

Problem 1.26

[Difficulty: 2]

1.26 While you're waiting for the ribs to cook, you muse about the propane tank of your barbecue. You're curious about the volume of propane versus the actual tank size. Find the liquid propane volume when full (the weight of the propane is specified on the tank). Compare this to the tank volume (take some measurements, and approximate the tank shape as a cylinder with a hemisphere on each end). Explain the discrepancy.

Given: Geometry of tank, and weight of propane.

Find: Volume of propane, and tank volume; explain the discrepancy.

Solution: Use Table G.2 and other sources (e.g., Google) as needed.

The author's tank is approximately 12 in in diameter, and the cylindrical part is about 8 in. The weight of propane specified is 17 lb.

The tank diameter is $D = 12\text{ in}$

The tank cylindrical height is $L = 8\text{ in}$

The mass of propane is $m_{\text{prop}} = 17\text{ lbm}$

The specific gravity of propane is $SG_{\text{prop}} = 0.495$

The density of water is $\rho = 998 \frac{\text{kg}}{\text{m}^3}$

The volume of propane is given by $V_{\text{prop}} = \frac{m_{\text{prop}}}{\rho_{\text{prop}}} = \frac{m_{\text{prop}}}{SG_{\text{prop}} \cdot \rho}$

$$V_{\text{prop}} = 17\text{ lbm} \times \frac{1}{0.495} \times \frac{\text{m}^3}{998\text{ kg}} \times \frac{0.454\text{ kg}}{1\text{ lbm}} \times \left(\frac{1\text{ in}}{0.0254\text{ m}} \right)^3 \quad V_{\text{prop}} = 953\text{ in}^3$$

The volume of the tank is given by a cylinder diameter D length L , $\pi D^2 L / 4$ and a sphere (two halves) given by $\pi D^3 / 6$

$$V_{\text{tank}} = \frac{\pi \cdot D^2}{4} \cdot L + \frac{\pi \cdot D^3}{6}$$

$$V_{\text{tank}} = \frac{\pi \cdot (12\text{ in})^2}{4} \cdot 8\text{ in} + \pi \cdot \frac{(12\text{ in})^3}{6} \quad V_{\text{tank}} = 1810\text{ in}^3$$

The ratio of propane to tank volumes is $\frac{V_{\text{prop}}}{V_{\text{tank}}} = 53\%$

This seems low, and can be explained by a) tanks are not filled completely, b) the geometry of the tank gave an overestimate of the volume (the ends are not really hemispheres, and we have not allowed for tank wall thickness).