HW

48, 58, 63, 76, 92, 107

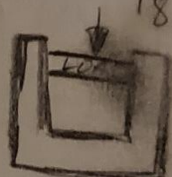
48

GIVEN: A coining press is used to produce commemorative coins with the likenesses of all the US presidents. The coining process requires a force of 18,000 lb. The hydraulic cylinder has a diameter of 2.50 in.

Problem: Compute the required oil pressure.

FBD

18,000 lb



$D = 2.50\ in$

$$\text{Pressure} = \frac{P}{A}$$

$$\text{Area} = \frac{\pi D^2}{4}$$

$$\frac{[lb]}{[in^2]} = psi$$

SEE EX prob. 1-3

Eq. (1-3)

Solution: $\text{Pressure}_{oil} = \dfrac{F}{A}$

$F = \text{load} = 18{,}000[lb]$

$D = 2.50\,[in]$

$$\text{Area} = \frac{\pi D^2}{4} = \frac{\pi (2.50\,[in])^2}{4} = \frac{19.6[in^2]}{4} = 4.91[in^2]$$

$$\text{Pressure}_{oil} = \frac{18{,}000\,[lb]}{4.91[in^2]} = 3666\,\frac{[lb]}{[in^2]}$$

$$\boxed{\text{Pressure}_{oil} = 3666\ psi}$$

EN: Compute the pressure change required to cause a decrease in the volume of mercury by 1.00 percent. Expless the result in both psi and MPa

Solution:

* The 1.0% volume change indicates

$$\frac{\Delta V}{V} = -0.1$$

* $\Delta p = -E\left[\frac{\Delta V}{V}\right] = -E(-0.01)$

* TABLE 1.3 @ 9atm pressure & 68°F (20°C)

Mercury = 3,590,000 [psi]

Mercury = 24,750 [MPa]

* Bulk Modulus
$E = \frac{-\Delta P}{\left(\frac{\Delta V}{V}\right)}$
* 1.00% *
$\frac{\Delta V}{V} = -0.01$
EX: problem 1.9

$\Delta P_{psi} = E\left[\frac{\Delta V}{V}\right]$

$\Delta P = (-3{,}590{,}000 [psi])(-0.01)$

$\boxed{\Delta P = 35900.00 [psi]}$

$\Delta P_{MPa} = E\left[\frac{\Delta V}{V}\right]$

$\Delta P = (-24{,}750 [MPa])(-0.01)$

$\boxed{\Delta P = 247.50 [MPa]}$

IVEN: A measure of the stiffness of a linear actuator system is the amount of force required to cause a certain linear deflection. For an actuator that has an inside diameter of 0.50 in & a length of 42.0 in and that is filled with machine oil.

Problem: Compute the stiffness in $\frac{lb}{in}$

Solution

$D = 0.50 [in]$

$L = 42.0 [in]$

$E_{Machine\ oil} = 189{,}000 [psi] = 189{,}000 \left[\frac{lb}{in^2}\right]$

$Area = \frac{\pi D^2}{4} = \frac{\pi (50^2)}{4} = 0.196 [in^2]$

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

$\text{Stiffness} = \frac{F}{\Delta L} \Rightarrow K = \frac{F}{\delta}$

$\text{Pressure} = \frac{F}{A}$

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

$\frac{F}{\Delta L} = \frac{E(A)}{L} = \frac{(189{,}000 [\frac{lb}{in^2}])(0.196 [in^2])}{42 [IN]}$

$\boxed{\text{stiffness} = 882 [\frac{lb}{IN}]}$

N: In the US, hamburger & other meats are sold by the pound. Assuming tha this is 1.00 [lb] Force
blem: Compute the mass in slug, the mass in Kg, and weigh in N

$lb\text{-}s^2/ft$ = slugs
Newton (N) = $kg\,m/s^2$
$F = ma = kg \cdot \frac{m}{s^2} = N$

Solution: 1.00 [lb]

* mass in slugs

EX: Problem 1.8

$$mass = \frac{w}{g} = \frac{1.00\,[lb]}{32.2\left[\frac{ft}{s^2}\right]} = \frac{1.00}{32.2}\left[\frac{lb\text{-}s^2}{ft}\right]$$

$$= 0.03\left[\frac{lb\text{-}s^2}{ft}\right] = \boxed{0.03\ slugs}$$

* mass in kg (see TABLE K.1: conversion factor)

$$\left(\frac{0.03\,[\cancel{slugs}]}{1}\right)\left(\frac{14.59\,[kg]}{1\,[\cancel{slugs}]}\right) = \boxed{.4377\,[kg]}$$

* weigh in N

$$W = mg = (.4377\,[kg])\left(9.81\left[\frac{m}{s^2}\right]\right) = 4.29\left[kg\frac{m}{s^2}\right]$$

$$W = 4.29\left[kg\,\frac{m}{s^2}\right] = 4.29\,[N]$$

$$\boxed{W = 4.29\,[N]}$$

GN: A cylindrical container is 150mm in diameter and weighs 2.25 N when empty. When filled to a depth of 200 m with a certain oil, it weight 35.4 N.

Problem: Calculate the specific gravity of the oil.

Solution: $F_1 = 2.25\,N$

FBD:

$\varnothing = 150[mm]$

$W = 2.25[N]$

Depth = 200 [mm]

$\text{Weight}_{oil} = 35.4\,N$

$W = mg$

$\gamma = \frac{w}{V} = \frac{mg}{V} = \rho g$

$V_{cylinder} = \pi r^2 h$

$r = \frac{D}{2}$

$Sg = \frac{\rho_o}{\rho_w @ 4°C}$ $\qquad \rho_o = \frac{m}{V}$

* $V_{cylinder} = \pi r^2 h = \pi\left(\frac{D}{2}\right)^2 h$

$= \pi\left(\frac{150[mm]}{2}\right)^2 (200[mm])$

$= \pi(5625[mm^2])(200[mm]) = 3534291\ mm^3$

$V_{cylinder} = \left(\frac{3534291\ [mm^3]}{1}\right)\left(\frac{1\times10^{-9}\ [m^3]}{1\ (mm^3)}\right) = .003534[m^3]$

* $MASS_{oil} = \frac{W}{g} = \frac{35.4[N]}{9.81[m/s^2]} = \frac{35.4\left[kg\ \frac{\cancel{m}}{\cancel{s^2}}\right]}{9.81\left[\frac{\cancel{m}}{\cancel{s^2}}\right]} = 3.6[kg]$

* Density $= \rho_o = \frac{m}{V} = \frac{3.6[kg]}{.003534[m^3]} = 1021.10\left[\frac{kg}{m^3}\right]$

* Specific gravity of oil

$Sg_o = \frac{\rho_o}{\rho_w @ 4°C} = \frac{1021.10\left[\cancel{\frac{kg}{m^3}}\right]}{1000\left[\cancel{\frac{kg}{m^3}}\right]} = \boxed{1.02}$

GIVEN: ALCOHOL HAS A SPECIFIC GRAVITY OF 0.79

PROBLEM: Calculate its density both in $\frac{slugs}{ft^3}$ & $\frac{g}{cm^3}$

Solution:

$sg = 0.79$

Density

density

$\rho = sg(\rho_w @ 4°C)$

$\rho_w @ 4°C = 1000\left[\frac{kg}{m^3}\right]$

$\rho_w @ 4°C = 1.94\left[\frac{slugs}{ft^3}\right]$

* $\rho = 0.79\left(1.94\left[\frac{slugs}{ft^3}\right]\right)$

$= 1.5326\left[\frac{slugs}{ft^3}\right]$

$$\boxed{\rho = 1.53\left[\frac{slugs}{ft^3}\right]}$$

* $\rho = 0.79\left(1000\left[\frac{kg}{m^3}\right]\right) = 790.00\left[\frac{kg}{m^3}\right]$

$$\left(\frac{790.00[\cancel{kg}]}{[\cancel{m^3}]}\right)\left(\frac{1\cancel{000}[g]}{1[\cancel{kg}]}\right)\left(\frac{1[\cancel{m^3}]}{1\cancel{000},000[cm^3]}\right) = .79\frac{[g]}{[cm^3]}$$

$$\boxed{\rho = .79\left[\frac{g}{cm^3}\right]}$$

17, 18, 27, 35, 61

.17 Give 4 examples of the types of fluids that are non-Newtonian

* 3 TYPE OF TIME-~~INDEPENDENT~~ FLUIDS
  - PSEUDOPLASTIC – BLOOD PLASMA
  - DILATANT FLUIDS – CORN STARCH
  - BINGHAM FLUIDS – MUSTARD
* TIME-DEPENDENT
  - CRUDE OILS AT LOW TEMPERATURE

2.18 DYNAMIC VISCOSITY FOR A VARIETY OF FLUIDS

Figure D.1

WATER at 40°C

$\boxed{6.5 \times 10^{-4} \left[\frac{N \cdot s}{m^2}\right] \text{ OR } [Pa \cdot s]}$

Figure D.2

2.27 Hydrogen at 40°F

$\boxed{1.8 \times 10^{-7} \left[\frac{lb\text{-}s}{ft^2}\right]}$

2.35 SAE 30 oil at 210°F

$\boxed{2.2 \times 10^{-4} \left[\frac{lb\text{-}s}{ft^2}\right]}$

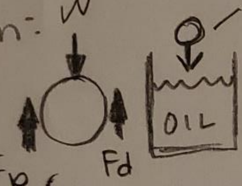
2.61

2.61 GIVEN: In a falling-ball viscometer, a steel ball 1.6 mm in diameter is allowed to fall freely in a heavy fuel oil having a specific gravity of 0.94. Steel weighs $77 \frac{KN}{m^3}$. If the ball is observed to fall 250 mm in 10.4 s

Problem: Calculate the viscosity of the oil

Solution:

FBD



$\varnothing$ 1.6[mm] = 0.0016[m]

$sg_o = 0.94$

$\gamma = 77\left[\frac{KN}{m^3}\right] = 77{,}000\left[\frac{N}{m^3}\right]$

Length = 250[mm]

time = 10.4[s]

$W - F_b - F_d = 0$ (2-6)

$W = \gamma_s V = \gamma_s \pi D^3/6$ (2-7)

$F_b = \gamma_f V = \gamma_f \pi D^3/6$ (2-8)

$F_d = 3\pi\eta v D$ (2-9)

$\eta = \frac{(\gamma_s - \gamma_f)D^2}{18v}$ (2-10)

2.6.4 Falling-Ball Viscometer

Solution:

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

$$\rho = .94\left(1000\left[\frac{Kg}{m^3}\right]\right) = 940\left[\frac{Kg}{m^3}\right]$$

$$\gamma_f = \rho g = \left(940\left[\frac{Kg}{m^3}\right]\right)\left(9.81\left[\frac{m}{s^2}\right]\right)$$

$$* \gamma_f = 9221.4\left[\frac{Kg}{m^2 \cdot s^2}\right] = 9221.4\left[\frac{N}{m^3}\right]$$

$$* \gamma_s = \rho g = sg * \left(1000\left[\frac{Kg}{m^3}\right]\right) * g = \gamma_g \frac{\left(1000\left[\frac{Kg}{m^3}\right]\right)\left(9.81\frac{m}{s^2}\right)}{\left(9.81\ m/s^2\right)} - \left(77{,}000\left[\frac{Kg}{m^3}\right]\right)\left(1000\left[\frac{Kg}{m^3}\right]\right)$$

$$\gamma_s = 77{,}000{,}000\left[\frac{Kg}{m^2 \cdot s^2}\right] = 77{,}000{,}000\left[\frac{N}{m^3}\right]$$

$$* D = 0.0016[m]$$

$$* V = \frac{0.25[m]}{10.4[s]} = 2.4\left[\frac{m}{s}\right]$$

$$\eta = \frac{\left(\left(77{,}000{,}000\left[\frac{N}{m^3}\right]\right) - 9221.4\left[\frac{N}{m^3}\right]\right)\left(0.0016[m]\right)^2}{18\left(2.4\left[\frac{m}{s}\right]\right)} = \boxed{4.56\left[N \cdot s\right]}$$