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MET 330 Homework #1 1/20/22

1.48 $F = 18000\ lbf$ $d = 2.50\ in$

$P = \frac{F}{A}$ $A = \pi \frac{d^2}{4} = \pi \frac{2.50^2}{4} \Rightarrow A = 4.91\ in^2$

$P = \frac{18000\ lbf}{4.91\ in^2}$

$\boxed{P = 3665.99\ Psi}$

1.58. compute the pressure change requried to decrease the of mercury by 1%. Express in both Psi + MPa

Bulk Modulous $E = \frac{-\Delta P}{(\Delta V)/V}$

$E_{Hg} = 3590000\ psi + 24750\ MPa$

$\Delta p = -E(\Delta V/V)$ $(\Delta V)/V = 0.01$

$\Delta P_{psi} = -3590000(-0.01) \Rightarrow \Delta P_{psi} = 35900\ psi$

$\Delta P_{MPa} = -24750(-0.01) \Rightarrow \Delta P_{MPa} = 247.50\ MPa$

1.63. $d = 0.50\ in$ $l = 42.0\ in$ compute the stiffness in lb/in

Bulk Modulous $E = \frac{-\Delta P}{(\Delta V)/V}$

Stiffness $= F/\Delta L$

Volume $= \Delta(L) \Rightarrow \Delta V = -A(\Delta L)$

$E = \frac{-(F/A)}{-A(\Delta L)/A(L)} \Rightarrow E = -\frac{F}{A} \left(\frac{AL}{-A(\Delta L)}\right)$

$E = FL/A(\Delta L) \Rightarrow \frac{EA}{L} = F/\Delta L$

$\frac{(189000\ psi)(0.196\ in^2)}{42\ in} = F/\Delta L$

Stiffness $= 882.\ lb/in$

1.76. 1.00 lbf compute the mass in slugs, kg + weight in N

slug:

$m = \frac{F}{a} = \frac{lb}{ft/s^2} \Rightarrow lb\left(\frac{s^2}{ft}\right) = \frac{lb \cdot s^2}{ft}$

$\frac{1.00\ lbf}{32.2} = \boxed{0.031\ slug}$

Kg:

$g_c = \frac{32.2\ lbm}{lbf/ft/s^2} = \frac{32.2\ lbm\text{-}ft/s^2}{lbf}$

1.00 lbf ⇒ lbm

1.00 lbf = 1 lbm @ $g = 32.2\ ft/s^2$

1.00 lbf = 453.592 g

$\boxed{1.00\ lbf = 0.454\ kg}$

N:

$W = ma$

$W = (0.454\ kg)(9.81\ m/s^2)$

$W = 4.45\ kg \cdot m/s^2$ or $\boxed{4.45\ N}$

1.92 Cylindrical container d = 150 mm

W = 2.25 N when empty

depth 200 mm w/ oil W = 35.4 N calculate sg of oil

$sg = \frac{\gamma_s}{\gamma_{w@4°C}}$ $\gamma_s = W/V$

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

$V = \pi r^2 h = 3.14(0.075m)^2(0.200m)$

$V = 0.00353\ m^3$

$\gamma_s = \frac{33.15\ N}{3.53 \times 10^{-3}\ m^3} = 9.390\ kN/m^3 \Rightarrow sg_{oil} = \frac{9.390\ kN/m^3}{9.807\ kN/m^3} = \boxed{0.9575}$

1.107. Alcohol has a $sg = 0.79$ calculate density in both slugs/ft^3 + g/cm^3

$sg = \frac{\rho_s}{\rho_w @ 4°C}$ $\rho_w = 1000$ kg/m^3

$0.79 = \frac{\rho_s}{1000 \text{ kg/m}^3} \Rightarrow \rho_s = 790$ kg/m^3

$790 \text{ kg/m}^3 \left| \frac{1000 \text{ g}}{1 \text{ kg}} \right| \frac{(1 \text{ m})^3}{(100 \text{ cm})^3}$

$790 \text{ kg/m}^3 = \boxed{0.79 \text{ g/cm}^3}$

$790 \text{ kg/m}^3 \left| \frac{1 \text{ slug}}{14.59 \text{ kg}} \right| \frac{(1 \text{ m})^3}{(3.281 \text{ ft})^3}$

$790 \text{ kg/m}^3 = \boxed{1.53 \text{ slug/ft}^3}$

2.17 4 Ex. of non-Newtonial fluids

Ketchup, Mustard, Mayonnaise, + Toothpaste

2.19 Water @ 40° C $\eta = 6.3 \times 10^{-4}$ Pa·s

2.27 Hydrogen @ 40° F $\eta = 1.9 \times 10^{-7}$ lb-s/ft^2

2.35 SAE 30 @ 210°F $\eta = 2.3 \times 10^{-4}$ lb-s/ft^2

2.61 In a falling ball viscometer, a steel ball 1.6mm in d is allowed to fall freely in a heavy fuel w/ a S.g. of 0.94. Steel weighs 77 KN/m³. If the ball falls 250 mm in 10.4s calculate the viscosity of the fluid

$(0.25\,m)/(10.4\,s) = v$

$v = 0.024\ m/s$

$d = 0.0016m$

$$\eta = \frac{(\gamma_s - \gamma_f)\,d^2}{18v}$$

$$\gamma = \frac{\rho_s}{\rho_{w@4°C}}$$

$$0.94 = \frac{\rho_o}{1000\ kg/m^3}$$

$\rho_{oil} = 940\ kg/m^3$

$\gamma_s = (940\ kg/m^3)(9.81\ m/s^2)$

$\gamma_s = 9221.4\ \frac{kg}{m^2 s^2} \Rightarrow 9221.4\ \frac{N}{m^3} \Rightarrow 9.22\ kN/m^3$

$\gamma_f = 77\ \frac{kN}{m^3}$ Given

$$\eta = \frac{(77\frac{kN}{m^3} - 9.22\frac{kN}{m^3})(0.0016m)^2}{18(0.024\,m/s)} \Rightarrow \frac{kN/m}{m/s} \Rightarrow \frac{kN}{m}\cdot\frac{s}{m} \Rightarrow \frac{kN\cdot s}{m^2}$$

$$\eta = 0.000402\ \frac{kN\cdot s}{m^2} \Rightarrow \boxed{0.402\ Pa\cdot s}$$