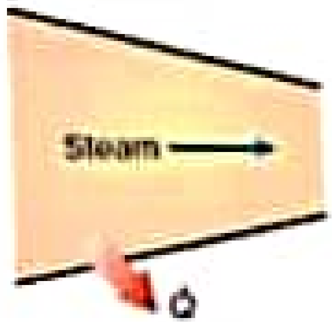
Time left 0:53:33

Steam enters a nozzle at 400°C and 600 kPa with a velocity of 5 m/s, and leaves at 300°C and 100 kPa while losing heat at a rate of 20 kW. For an inlet area of 800 cm^2, the velocity of the steam at the nozzle exit in m/s is:

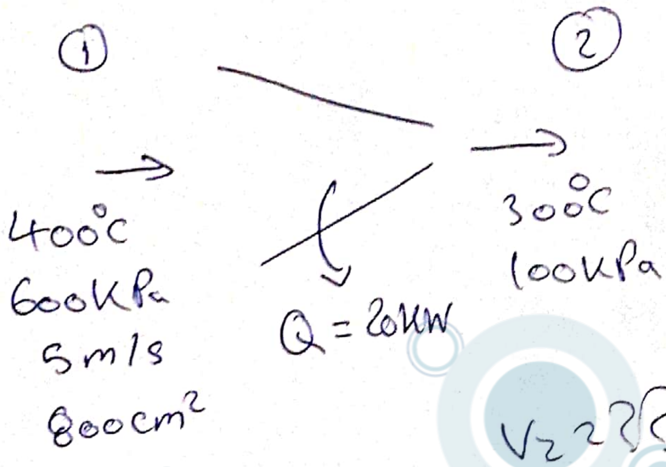


Answer:

The volume flow rate of the steam at the nozzle exit in m^3/kg is:

Answer:

Solution:-



$V_2 = ??$

$\dot{V}_2 = ??$

$$\dot{E}_{in} = \dot{E}_{out}$$

$$\cancel{Q_{in}} + \cancel{W_{in}} + \dot{m}\,(h + K.E + \cancel{P.E})_{in} = Q_{out} + \cancel{W_{out}} + \dot{m}\,(h + K.E + \cancel{P.E})_{out}$$

$$\dot{m} = \rho_1 V_1 A_1$$

$$\rho_1 = \frac{1}{v_1}$$

@ 400°C, 600KPa $\Rightarrow$ superheated

$v_1 = 0.51374$ (Table A-6)

$$\dot{m} = \frac{1}{0.51374} * 5 * 800\times10^{-4} = 0.78 \text{ Kg/s}$$

$$h_{in} = 3270.8 \text{ KJ/Kg}$$

$h_{out} = h$ @ 100KPa, 300°C
(superheated)

$$h_{out} = 3074.5 \text{ KJ/Kg}$$

$$0.78\left(3270.8 + \frac{(5)^2}{2}\cdot\frac{1}{1000}\right) = 20 + 0.78\left(3074.5 + \frac{V_2^2}{2}\cdot\frac{1}{1000}\right)$$

$$V_2 = 584.25 \ m/s$$

$$\dot{m} = \rho \dot{V}$$

$$\dot{m}_2 = \rho_2 \dot{V}_2$$

$$\dot{m}_2 = \dot{m}_1 = 0.78 \ kg/s$$

$$\rho_2 = \frac{1}{v_2}$$

v_2 @ 100 kPa, 300°C = 2.6389 m³/kg

$$\dot{V}_2 = \frac{0.78}{v_2} = 2.06 \ m^3/s.$$

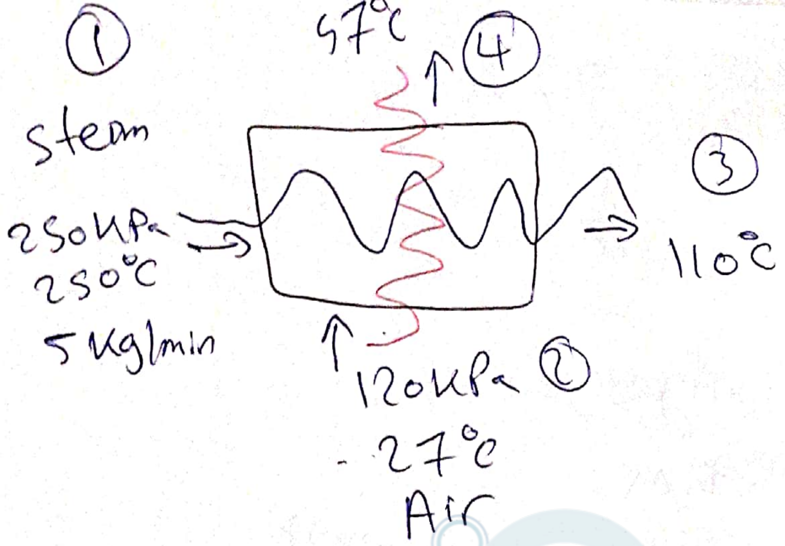
Time left 0:45:40

In a steam-heating system, air is heated by being passed over some tubes through which steam flows steadily. Steam enters the heat exchanger at 250 kPa and 250°C at a rate of 5 kg/min and leaves at 200 kPa and 110°C. Air enters at 120 kPa and 27°C and leaves at 57°C. The volume flow rate of air at the inlet in m^3/kg is:

Answer:

The rate of heat transfer to the air in kW is:

Answer:



$\dot{V}_2 = ??$

$\dot{Q} = ??$

$\dot{V}_2 = \frac{\dot{m}_2}{\rho_2}$

$\dot{m}_1 h_1 + \dot{m}_2 h_2 = \dot{m}_3 h_3 + \dot{m}_4 h_4$

$h_1 = h @ \begin{smallmatrix} 250kPa \\ 250^\circ C \end{smallmatrix}$

@ 250kPa, 250°C $\Rightarrow$ superheated

$h_1 = 2969.55$ kJ/kg

$h_2 = C_p T_2 = 1.005(27+273)$

$= 301.5$ kJ/kg

$h_3 = h @ 110°C, 250kPa$

@ 110°C, 250kPa $\Rightarrow$ subcooled

$h_3 = h_f @ 110°C = 461.42$

$h_4 = C_p T_4 = 1.005(57+273)$

$= 331.65$ kJ/kg

$\dot{m}_1 = \dot{m}_3 = \frac{5}{60}$ kg/s

$$\frac{5}{60}(2969.55) + \dot{m}(301.5) = \frac{9}{60}(461.42) + \dot{m}(851.65)$$

$$\dot{m} = 6.932\ kg/s$$

$$\rho_2 = \frac{1}{v_2}$$

$$P_2 v_2 = R T_2$$

$$v_2 = \frac{0.287(300)}{120}$$

$$= 0.7175\ m^3/kg$$

$$\dot{V} = \frac{\dot{m}}{\rho_2} = \dot{m} v_2 = 4.97\ m^3/s.$$

$$\dot{Q} = \dot{m}_{air} \Delta h$$

$$= 6.932(c_p(T_2 - T_1))$$

$$= 209\ kW$$

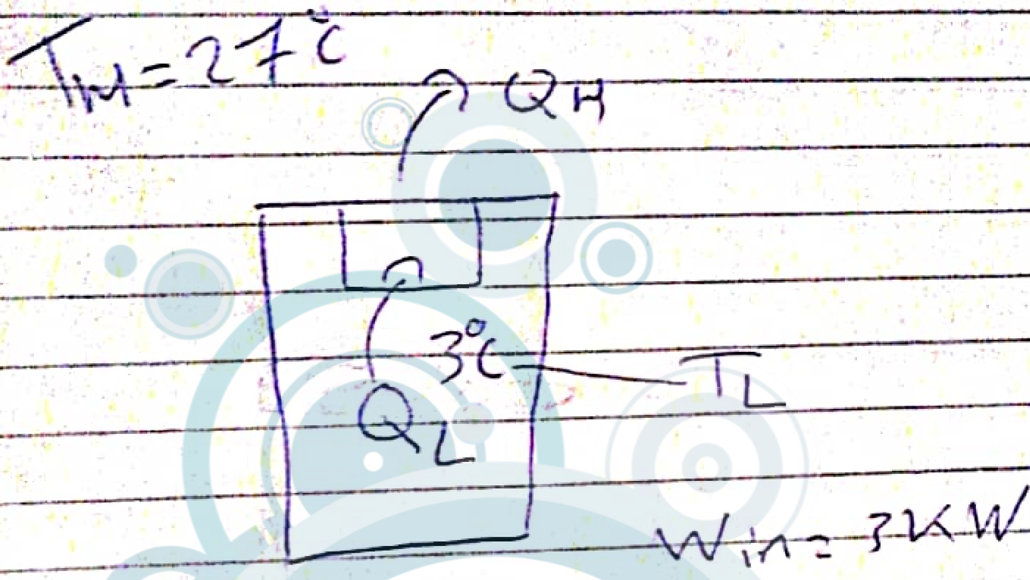
Time left 0

A Carnot refrigerator operates in a room in which the temperature is 27°C and consumes 3 kW of power when operating. If the food compartment of the refrigerator is to be maintained at 3°C, the coefficient of performance for this Carnot refrigerator is:

Answer:

The rate of heat removal from the food compartment in kW is:

Answer:



$$COP_{carnot\ (refrigerator)} = \frac{1}{T_H / T_L - 1}$$

$$= \frac{1}{\frac{27+273}{3+273} - 1} = 11.5$$

$$COP = \frac{\dot{Q}_L}{\dot{W}_{in}}$$

$$11.5 = \frac{\dot{Q}_L}{3}$$

$$\dot{Q}_L = 34.5\,kW$$

Time left 0:46:22

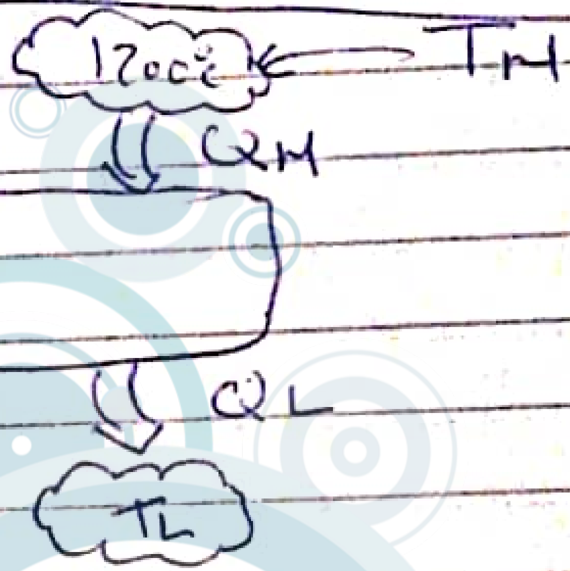
A heat engine receives heat from a heat source at 1200°C and has a thermal efficiency of 60 percent. The heat engine does maximum work equal to 300 kJ. The heat supplied to the heat engine by the heat source in kJ is:

Answer:

The temperature of the heat sink in °C is:

Answer:

$\boxed{W_{max} \equiv \text{carnot or } Q_{in\,min}}$



$W_{net} = 300\,kJ$

$\eta_{th} = 60\%$

$Q_{in} = \frac{W_{net}}{\eta_{th}} = \frac{300}{0.60} = 500\,kJ$

$T_L = ??$

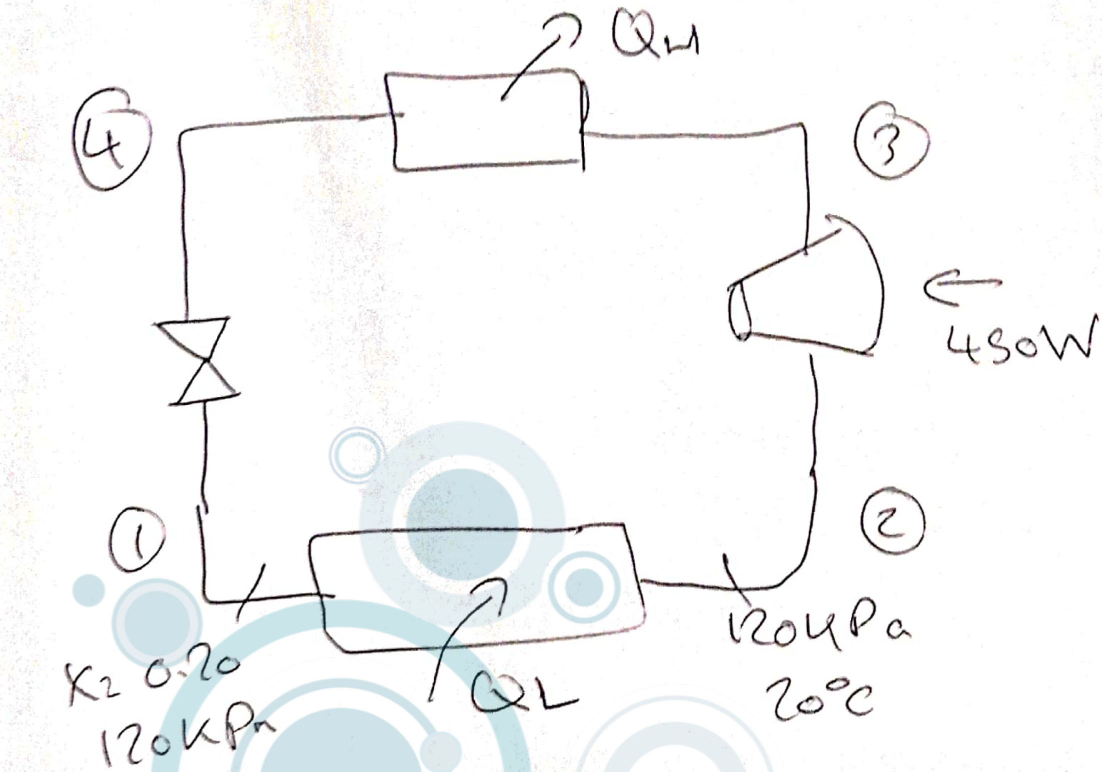
$\eta_{th} = 1 - \frac{T_L}{T_H}$

$0.60 = 1 - \frac{T_L}{1200+273}$

$T_L = 589.2\,K = 316.2^\circ C$

Scanned with CamScanner

Refrigerant-134a enters the evaporator coils placed at the back of the freezer section of a household refrigerator at 120 kPa with a quality of 20 percent and leaves at 120 kPa and 20°C. If the compressor consumes 450 W of power and the COP the refrigerator is 1.2, determine (a) the mass flow rate of the refrigerant and (b) the rate of heat rejected to the kitchen air.



$\dot{m} ??$

$COP_R = 1.2$

$$COP_R = \frac{\dot{Q}_L}{\dot{W}_{in}}$$

$$1.2 = \frac{\dot{Q}_L}{450}$$

$$\dot{Q}_L = 540W$$

$$\dot{Q}_L = \dot{m}(h_2 - h_1)$$

$$h_1 = h_f + x h_{fg}$$
$$= 22.47 + 0.2(214.52)$$
$$= 65.374$$

@ 120KPa, 20° ⟹ Superheated

$$h_2 = 271 \ kJ/kg$$

$$540\times10^{-3} = \dot{m}(271 - 65.374)$$

$\dot{m} = 2\times10^{-3}\ kg/s$

$\dot{W}_{in} = \dot{Q}_H - \dot{Q}_L$

$Q_H = 990W$