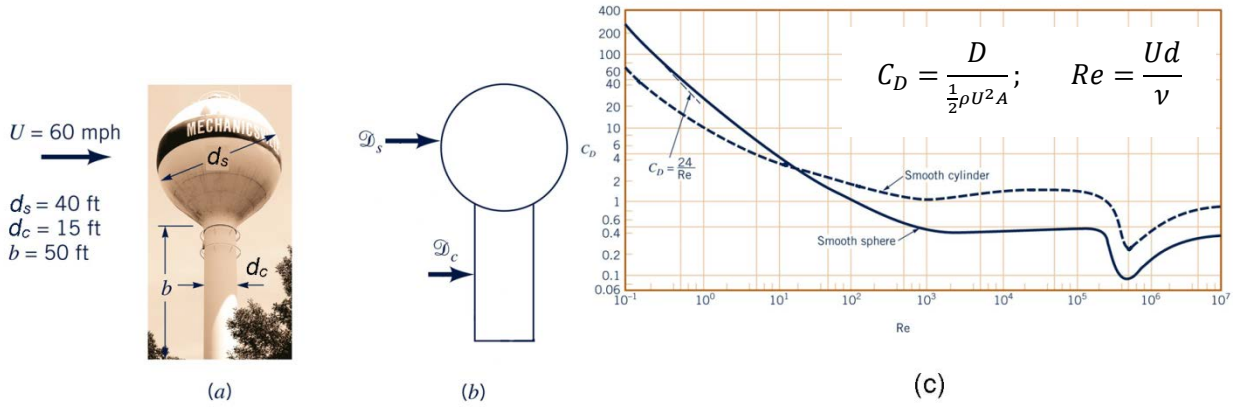
December 9, 2013

NAME

Fluids-ID

Quiz 15. A 60-mph (i.e. 88-fps) wind of air (ρ = 0.00238 slugs/ft^3 and ν = 1.57×10^{-4} ft^2/s) blows past the water tower shown in figures (a) and (b). Use the drag coefficient shown in figure (c), estimate the total drag, D, acting on the water tower. You may treat the water tower as a sphere resting on a circular cylinder and assume that the total drag is the sum of the drag from these parts, D_s and D_c, respectively.



(a) (b) (c)

Note: Attendance (+2 points), format (+1 point)

Solution:

$$D_s = \frac{1}{2}\rho U^2 A \cdot C_{Ds} = \frac{1}{2}\rho U^2 \cdot \left(\frac{\pi}{4} d_c^2\right) \cdot C_{Ds}$$

$$D_c = \frac{1}{2}\rho U^2 A \cdot C_{Dc} = \frac{1}{2}\rho U^2 \cdot (b d_c) \cdot C_{Dc}$$

(+2 points)

Calculating Reynolds number

$$Re_s = \frac{U d_s}{\nu} = \frac{(88\ ft/s)(40 ft)}{1.57 * 10^{-4}\ \mathrm{ft^2/s}} = 2.24 * 10^7$$

$$Re_c = \frac{U d_c}{\nu} = \frac{(88\ ft/s)(15 ft)}{1.57 * 10^{-4}\ \mathrm{ft^2/s}} = 8.41 * 10^6$$

(+2 point)

From Figure $C_{Ds} \approx 0.3$ and $C_{Dc} \approx 0.7$

(+2 points)

Thus,

$$D_s = \frac{1}{2}(0.00238\ slugs/ft^3)(88\ \text{ft/s})^2\left(\frac{\pi}{4}\right)(40\ ft)^2(0.3) = 3{,}470\ \text{lb}$$

$$D_c = \frac{1}{2}\left(0.00238\frac{slugs}{ft^3}\right)(88\ \text{ft/s})^2(50ft * 15ft)^2(0.7) = 4{,}840\ \text{lb}$$

Thus,

$$D = D_s + D_c = 3{,}470 + 4{,}840 = \mathbf{8{,}310\ lb}$$

(+1 point)