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ESO 201A

Solution of
Quiz # 2 (Set B)

2022-23-I

1. Assumptions :
- 1. Steady state
 - 2. $\Delta K E = 0$
 - 3. $\Delta P E = 0$
 - 4. $q = 0, w = 0$ (for throttle)
 - 5. $w = 0$ (for evaporator)
- valid for all three components
(2 points)

The schematic diagram of the vapour compression refrigeration system is shown in Fig. 1.

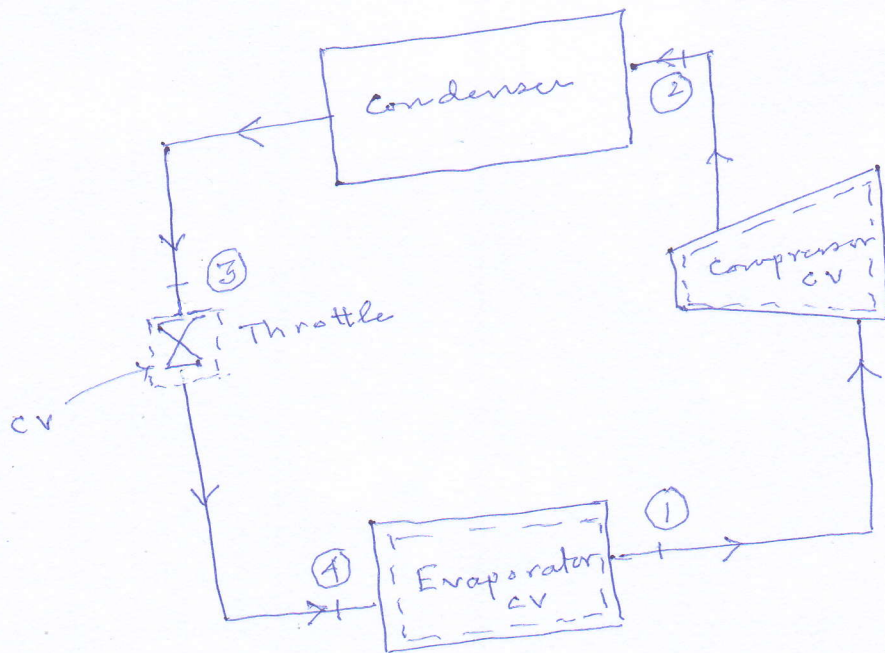


Fig. 1 Schematic diagram of the refrigerator

(4 points for the diagram, 3 points for CVs.)

(2)

(i) ThrottleFirst law to the cv $\Rightarrow h_4 = h_3 = 241.8 \text{ kJ/kg}$

$$h_4 = 241.8 = h_{f@4} + x_4 h_{fg@4}$$

$$= 167.4 + x_4 (215.6)$$

$$\Rightarrow x_4 = \frac{241.8 - 167.4}{215.6}$$

$$= \frac{74.4}{215.6} = \boxed{0.345}$$

(2 points)

(ii) Evaporator

Applying the first law to the cv,

$$\dot{Q}_{in} - \cancel{\dot{Q}_{out}}^0 = \dot{Q}_{evap} = \dot{m} (h_1 - h_4)$$

$$\Rightarrow \dot{Q}_{in} = 0.1 (387.2 - 241.8)$$

$$= 0.1 (145.4)$$

$$= \boxed{14.54 \text{ kW}}$$

(2 points)

(iii)

Compressor

Applying the first law to the cv,

$$\cancel{\dot{Q}_{in}}^0 - \dot{Q}_{out} = \dot{Q}_{comp} = \dot{m} (h_2 - h_1) + (\cancel{\dot{W}_{out}}^0 - \dot{W}_{in})$$

$$\Rightarrow -\dot{Q}_{out} = \dot{m} (h_2 - h_1) - \dot{W}_{in}$$

$$= 0.1 (435.1 - 387.2) - 5$$

$$= 0.1 (47.9) - 5$$

$$= 4.79 - 5 = -0.21$$

$$\Rightarrow \boxed{\dot{Q}_{out} = 0.21 \text{ kW}}$$

(2 points)