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MET 330
Homework #1

Chapter One

1.48

The coining process requires a F = 18,000 lb. The hydraulic cylinder has a diameter of 2.50in. compute required oil pressure.

$$p = \frac{F}{A} = \frac{18000\,lb}{4.91\,in^2} = \boxed{3667\,psi}$$

$$A = \frac{\pi d^2}{4} = \frac{\pi(2.50in)^2}{4} = 4.91in^2$$

1.58

compute the pressure Δ required to cause a decrease in the volume of machine oil by 1.00 percent. Express in both psi and mPa.

$$\frac{\Delta V}{V} = -0.01 \qquad \Delta p = -E\left(\frac{\Delta V}{V}\right) = (-189000)(-0.01) =$$

$$\Delta p = (-1303\,mpa)(-0.01) = 13.03\,Mpa \qquad \boxed{1890\,psi \quad 13.03\,mPa}$$

1.63

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

$$k = \frac{A \cdot E}{L} = \frac{(0.1963in^2)(189000\,psi)}{42.0in} = \frac{37110\,lb}{42.0in} = \boxed{884\,lb/in}$$

$$A = \frac{\pi(d)^2}{4} = \frac{\pi(0.50in)^2}{4} = 0.1963in^2$$

1.76
Assuming 1.00lb force, compute mass in slugs, mass in kg, and weight in N.

$m = \frac{W}{g} = \frac{1.00 lb_f}{32.2 ft/s^2} = \boxed{0.0311 \text{ slugs}}$

$m(kg) = \frac{1.00 lb}{2.205 kg/lb} = \boxed{0.4535 kg}$

$W = mg = (0.4535 kg)(9.81 m/s^2) = \boxed{4.45 N}$

1.92
A cylindrical container is 150mm = d, W = 2.25N when empty. When filled to depth of 200mm w/ oil, it W = 35.4N. Calculate specific gravity.

$d = 150mm = 0.15m$
$W_{emp} = 2.25N$
$W_{oil} = 35.4N$
$h = 200mm = 0.2m$
$\rho_{water} = 9810 N/m^3$

$W_{oil} = W_{final} - W_{initial}$
$33.15N = 35.4N - 2.25N$

$V = \pi r^2 h = \pi(0.075m)^2(0.2m) = 0.0035 m^3$

$sg = \frac{W_{oil}/V}{\gamma_{water}} = \frac{(33.15N)/(0.0035m^3)}{9810 N/m^3} = \frac{9471.42 N/m^3}{9810 N/m^3} = \boxed{0.965}$

1.107 $sg_{alcohol} = 0.79$ calculate its density in slugs/ft³ and g/cm³

$\rho_{alcohol} = sg \cdot \rho_{water} = (0.79)(1.94 slugs/ft^3) = \boxed{1.53 slug/ft^3}$

$\rho_{alcohol} = (0.79)(1.00 g/cm^3) = \boxed{0.79 g/cm^3}$

Chapter Two

2-17
Four examples of non-newtonian fluids: blood plasma + molasses (psuedoplastic), oobleck (cornstarch + water mix a dilantant fluid), and mustard (bingham).

2.18 Value of viscosity of water at 40°C:
6.5×10^{-4} N·s/m² or Pa·s

2.27 Value of viscosity of hydrogen at 40°C:
1.2×10^{-5} N·s/m² or Pa·s

2.35 SAE 30 Oil at 210°F:
2.4×10^{-4} lb-s/ft²

2.61 steel ball d = 1.6 mm = 0.0016 m   sg = 0.94   w = 77 kN/m³ = 77,000 N/m³
h = 250 mm = 0.250 m   t = 10.4 s. Calculate viscosity of oil.
$\gamma_{water} = 9810\ N/m^3$

$$V = \frac{h}{t} = \frac{-0.250\,m}{10.4\,s} = -0.024\ m/s$$

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

$$\gamma_f = 0.94 \times 9810\ N/m^3 = 9221.4\ N/m^3$$

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

$$\eta = \frac{(0.0016\,m)^2(77{,}000\ N/m^3 - 9221.4\ N/m^3)}{18(0.024\ m/s)} = \frac{0.00000256\,m^2\,(67778.6\ N/m^3)}{0.432\ m/s}$$

$$= \frac{0.1735\ N/m}{0.432\ m/s} = 0.402\ N\cdot s/m^2$$

Chapter Three

3.6
The value for abs. pressure will always be greater than that for gage pressure : True || [False]

The value for absolute pressure can be equal to or greater than gage pressure, because the formula for absolute pressure is:

$P_{abs} = P_{gage} + P_{atm}$ It can never be less, but it is not always greater like in the case of a perfect vacuum.

3.7
As long as you are on surface of Earth, patm will be 14.7psia True || [False]

We assume 14.7psia at sealevel, however elevation is not consistent around the world and the higher the elevation is, the lower the atmospheric pressure.

3.8
The pressure in a certain tank is −53.6 Pa (abs)
True || [False]

Absolute pressure cannot be negative

3.9
The pressure in a certain tank is −4.65psig
[True] | False

Gage pressure can be negative relative to atmospheric pressure. $P_{abs} = -4.65\,psig + 14.7\,psig = 10.05\,psig$

3.10 Pressure in certain tank is −175 kPa (gage)
True | [False] Absolute pressure cannot be negative. If gage pressure is −175kPa then $P_{abs} = -175\,kPa + 101\,kPa = -74\,kPa$

3.11 Riding in open air cockpit 4,000 ft above sealevel, what would patm be if it conforms to standard atmosphere?

$$y = y_1 + \frac{(x - x_1)}{(x_2 - x_1)} \cdot (y_2 - y_1) \quad \frac{4000-1000}{5000-1000} = 0.75$$

$P_2 - P_1 = 12.227 - 14.173 = -1.946$

$y = 14.173 + (0.75 \cdot (-1.946))$

$y = 14.173 - 1.4595 =$ **12.7135 psia**

3.13 What is pressure at surface of glass of milk? (gage) **Ø psig**

3.41 Open tank contains ethylene glycol T=25°C Compute pressure at depth 12m

$\Delta p = \gamma h$

$\Delta p = 10.79\,kN/m^3 (12m)$

$= $ **129.5 kN/m²**

$\rho_{EG} = 1100\,kg/m^3$ (appendix B)

$P = \rho \cdot g \cdot h$

$= 1100\,kg/m^3 \cdot 9.81\,m/s^2 \cdot 12m$

$= 129{,}492 =$ **129.5 kPa**

3.62 Calculate pressure at point A.

$Sg_{merc} = 13.54$ $\quad 13.54 \times 1000 = 13{,}540\,kg/m^3$

$100mm = 0.1m \quad 75mm = 0.075m$

$\rho_{water} = 1000\,kg/m^3$

$P_A + (\rho_{water} \times g \times h_{water}) + (\rho_{merc} \times g \times h_{merc}) = 0$

$P_A + (1000\,kg/m^3 \times 9.81\,m/s^2 \times 0.1m) + (13{,}450\,kg/m^3 \times 9.81\,m/s^2 \times 0.075m) = 0$

$P_A + (981\,Pa) + (9962.055\,Pa) = 0$

$P_A = -10943.055 =$ **−10.9 kPa (gage)**

3.83 What would be the reading of barometer in inches of mercury corresponding to patm of 14.2psia?

$1 \text{ psia} = 2.036 \text{ inHG}$ $\quad 14.2\text{psia}\left(\frac{2.036\text{inHG}}{1\text{psia}}\right) =$

$\boxed{28.91 \text{ inHG}}$

3.90 The pressure in a vacuum chamber is -12.6psig. Express in inHG.

$-12.6\text{psig} + 14.7\text{psi} = 2.1\text{psia}$

$2.1\text{psia} \times 2.036 = \boxed{4.2756 \text{ inHG}}$

3.94 h? $\quad p_{gage} = 160\text{kPa} = 160{,}000\text{Pa}$ $\quad P = \rho g h$

$\rho = 1{,}000 \text{kg/m}^3$

$g = 9.81 \text{m/s}^2$

$h = \frac{P}{\rho g} = \frac{160{,}000}{(1000)(9.81)} =$

$h = \frac{160{,}000}{9810} = \boxed{16.3 \text{m}}$