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Fluid Mechanics Fundamentals and Applications

(3rd Edition)

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Chapter 2, Problem 16P

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Problem

A cylindrical tank of methanol has a mass of 40 kg and a volume of 51 L. Determine the methanol's weight, density, and specific gravity. Take the gravitational acceleration to be 9.81 m/s². Also, estimate how much force is needed to accelerate this tank linearly at 0.25 m/s².

Step-by-step solution

Step 1 of 4

Calculate the weight of the methanol.

$$W = mg$$

Here, m is the mass of methanol and g is the acceleration due to gravity.

Substitute 40 kg for m and 9.81 m/s² for g .

$$\begin{aligned} W &= 40 \times 9.81 \\ &= 392.4 \text{ N} \end{aligned}$$

Therefore, the weight of the methanol is 392.4 N.

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Step 2 of 4

Convert the units for 1L to m³.

$$\begin{aligned} 1\text{L} &= \left(\frac{1}{10}\right)^3 \times \text{m}^3 \\ &= 0.001\text{m}^3 \end{aligned}$$

Calculate the density of methanol.

$$\rho = \frac{m}{V}$$

Here, m is the mass of methanol and V is the volume of a methanol.

Substitute 40 kg for m and 51 × 0.001 m³ for V .

$$\begin{aligned} \rho &= \frac{40}{51 \times 0.001} \\ &= 784.31 \text{ kg/m}^3 \end{aligned}$$

Therefore, the density of methanol is 784.31 kg/m³.

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Calculate the specific gravity of the methanol.

$$\text{S.P} = \frac{\rho}{\rho_{\text{water}}}$$

Here, ρ is the density of methanol and ρ_{water} is the density of water.

Substitute 784.31 kg/m^3 for ρ and 1000 kg/m^3 for ρ_{water} .

$$\begin{aligned} \text{S.P} &= \frac{784.31}{1000} \\ &= 0.784 \end{aligned}$$

Therefore, the specific gravity of the methanol is **0.784**.

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Step 4 of 4

Calculate the force require to accelerate the tank.

$$F = ma$$

Here, m is the mass of methanol and a is the acceleration of the tank.

Substitute 40 kg for m and 0.25 m/s^2 for a .

$$\begin{aligned} F &= 40 \times 0.25 \\ &= 10 \text{ N} \end{aligned}$$

Therefore, the forces require to accelerate the tank is **10 N**.

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