Robert Morris

Chapter 1

48)

Required force = 18000 lb

Diameter = 2.50 in

Pressure = ?

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

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

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

58)

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

$\Delta V = 1\%$

$E_m = 3590000$ PSI or 24750 MPa

$$E = \frac{-\Delta P}{(\Delta V)/V} \Rightarrow \Delta P = -E[\Delta V/V]$$

$$\Rightarrow \Delta P = (-24750\ MPa) \cdot \left[\frac{1}{100}\right]$$

$$\Rightarrow \Delta P = 247.5\ MPa$$

or

35900 PSi

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63)

63) $d_i = 0.5''$ $L = 42''$ $E_{mo} = \dfrac{189000 \text{ PSi}}{\text{or } 1303 \text{ MPa}}$

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

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

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

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

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

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

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

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

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

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76)

1.00 lb force $= 0.0319$ slug $\doteq 0.454$ kg $= 4.448$ N

92)

92) $d = 150\,mm$ $\quad W_E = 2.25\,N$
$h = 200\,mm$ $\quad W_f = 35.4\,N$

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

$W_{oil} = W_f - W_E = 35.4 - 2.25 = 33.15N$

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

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

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

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

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

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

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107)

Alcohol $sg = 0.79$

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

$$sg = \frac{\rho_s}{\rho_w @ 4°c}$$

$\rho_w @ 4°c = 1000\ kg/m^3 = 1\ g/cm^3$

$\rho_w @ 4°c = 1.94\ slugs/ft^3$

Density in $slugs/ft^3$

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

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

Density in g/cm^3

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

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

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Chapter 2

17)

ketchup, paint, shampoo, toothpaste

18)

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

27)

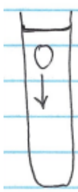
Dynamic viscosity of hydrogen at 40°F

1.75×10^{-7} lb-s/ft²

35)

SAE 30 oil @ 210°F = 2.2×10^{-4} lb-s/ft²

61)



Steel bar

Diameter 1.6mm

$sg = 0.94$

Weight = 77 kN/m³

Falls through 250mm in 10.4 s

Viscosity of oil = ?

$\gamma_f = sg \times \gamma_w @ 4°C$

$= 0.94 \times 9.81\ kN/m^3$

$= 9.2214\ kN/m^3$

$\gamma_b = 77\ kN/m^3$

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

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

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

$= \cancel{4.01\ kN \times 10^{-4}\ kN/m}$

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

$= 0.401\ N \cdot s/m^2$ $\qquad N/m^2 = Pa$

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