Tutorial-8

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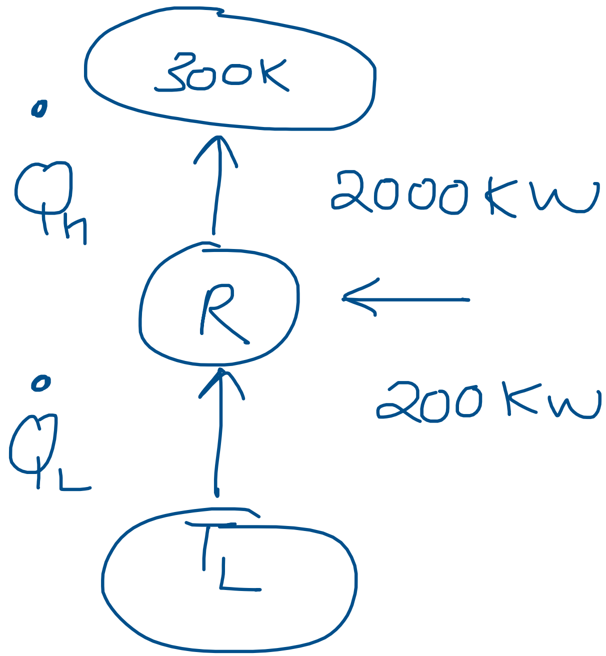
Kartik Choudhary [B20CS025]

Tutorial 8 Thermodynamics [MEL2020]

1.



$$\dot{Q}_L = \dot{Q}_H - \dot{W}_{net,in} = 2000 - 200 = \underbrace{1800\text{ kW}}$$

COP T_L

$$COP_{R,max} = \frac{T_L}{T_H - T_L}$$

$$COP_R = \frac{\dot{Q}_L}{\dot{W}_{net,in}} = \frac{1800\ kW}{200\ kW} = 9$$

$$9 = \frac{T_L}{300 - T_L} \Rightarrow \boxed{T_L = 270K = -3^\circ C}$$

(2) Given data, power input = 450 W

COP of refridgerator = 2.5

Temprature $T_1 = 8^\circ C$

$T_2 = 20^\circ C$

mass of watermelon = 10 kg

specific heat $= 4.2\ KJ/kg^\circ C$

The amount of heat removed from 5 watermelons

$$Q_1 = mc_p dt$$

$$Q_1 = 5 \times 10 \times 4.2 \times [20 - 8]$$

$$Q_1 = 2520\ KJ$$

we know that $COP = Q_2/W$

$$2.5 = \frac{Q_2}{450}$$

$$Q_2 = 1125\ W = 1.125\ kW$$

So time required to cool the watermelon is

$$t = \frac{Q_1}{Q_2} = \frac{2520}{1.125} = 2240 \text{ sec}$$

3. we know

$$\text{efficiency} = \frac{W}{Q}$$

$$Q = \frac{W}{\text{efficiency}} = \frac{300000}{0.32} = 937500 \text{ Kw}$$

t = time = 24h = 86400s

C = 28000 KJ/kg

$$\frac{t}{c} = \frac{86400s}{28000 \text{ KJ/kg}} = 3.08 \frac{\text{kg}}{\text{kw}}$$

M = (937500kw)(3.08 Kg) = 2887500k

$m_{coal} = ([illegible]) \left(\frac{[illegible]}{kw} \right) = 2887500\,kg$

a) The amount of coal consumed during 24 hour period = 2887500 kg

to find the rate of air flowing through the furnace, we use the gravimetric air-fuel ration

$$\frac{m_{air}}{m_{coal}} = 12$$

$$m_{air} = 12 \times m_{coal}$$

$$m_{air} = 12 \times 2887500\,kg = 34650000\,kg$$

to find the flow

$$M_{air} = \frac{34650000\,kg}{24\,hr} \cdot \frac{1\,h}{3600\,s} = 401.01\,kg/s$$

b) The rate of air flowing through the furnace is

<u>401.01 kg/s</u>

4.

The initial specific enthalpy is obtained from A-12 for the given pressure and quality, while the final one is taken from A-13 for the given pressure and temperature using interpolation.

Then the mass flow rate is determined from the energy balance.

$$\dot{m}h_1 + \dot{Q}_L = \dot{m}h_2$$

$$\dot{m} = \underline{\dot{W}COP_R}$$

$h_2 - h_1$

$$= \frac{0.6 \times 1.2}{234.75 - 60.708} \ \frac{kg}{s}$$

$$= \boxed{0.00414 \ \frac{kg}{s}}$$

The heat rejected to the kitchen air is determined from the power and the COP

$$\dot{Q}_H = \dot{W} + \dot{Q}_L$$

$$= \dot{W} \left(1 + COP_R\right)$$

$$= 0.6 \left[1 + 1.2\right] \ kW$$

$$= \boxed{1.32\,KW}$$

b) Rate of heat rejected $= 1.32\,KW$