APPLIED THERMODYNAMICS
TUTORIAL 10(11/10/2016) Solution

Dated 11.10.2016 **Time: 50 Mins**

Q. 1

Assumptions **1** Steady operating conditions exist. **2** Kinetic and potential energy changes are negligible.

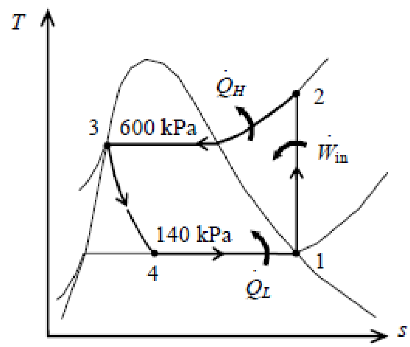
Analysis In an ideal vapor-compression refrigeration cycle, the compression process is isentropic, the refrigerant enters the compressor as a saturated vapor at the evaporator pressure, and leaves the condenser as saturated liquid at the condenser pressure. From the refrigerant tables (Tables A-12 and A-13),

$$\left.\begin{array}{l} P_1 = 140 \text{ kPa} \\ \text{sat. vapor} \end{array}\right\} \begin{array}{l} h_1 = h_{g\ @\ 140\text{kPa}} = 239.16 \text{ kJ/kg} \\ s_1 = s_{g\ @\ 140\text{kPa}} = 0.94456 \text{ kJ/kg}\cdot\text{K} \end{array}$$

$$\left.\begin{array}{l} P_2 = 600 \text{ kPa} \\ s_2 = s_1 \end{array}\right\} h_2 = 269.20 \text{ kJ/kg}$$

$$\left.\begin{array}{l} P_3 = 600 \text{ kPa} \\ \text{sat. liquid} \end{array}\right\} h_3 = h_{f\ @\ 600\text{kPa}} = 81.51 \text{ kJ/kg}$$

$$h_4 \cong h_3 = 81.51 \text{ kJ/kg (throttling)}$$



The cooling load of this refrigerator is

$$\dot{Q}_L = \dot{m}_{ice}(\Delta h)_{ice} = (7/3600 \text{ kg/s})(293 \text{ kJ/kg}) = 0.7642 \text{ kW}$$

Then the mass flow rate of the refrigerant and the power input become

$$\dot{m}_R = \frac{\dot{Q}_L}{h_1 - h_4} = \frac{0.7642 \text{ kW}}{(239.16 - 81.51) \text{ kJ/kg}} = 0.004847 \text{ kg/s}$$

and

$$\dot{W}_{in} = \dot{m}_R(h_2 - h_1) = (0.004847 \text{ kg/s})(269.20 - 239.16) \text{ kJ/kg} = \mathbf{0.146\ kW}$$