

# Heat Transfer Practice Problems

Week 6

- Q1** A 6-mm-diameter electrical transmission line carries an electric current of 50 A and has a resistance of 0.002 ohm per meter length. Determine the surface temperature of the wire during a windy day when the air temperature is 10 °C and the wind is blowing across the transmission line at 40 km/h.

Air properties at 10 °C :  $k = 0.0248 \frac{W}{m \cdot K}$   $\nu = 1.424 \times 10^{-5} \frac{m^2}{s}$   $Pr = 0.716$   $\rho = 1.257 \text{ kg/m}^3$   
 (Assume film temperature)

$$Re = \frac{VD}{\nu} = 4681.65$$

$$Nu = \frac{hD}{k} = CRe^a Pr^b = 32.03 \quad (C = 0.1930, a = 0.618)$$

$$h = Nu \frac{k}{D} = 132.39 \frac{W}{m^2 K}$$

$$\dot{Q} = IR = 5 \text{ W}$$

$$\dot{Q} = hA_s(T_s - T_{inf})$$

$$T_s = T_{inf} + \frac{\dot{Q}}{hA_s} = 12 \text{ }^\circ\text{C}$$

$$V = 40 \text{ km/h} \quad D = 6 \text{ mm}$$

$$I = 50 \text{ A} \quad R = 0.002 \text{ ohm}$$

$$T_{inf} = 10 \text{ }^\circ\text{C} \quad A_s = \pi DL = 0.01885 \text{ m}^2$$

- Q2** A 1.8-m-diameter spherical tank of negligible thickness contains iced water at 0 °C. Air at 25 °C flows over the tank with a velocity of 7 m/s. Determine the rate of heat transfer to the tank and the rate at which ice melts. The heat of fusion of water at 0 °C is 333.7 kJ/kg.

Air properties at 25 °C :  $k = 0.0259 \frac{W}{m \cdot K}$   $\nu = 1.55 \times 10^{-5} \frac{m^2}{s}$   $Pr = 0.712$   $\rho = 1.186 \text{ kg/m}^3$   
 (Free stream temperature)  $\mu = 1.84 \times 10^{-5} \text{ kg/ms}$   $\mu_w = 1.73 \times 10^{-5} \text{ kg/ms}$

$$Re = \frac{VD}{\nu} = 917002.77$$

$$V = 7 \text{ m/s} \quad D = 1.8 \text{ m}$$

# Physics Problems Mechanics Heat

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