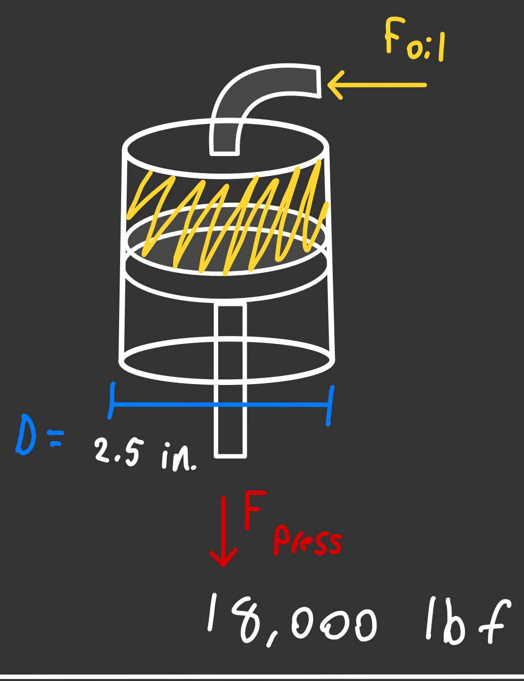
Problem

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:

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

$d = 2.50$ in.

Procedure

The pressure is obtained using its definition:

$$P = F/A$$

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

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

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

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

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

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%

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

Drawing

Data and Variables:

$\Delta V = 0.01$

$B = 25 \ GPa$

Procedure

To find the ΔP use the equation:

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

Calculations

$$\Delta P = 0.01 \left(\frac{1}{25 \times 10^9 \ Pa} \right)$$

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

$$\Delta P = 2.5 \times 10^6 \ Pa$$

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

$P = 362.6 \ Psi$

$P = 2.5 \ MPa$

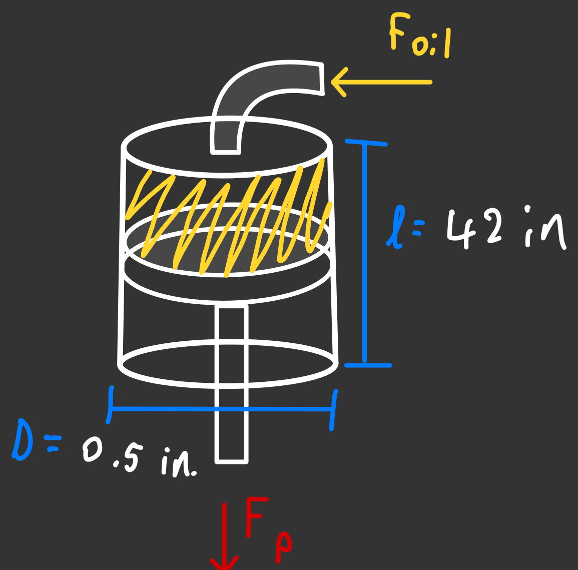
Problem

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:

$D = 0.5$ in

$l = 42.0$ in

machine oil

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

Procedure

$$F = P \cdot A$$

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

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

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

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

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

Calculations

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

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

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

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

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

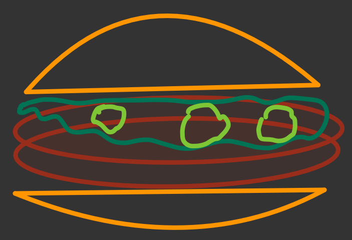
Problem

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 hamberger.

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:

$w = 1\ lbf$

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

Procedure

$1\ lbf = 1\ lbm \cdot g$

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

$Kg = slug \cdot 14.5939$

$N = kg \cdot g$

Calculations

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

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

$9.644 \times 10^{-4}\ slug \cdot 14.5939 = \boxed{0.014\ Kg}$

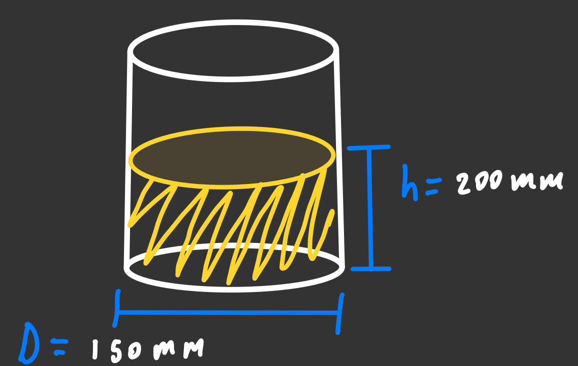
$0.014\ Kg \cdot 9.81\ m/s^2 = \boxed{0.138\ N}$

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

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:

$D = 15 \text{ cm}$

$h = 20 \text{ cm}$

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

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

Procedure

$\gamma = \frac{W}{V}$ — $\frac{\text{weight}}{\text{Voume}}$

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

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

Calculations

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

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

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

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

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

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

$$\rho = Sg \cdot 1.94$$

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

Calculations

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

$$\rho = 1.53 \ slugs/ft^3$$

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

$$\rho = 790 \ kg/m^3$$

$$\rho = 0.79 \ g/cm^3$$