

$$m_{ice, design} = 1.34 \text{ kg}$$

Final water to ice check

$$\dot{V} = 300 \text{ L/hr}$$

$$\dot{V} = 8.33 \times 10^{-5} \text{ m}^3/\text{s}$$

$$\rho_w = 1000 \text{ kg/m}^3$$

$$\dot{m}_w = \rho \dot{V} \Rightarrow (1000)(8.33 \times 10^{-5}) = 0.0833 \text{ kg/s}$$

$$\Delta T_w = \frac{\dot{Q}}{\dot{m}_w c_p} \Rightarrow \frac{742}{(0.0833)(4184)} = 2.13^\circ\text{C}$$

Circulating water is expected to warm by approx 2.1°C while removing heat from cans. This agrees with design assumption allowing the coolant to warm by as approx 3°C .

Water to ice convection

$$10.75 \text{ in} \times 2.0 \text{ in}$$

$$A_{flow} = (10.75)(2)(0.0254)^2 = 0.01387 \text{ m}^2$$

$$d_p = 0.010 \text{ m}$$

$$\rho_{ice} = 917 \text{ kg/m}^3$$

$$A_{ice} = \frac{6m_{ice}}{\rho_{ice} d_p} \Rightarrow \frac{6(1.34)}{(917)(0.010)} = 0.877 \text{ m}^2$$

$$A_{ice, eff} = 0.50 A_{ice} \Rightarrow (0.50)(0.877) = 0.438 \text{ m}^2$$

$$V_{ice} = \frac{\dot{V}}{A_{flow}} \Rightarrow \frac{8.33 \times 10^{-5}}{0.01387} = 0.00601 \text{ m/s}$$

$$Re_p = \frac{V_{ice} d_p}{\nu} \Rightarrow \frac{(0.00601)(0.010)}{1.788 \times 10^{-6}} = 33.6$$

$$Nu_p = 2 + 1.1 Re_p^{0.6} Pr^{1/3} \Rightarrow 2 + 1.1(33.6)^{0.6}(13.6)^{1/3} = 23.6$$

$$h_{ice} = \frac{Nu_p k}{d_p} \Rightarrow \frac{(23.6)(0.552)}{0.010} = 1304 \text{ W/m}^2 \cdot \text{K}$$

Final Corrected Cooling time check

$$UA_{ice} = h_{ice} A_{ice, eff} \Rightarrow (1304)(0.438) = 572 \text{ W/K}$$

$$C_w = \dot{m}_w c_p \Rightarrow (0.0833)(4184) = 349 \text{ W/K}$$