

Refrigeration Cycles Example

Given: - Refrigerant 134a in an Ideal Vapor Compression Refrigeration Cycle

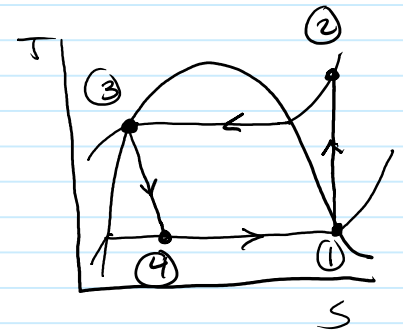
- Saturated Vapor enters the compressor at -10°C

- Saturated Liquid exits the condenser at 28°C

Determine: - The Compressor Power

- The Refrigerating Capacity

- Coefficient of Performance



State ①

$$T_1 = -10^{\circ}\text{C}$$

sat vapor

State ②

$$s_2 = s_1$$

$$P_2 = P_3$$

State ③

$$T_3 = 28^{\circ}\text{C}$$

sat liquid

State ④

$$h_4 = h_3$$

1-2

$$\frac{\dot{w}_c}{\dot{m}} = h_2 - h_1$$

Table R-1 $h_1 = h_{g1} = 241.35 \text{ kJ/kg}$
 $s_1 = s_{g1} = 0.9253 \text{ kJ/kg}\cdot\text{K}$

$$s_2 = s_1 = 0.9253 \text{ kJ/kg}\cdot\text{K}$$

Table R-1 $\Rightarrow P_2 = P_3 @ T = 28^{\circ}\text{C} \Rightarrow P_2 = P_3 = 0.72675 \text{ MPa}$

Double Interpolating $\Rightarrow h_2 = 267.9 \text{ kJ/kg}$

$$\frac{\dot{w}_c}{\dot{m}} = 267.9 \text{ kJ/kg} - 241.35 \text{ kJ/kg}$$

$$\frac{\dot{w}_c}{\dot{m}} = 26.55 \text{ kJ/kg}$$

2-3

$$\frac{\dot{Q}_{out}}{\dot{m}} = h_2 - h_3$$

Table R-1 @ $T_3 = 28^{\circ}\text{C}$, $h_3 = h_{f3} = 88.61 \text{ kJ/kg}$

$$\frac{\dot{Q}_{out}}{\dot{m}} = 267.9 \text{ kJ/kg} - 88.61 \text{ kJ/kg}$$

$$\frac{\dot{Q}_{out}}{\dot{m}} = 179.29 \text{ kJ/kg}$$

3-4

$$h_4 = h_3 = 88.61 \text{ kJ/kg}$$

4-1

$$\frac{\dot{Q}_{in}}{\dot{m}} = h_1 - h_4 = 241.35 \text{ kJ/kg} - 88.61 \text{ kJ/kg}$$

$$\frac{\dot{Q}_{in}}{\dot{m}} = 152.74 \text{ kJ/kg}$$

$$\frac{\dot{w}_{cycle}}{\dot{m}} = -\frac{\dot{w}_c}{\dot{m}} = -26.55 \text{ kJ/kg} \checkmark$$

$$\frac{\dot{Q}_{cycle}}{\dot{m}} = \frac{\dot{Q}_{in}}{\dot{m}} - \frac{\dot{Q}_{out}}{\dot{m}} = 152.74 \text{ kJ/kg} - 179.29 \text{ kJ/kg}$$

$$\frac{\dot{Q}_{cycle}}{\dot{m}} = -26.55 \text{ kJ/kg} \checkmark$$

$$\frac{\dot{w}_c}{\dot{m}} = 26.55 \text{ kJ/kg}$$

$$\text{Refrigerating Capacity} = \frac{\dot{Q}_{in}}{\dot{m}}$$

$$\frac{\dot{Q}_{in}}{\dot{m}} = 152.74 \text{ KJ/kg}$$

$$\beta = \frac{\dot{Q}_{in}/\dot{m}}{\dot{w}_c/\dot{m}} = \frac{152.74 \text{ KJ/kg}}{26.55 \text{ KJ/kg}} = 5.75$$