

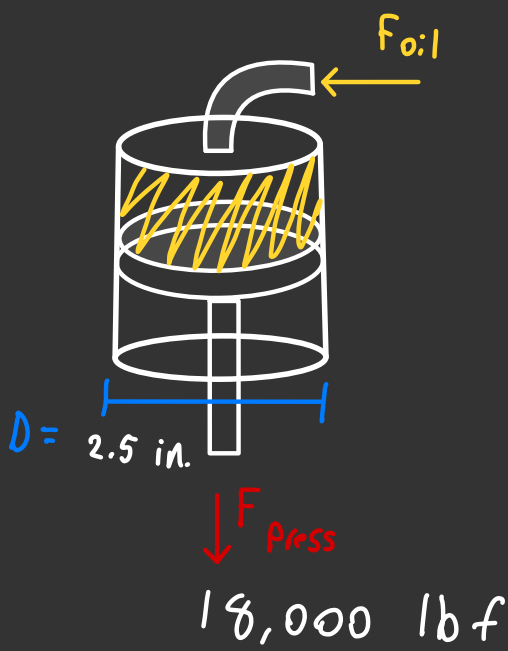
Problem

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 18 000 lb. The hydraulic cylinder has a diameter of 2.50 in. Compute the required oil pressure.

Purpose

compute the required oil pressure needed to drive the hydraulic cylinder to 18,000 lb of force output.

Drawing



Sources:

Mott, R., and Untener, J. Applied Fluid Mechanics. 7th Ed. 2015

Design Considerations:

The following must be assumed:

- 1) Incompressible fluid
- 2) Isothermal process
- 3. Newtonian fluid

Data and Variables:

$$F_{press} = 18,000\text{ lb.}$$

$$d = 2.50\text{ in.}$$

Procedure

The pressure is obtained using its definition:

$$P = \frac{F}{A}$$

The force is given and the area (perpendicular to the force direction) can be computed from the corresponding geometric relation:

$$A = \frac{\pi}{4} \cdot D^2$$

Calculations

$$A = \frac{\pi}{4} \cdot (2.5\text{ in})^2 = 4.91\text{ in}^2$$

$$P = \frac{18,000\text{ lbf}}{4.91\text{ in}^2}$$

$$P = 3667 \frac{\text{lbf}}{\text{in}^2}$$

$$P = 3667\text{ psi}$$

Problem

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

Purpose

compute the required pressure needed
To decrease the volume of mercury by 1%

Drawing



Sources:

Mott, R., and Untener, J. Applied Fluid Mechanics. 7th Ed. 2015

Design Considerations:

The following must be assumed:

- 1) Incompressible fluid
- 2) Isothermal process

Data and Variables:

$$\Delta V = 0.01$$

$$B = 2.5 \times 10^9 \text{ Pa}$$

Procedure

To find the ΔP use the equation:

$$\Delta P = - \frac{\Delta V}{V_i} \cdot \frac{1}{B}$$

Calculations

$$\Delta P = 0.01 \left(\frac{1}{2.5 \times 10^9 \text{ Pa}} \right)$$

$$\Delta P = 2.5 \times 10^{10} \times 10^{-4}$$

$$\Delta P = 2.5 \times 10^6 \text{ Pa}$$

$$\Delta P = 2.5 \times 10^6 \text{ Pa} \cdot 1.45 \times 10^{-4} \frac{\text{psi}}{\text{Pa}}$$

$$P = 362.6 \text{ psi}$$

$$P = 2.5 \text{ MPa}$$

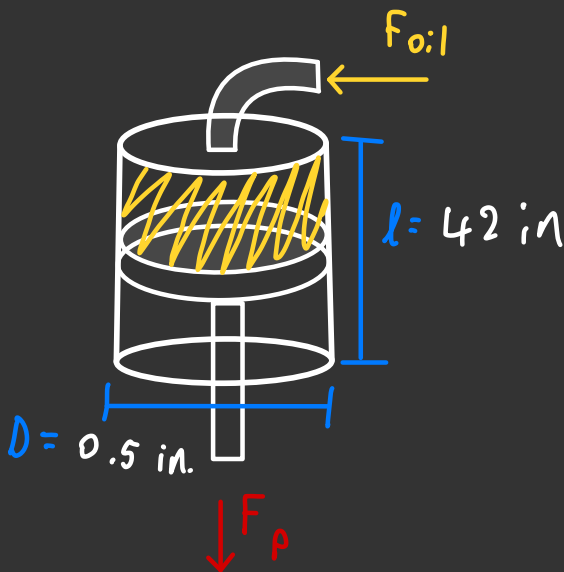
Problem

1.63 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 and a length of 42.0 in and that is filled with machine oil, compute the stiffness in lb/in.

Purpose

find the force of deflection in an actuator.

Drawing



Sources:

Mott, R., and Untener, J. Applied Fluid Mechanics. 7th Ed. 2015

Design Considerations:

The following must be assumed:

- 1) Incompressible fluid
- 2) Isothermal process

Data and Variables:

$D = 0.5 \text{ in}$

$l = 42.0 \text{ in}$

machine oil

$B = 189,000 \text{ psi} = 1,303 \text{ MPa}$

Procedure

$F = P \cdot A$

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

$A = \frac{\pi}{4} \cdot D^2$

$K = \frac{F}{l}$

$K = \frac{(-\frac{\cancel{\Delta V} \cdot B}{\cancel{V}}) \cdot A}{l}$

$K = \frac{B \cdot A}{l}$

Calculations

$V = \pi \left(\frac{0.5}{2}\right)^2 \cdot 42 = 8.25 \text{ in}^3$

$A = \frac{\pi}{4} \cdot 0.5^2 = 0.19635$

$K = \frac{189,000 \text{ psi} \cdot 0.196 \text{ in}}{42 \text{ in}}$

$K = 883.57 \text{ lb/in}$

$K = 884 \text{ lb/in}$

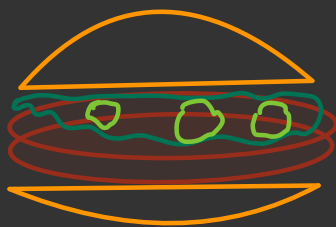
Problem

1.76 In the United States, hamburger and other meats are sold by the pound. Assuming that this is 1.00-lb force, compute the mass in slugs, the mass in kg, and the weight in N.

Purpose

Find the mass and weight of a 1 lb hamburger.

Drawing



Sources:

Mott, R., and Untener, J. Applied Fluid Mechanics. 7th Ed. 2015

Design Considerations:

The following must be assumed:

- 1) Incompressible fluid
- 2) Isothermal process

assume food is water

Data and Variables:

$$w = 1 \text{ lbf}$$

$$g = 32.2 \text{ ft/s}^2 = 9.81 \text{ m/s}^2$$

Procedure

$$1 \text{ lbf} = 1 \text{ lbm} \cdot g$$

$$\text{slug} = \frac{1 \text{ lbm}}{g}$$

$$\text{kg} = \text{slug} \cdot 14.5939$$

$$N = \text{kg} \cdot g$$

Calculations

$$\frac{1 \text{ lbf}}{32.2 \text{ ft/s}^2} = 0.031 \text{ lbm}$$

$$\frac{0.031 \text{ lbm}}{32.2 \text{ ft/s}^2} = 9.644 \times 10^{-4} \text{ slug}$$

$$9.644 \times 10^{-4} \text{ slug} \cdot 14.5939 =$$

$$0.014 \text{ kg}$$

$$0.014 \text{ kg} \cdot 9.81 \text{ m/s}^2 = 0.138 \text{ N}$$

Problem

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.

Purpose

Sources:

Mott, R., and Untener, J. Applied Fluid Mechanics. 7th Ed. 2015

Design Considerations:

The following must be assumed:

- 1) Incompressible fluid
- 2) Isothermal process

Data and Variables:

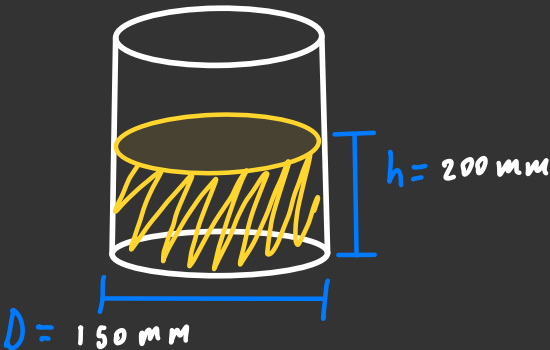
$D = 15 \text{ cm}$

$h = 20 \text{ cm}$

$w_{oil} = 33.15 \text{ N}$

$\gamma_{water} = 9810 \text{ N/m}^3$

Drawing



Procedure

Calculations

$$\gamma = \frac{w}{V} \quad \frac{\text{weight}}{\text{Volume}}$$

$$V = \pi \cdot \left(\frac{15}{2}\right)^2 \cdot 20 = 3,534 \text{ cm}^3$$

$$V = 0.0035 \text{ m}^3$$

$$V = \pi \cdot \left(\frac{D}{2}\right)^2 \cdot h$$

$$\gamma = \frac{33.15 \text{ N}}{0.0035 \text{ m}^3} = 9379 \text{ N/m}^3$$

$$Sg = \frac{9379}{9810} = 0.956$$

$$\text{Newton} = 1 \text{ kg} \cdot \text{m} / \text{s}^2$$

Problem

1.107 Alcohol has a specific gravity of 0.79. Calculate its density both in slugs/ft^3 and g/cm^3

Purpose

Drawing



Sources:

Mott, R., and Untener, J. Applied Fluid Mechanics. 7th Ed. 2015

Design Considerations:

The following must be assumed:
1) Incompressible fluid
2) Isothermal process

Data and Variables:

$$Sg = 0.79$$

Procedure

Calculations

$$Sg = \frac{\rho}{1.94}$$

$$\rho = Sg \cdot 1.94$$

$$\rho = Sg \cdot 1000 \text{ kg/m}^3$$

$$\rho = 1.94 \text{ slugs/ft}^3 \cdot 0.79$$

$$\rho = 1.53 \text{ slugs/ft}^3$$

$$\rho = 1000 \text{ kg/m}^3 \cdot 0.79$$

$$\rho = 790 \text{ kg/m}^3$$

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