Jacob Schwacke | MET330 | HW1 | 1-23-20

76) Meat $w = 1\,lbf$

$m = \frac{w}{g}$

$m = \frac{1\,lbf}{32.2\,ft/s^2}$

$m = 0.031\,lb \cdot s^2/ft$

$\boxed{m = 0.031\,slugs}$

$1\,lbf = 4.448\,N$

$w = 1\,lbf = 4.448\,N$

$m = \frac{w}{g} = \frac{4.448\,N}{9.81\,m/s^2}$

$m = 0.453\,N \cdot s^2/m$

$\boxed{m = 0.453\,kg}$

$1\,lbf = 4.448\,N$

$w = 1\,lbf = 4.448\,N$

$\boxed{w = 4.448\,N}$

92) $D = 150\,mm$ $w = 2.25\,N$ Depth = 200m, then 35.4N

$r = 0.075\,m$ ↓ 0.2m

Weight of oil = $35.4 - 2.25 = 33.15\,N \left(\frac{1\,kN}{1000\,N}\right)$

Weight of oil = $0.03315\,kN$

$V = \pi r^2 h$

$V = \pi (0.075\,m)^2 (0.2\,m)$

$V = 3.534 \times 10^{-3}\,m^3$

$\gamma_{oil} = \frac{W_{oil}}{V}$

$\gamma_{oil} = \frac{0.03315\,kN}{3.534 \times 10^{-3}\,m^3}$

$\gamma_{oil} = 9.38\,kN/m^3$

$sg = \frac{\gamma_{oil}}{\gamma_{water@4°C}}$

$sg = \frac{9.38\,kN}{9.81\,kN/m^3}$

$\boxed{sg = 0.956}$

107) Alcohol specific gravity = 0.79

$sg = 0.79$

$\rho = sg\,(\rho_{water@4°C})$

$\rho = 0.79\,(1.94\,slug/ft^3)$

$\boxed{\rho = 1.53\,slug/ft^3}$

$1\,slug/ft^3 = 0.515\,g/cm^3$

$\rho = 1.53\,slug/ft^3 \left(\frac{0.515\,g/cm^3}{1\,slug/ft^3}\right)$

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

chapter 2

35.) viscosity of SAE 30 oil at 210°f is 2.2×10^{-4} lb·s/ft^2

17) Four examples of non-Newtonian types are.

- Bingham fluids
- pseudoplastic
- dilatant fluids
- Thixotropic fluids.

1.48

Given: $F = 18,000\,lb$ $\quad d = 2.50\,in$

To Find: $p = ?$

Solution

First, we need to find area

$$A = \frac{\pi}{4} d^2$$

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

$$= 4.908\,in^2$$

$$p = \frac{F}{A} = \frac{18,000}{4.908} = 3667\,lb\,in^{-2}$$

$$\boxed{P = 3667\,Psi}$$

1.58 ②

Given:

$\Delta V/V = 1\% = .001$ (Decrease in Volume)

For Mercury

$E = 3590000$ psi $= 24750$ MPa

To Find: $\Delta P = ?$

Solution

Bulk Modules is given by

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

$$\Rightarrow \Delta P = -E \cdot (\Delta V)/V$$

In Psi

$$\Delta P = -(3590\cdot000)(-0.01)$$
$$= +35,900 \text{ psi}$$

In MPa

$$\Delta P = -(24750)(-0.01)$$
$$= +247.5 \text{ MPa}$$

The negative sign is because the increase in pressure causes a decrease in volume of mercury.

1.63

Given $d = 0.5$ in $L = 42$ in $E = 189000$ psi

To Find: stiffness $k = ?$

Solution:

$$A = \frac{\pi}{4} d^2 = \frac{\pi}{4}(0.5^2) = 0.1963 \text{ in}^2$$

Now,

$$E = \frac{-P}{(\Delta V)/V} \quad \text{---} ①$$

But

$$V = A \times L$$

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

The negative sign is to compensate the decrease in volume

Finally,

$$P = F/A$$

Put in eq ①

$$E = \frac{-F}{A} \times \frac{\Delta L}{-A(\Delta L)} = \frac{FL}{A(\Delta L)}$$

$$\Rightarrow \frac{F}{\Delta L} = \frac{EA}{L}$$

$$= \frac{189000 \times 0.1963}{42}$$

$$= 883.3 \text{ lb/in}$$

stiffness of actuator is 883.3 lb/in

2.61

Given

$D = 1.6 \times 10^{-3}\ m$, distance $d = 0.25\ m$

$S_{oil} = 0.94$

$\gamma_{steel} = 77\ kN/m^3$

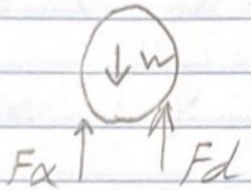
$t = 10.4\ s$

To Find

Viscosity $\eta =$

Solution

The free body diagram of the ball is given



From diagram

$$W - F_b - F_d = 0 \quad \text{—①}$$

But

$$F_b = \gamma_f V = \gamma_f \left(\frac{\pi D^3}{6}\right) \quad \text{—②}$$

$$S.G = \frac{\text{specific weight of oil}}{\text{specific weight of water}}$$

$$0.94 = \frac{\gamma_f}{9.81\ kN/m^3}$$

$$\Rightarrow \gamma_f = 9.22\ kN/m^3$$

Put in eq (2)

$$F_b = 9.22 \times \frac{\pi D^3}{6}$$

$$= \frac{9.22 \times \pi \times (1.6 \times 10^{-3})^3}{6}$$

$$= 1.97 \times 10^{-8} \text{ kN}$$

Now, the velocity is calculated as,

$$V = \frac{0.25}{10.4} = 0.024 \text{ m/s}$$

The weight of the ball is

$$W = \gamma V$$

$$= \frac{77 \times \pi \times (1.6 \times 10^{-3})^3}{6}$$

$$= 1.65 \times 10^{-7} \text{ kN}$$

Put values of F_b and W in eq (1)

$$(1.65 \times 10^{-7}) - (1.97 \times 10^{-8}) - F_d = 0$$

$$\Rightarrow F_d = 1.453 \times 10^{-7} \text{ kN}$$

Finally, the equation for viscosity is given by

$$\eta = \frac{Fd}{3\pi v D}$$

$$= \frac{1.453 \times 10^{-7}}{3\pi (0.024)(1.6 \times 10^{-3})}$$

$$= 4.015 \times 10^{-4} \text{ kN.s/m}^2$$

$$= 0.4015 \text{ N.s/m}$$

$$\Rightarrow \boxed{\eta = 0.4015 \text{ Pa.s}}$$

Homework 1

Chapter 2

Question 18

The viscosity of water at 40°C is approximated as $\mu = 6.5 \times 10^{-4}$ Pa·s

Question 27

The viscosity of Hydrogen at 40°F is approximated as 1.7×10^{-7}

Question 61

Given:

$D = 1.6 \times 10^{-3}$ m

unknown

$\mu = ?$

Specific gravity of oil = 0.94

Specific weight of steel ball = $\gamma = 77$ kN/m^3

$t = 10.4$ s

Solution

$$\mu = \frac{F}{3\pi v D}$$

Equilibrium

$$W - F_b - F_d = 0$$

$F_b = \gamma_f \cdot V$

$$\text{Specific gravity} = \frac{\text{Specific weight of oil}}{\text{Specific weight of water}}$$

$$= 0.94 = \frac{\gamma_f}{9.81\ kN/m^3}$$

$$\gamma_f = 9.22\ kN/m^3$$

$$F_s = 9.22\left(\frac{\pi D^3}{6}\right)$$

$$F_s = 9.22\left(\frac{\pi \times (1.6\times10^{-2})^3}{6}\right)$$

$$F_b = 9.22\ (2.14\times10^{-9})$$

$$F_b = 1.97\times10^{-8}\ kN$$

$$\text{Velocity} = \frac{\text{Distance}}{\text{time}}$$

$$V = \frac{0.25m}{10.4s}$$

$$V = 0.024\ m/s$$

$$W = \gamma . V$$

$$W = (77\ kN/m^3)\times(2.14\times10^{-9})$$

$$W = 1.65\times10^{-7}\ kN$$

$$\therefore W - F_b - F_d = 0$$

$$(1.65\times10^{-7}\ kN) - (1.97\times10^{-8}\ kN) - F_d = 0$$

$$(1.453\times10^{-7}) - F_d = 0$$

$$F_d = 1.453\times10^{-7}\ kN$$

$$\therefore \pi = \frac{1.453\times10^{-7}\ kN}{3\pi(0.024\ m/s)(1.6\times10^{-3}\ m)}$$

$$\pi = 0.40147\ N\cdot s/m^2$$

$$\Rightarrow \pi = 0.4015\ Pa\cdot s$$