MET 330 Ch. 1 Homework Joey Cantrell

1.48 A coining press is used to produce commemorative coins with the likenesses of all the U.S. presidents. The coining process requires a force of 18000 lb. The hydraulic cylinder has a diameter of 2.50 in. Compute the required oil pressure.

Solution: We know $p = \frac{F}{A}$ and $A = \frac{\pi D^2}{4}$

So $A = \frac{\pi(2.50in)^2}{4} = 4.909 in^2$

Then $F = \frac{18000 lb}{4.909 in^2} = \boxed{3666.7 psi}$

1.58 Compute the pressure change required to cause a decrease in the volume of mercury by 1.00%. Express the result in both psi and MPa.

Solution: We know $E = \frac{-\Delta p}{(\Delta V)/V}$

So $\Delta p = -E\left(\frac{\Delta V}{V}\right) = -3590000 psi\left(-\frac{1.00}{100}\right) = \boxed{35900 psi}$

Also, $\Delta p = -24750 MPa\left(-\frac{1.00}{100}\right) = \boxed{247.5 MPa}$

1.63 For an actuator that has an inside diameter of 0.50 in and a length of 42.0 in and that is filled with machine oil, compute the stiffness in lb/in.

Solution: We know $\text{stiffness} = \frac{F}{\Delta L}$, $E = \frac{-\Delta p}{(\Delta V)/V}$, $p = \frac{F}{A}$, and $\Delta V = -A(\Delta L)$, $A = \frac{\pi D^2}{4}$

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

$\rightarrow \frac{F}{\Delta L} = \frac{EA}{L} = \frac{(189000 \cancel{lb/in^2})(\pi(0.50 in)^2/4)}{42.0 in} = \boxed{883.6 lb/in}$

1.76 In the U.S., hamburger is sold by the pound. Assuming this is 1.00 lbf, compute the mass in slugs, the mass in kg, and weight in N.

Solution: $1.00 lbf = 1.00 \frac{slug \cdot ft}{s^2} \rightarrow m = \frac{W}{g} = \frac{1.00 \frac{slug \cdot \cancel{ft}}{\cancel{s^2}}}{32.2 \cancel{ft/s^2}} = \boxed{0.031 slugs}$

$1.00 lbf = 4.448 N \rightarrow m = \frac{4.448 kg \cdot \cancel{m/s^2}}{9.81 \cancel{m/s^2}} = \boxed{0.453 kg}$

We know $1.00 lbf = \boxed{4.448 N}$

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1.92 A cylindrical container is 150 mm in diameter and weighs 2.25 N when empty. When filled to a depth of 200 mm with a certain oil, it weighs 35.4 N. Calculate the specific gravity of the oil.

Solution: We know $V = \pi r^2 h$, $W_{oil} = 35.4N - 2.25N = 33.15N$

So $\gamma_{oil} = \frac{W_{oil}}{V} = \frac{33.15N}{\pi(.150m/2)^2(0.200m)} = 9379.5\ N/m^2 = 9.3795\ kN/m^2$

Then $sg = \frac{\gamma_{oil}}{\gamma_w @ 4°C} = \frac{9.3795\ kN/m^2}{9.81\ kN/m^2} = \boxed{0.956}$

1.107 Alcohol has a specific gravity of 0.79. Calculate its density both in slugs/ft³ and g/cm³.

Solution: We know $sg = \frac{\rho_s}{\rho_w @ 4°C}$ and $\rho_w @ 4°C = 1.94 \frac{slugs}{ft^3} = 1000 \frac{kg}{m^3}$

So $0.79 = \frac{\rho_A}{1.94\ slugs/ft^3} \rightarrow \rho_A = \boxed{1.533\ \frac{slugs}{ft^3}}$

Also, $0.79 = \frac{\rho_A}{1000\ kg/m^3} \rightarrow \rho_A = 790 \frac{\cancel{kg}}{\cancel{m^3}} \left(\frac{1000g}{1\cancel{kg}}\right)\left(\frac{(1\cancel{m})^3}{(100\,(cm))^3}\right) = \boxed{0.79\ g/cm^3}$

MET 330 Ch. 2 Homework

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2.17 Give four examples of the types of fluids that are non-Newtonian.

Solution: $\boxed{\text{Dilatant fluids, Bingham fluids, Electrorheological fluids, and Thixotropic fluids}}$

2.18 Value of viscosity for Water at 40°C.

Solution: $\boxed{6.5 \times 10^{-4}\ Pa \cdot s}$

2.27 Value of viscosity for Hydrogen at 40°F.

Solution: $\boxed{1.7 \times 10^{-7}\ \frac{lb \cdot s}{ft^2}}$

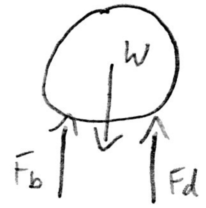
2.35 Value of viscosity for SAE 30 oil at 210°F.

Solution: $\boxed{2.2 \times 10^{-4}\ \frac{lb \cdot s}{ft^2}}$

2.61 In a falling ball viscometer, a steel ball 1.6mm in diameter is allowed to fall freely in a heavy fuel oil having a specific gravity of 0.94. Steel weighs 77kN/m³. If the ball is observed to fall 250mm in 10.4s, calculate the viscosity of the oil.

Solution: We know $\eta = \frac{F_d}{3\pi v D}$, $V = \frac{\pi D^3}{6}$, $W = \gamma V$

FBD of Ball



$F_b + F_d - W = 0 \rightarrow F_d = W - F_b \rightarrow F_d = 1.65 \times 10^{-7} kN - 1.978 \times 10^{-8} kN$

$F_d = 1.45 \times 10^{-7} kN$

$F_b = \gamma_f V = (9.221 \frac{kN}{m^3})(\frac{\pi (0.0016m)^3}{6}) = 1.978 \times 10^{-8} kN$

$0.94 = \frac{\gamma_f}{\gamma_{w@4°C}} \rightarrow \gamma_f = 9.221 \frac{kN}{m^3}$

$v = \frac{0.250m}{10.4s} = 0.024\ m/s$

$W = \gamma V = (77 \frac{kN}{m^3})(\frac{\pi (0.0016m)^3}{6}) = 1.65 \times 10^{-7} kN$

Then $\eta = \frac{1.45 \times 10^{-7} kN}{3\pi (0.024 m/s)(0.0016m)} = 4.016 \times 10^{-4} \frac{kN \cdot s}{m^2} = \boxed{0.4016 \frac{N \cdot s}{m^2}\ (Pa \cdot s)}$