9.76 A supertanker has length, breadth, and draught (fully loaded) dimensions of 325 m, 48 m, and 19 m, respectively. In open seas the tanker normally operates at a speed of 15 kt (1 kt = 0.515 m/s). For these conditions, and assuming that flat-plate boundary-layer conditions are approximated, estimate the skin-friction drag of such a ship steaming in 10°C water. What power is required to overcome the skin-friction drag? What is the boundary-layer thickness at 300 m from the bow?

9.76 Information and assumptions

From Table ~~A.4~~ B.2 $\nu = 1.4 \times 10^{-6}$ m^2/s and $\rho = 1026$ kg/m^3.
provided in problem statement

Find

skin friction drag, power required and boundary layer thickness 300 m from bow.

Solution

$$\mathrm{Re}_L = U_0 L/\nu = (15 \times 0.515) \times 325/(1.4 \times 10^{-6}) = 1.79 \times 10^9$$

From Fig. 9-~~14~~15 $C_f = 0.00153$. Then

$$F_s = C_f A \rho U_0^2/2$$

$$\begin{aligned} F_s &= 0.00153 \times 325(48+38) \times 1{,}026 \times (15 \times 0.515)^2/2 = \underline{\underline{1.309 \text{ MN}}} \\ P &= 1.309 \times 10^6 \times 15 \times 0.515 = \underline{\underline{10.1 \text{ MW}}} \end{aligned}$$

To find δ at $x = 300$ m

$$\begin{aligned} \mathrm{Re}_{300} &= U_0 x/\nu = 15 \times 0.515 \times 0.515 \times 300/(1.4 \times 10^{-6}) \\ &= 1.66 \times 10^9 \\ \delta/x &= 0.16/\,\mathrm{Re}_x^{1/7} = 0.0077 \\ \delta &= 300 \text{ m} \times .0077 \\ \delta &= \underline{\underline{2.31 \text{ m}}} \end{aligned}$$