Guía 8

1. $u_{carbón} = 30000 \frac{kJ}{kg}$ $\quad \dot{W}_{neto,sale} = 150\ MW$

$\dot{m} = 60 \frac{ton}{hr}$

$\dot{Q}_{in} = \dot{m}\, u$ $\quad \eta = \frac{\dot{W}_{sale}}{\dot{Q}_{in}}$

2. $\eta = \frac{W_{sale}}{Q_{in}}$ $\quad W_{sale} = 1.878 \times 10^{12}\ kWh$

$Q_{in} - Q_{out} = W_{sale} \Rightarrow Q_{out} = Q_{in} - W_{sale}$

$Q_{out} = \frac{W_{sale}}{\eta} - W_{sale} = \left(\frac{1}{\eta} - 1\right) W_{sale}$

3. $COP = 2.2$

funciona $\frac{1}{4}$ del tiempo

Compartimento de comida: sale a $800 \frac{kJ}{h} = \dot{Q}$

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

$\dot{Q}_L = 4\ \dot{Q}$ $\quad \dot{Q} = 800 \frac{kJ}{h}$ esto porque

El calor que sale en 1 día ~~se~~ ocupa solo $\frac{1}{4}$ de éste.

$Q_{día} = \dot{Q}\, \Delta t_1$ $\quad \Delta t_1 = 1\ día = 24\ hr.$

$\dot{Q}_L = \frac{Q_{día}}{\left(\frac{\Delta t_1}{4}\right)} = 4 \frac{Q_{día}}{\Delta t_1} = 4\ \dot{Q}$

4. $\dot{W}_{in} = 450\ W$

$m = 50\ kg$ de agua → enfriar desde $20°C$ a $8°C$

$$COP = \frac{\dot{Q}_L}{\dot{W}_{in}} \quad y \quad \dot{Q}_L = \frac{Q_{L\,TOTAL}}{\Delta t} \qquad Q_L = c\,m\,\Delta T$$

5. $T_1 = 32°C$ a $T_2 = 20°C$ en $15\ min = \Delta t$

$$Q_L = C_v\, m\, \Delta T \qquad m = 800\ kg \qquad C_v = 0.72\ \frac{kJ}{kg\,°C}$$

$$|\Delta T| = 12°C$$

$$COP_R = \frac{Q_L}{\dot{W}\,\Delta t} \Rightarrow \dot{W} = \frac{Q_L}{COP_R\,\Delta t}$$

6. $COP_{HP} = \dfrac{\dot{Q}_H}{\dot{W}_{in}}$

$\dot{Q}_1 = 60000\ \frac{kJ}{h}$; $\tilde{\dot{Q}} = 4000\ \frac{kJ}{h}$ ⟩ $\dot{Q}_H$

$$\dot{Q}_H = \dot{Q}_1 - \tilde{\dot{Q}}$$

$$\dot{W}_{in} = \frac{\dot{Q}_H}{COP_{HP}}$$

7) Entra 134a

Entra	Sale
$P_1 = 120\ kPa$	$P_2 = 120\ kPa = P_1$
$x = 20\%$	$T = -20°C$

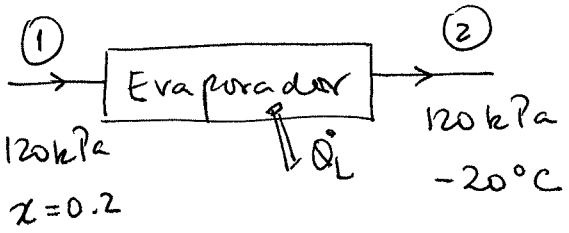
Consumo compresor $\rightarrow 450\ W$ $\qquad COP_R = 1.2$

Calcule

a. Flujo de masa.

$$COP_R = \frac{\dot{Q}_L}{\dot{W}_{in}} \qquad \dot{W}_{in} = 450\ W$$

$120\ kPa = 0.12\ MPa$



$h_1 = 65.38\ \frac{kJ}{kg}$ $\qquad h_2 = 238.84\ \frac{kJ}{kg}$

$h_1 = h_f + x(h_g - h_f)$

$= h_f + x\, h_{fg}$

$= 21.32 + 0.2 \times 212.54$

$= 63.82$

$T = -20°C$

$P = 0.1\ MPa \rightarrow h_1 = 236.54\ \frac{kJ}{kg}$

$$\dot{m} h_1 = \dot{Q}_L + \dot{m} h_2 \Rightarrow \dot{m} = \frac{\dot{Q}_L}{(h_1 - h_2)} = \frac{COP_R\ \dot{W}_{in}}{(h_1 - h_2)}$$

$$\dot{m} = \frac{1.2 \times 0.45 \text{ kW}}{(236.54 - 63.82)\frac{\text{kJ}}{\text{kg}}} = 0.00313 \frac{\text{kg}}{\text{s}}$$

b)

Para el ciclo:

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

$$COP\ \dot{W}_{in} + \dot{W}_{in} = \dot{Q}_H \Rightarrow \dot{Q}_H = \dot{W}_{in}(1 + COP)$$

$$= 0.45 \times (1 + 1.2)$$

$$= 0.99 \text{ kW}.$$

10) $\dot{W}_{in} = 500$ W $COP = 4.5$ $T_H = 25°C$

a) $COP = \frac{\dot{Q}_L}{\dot{W}_{in}} \Rightarrow \dot{Q}_L = COP\ \dot{W}_{in} = 4.5 \times 500$

$$= 2250 \text{ W} = 2.25 \text{ kW}$$

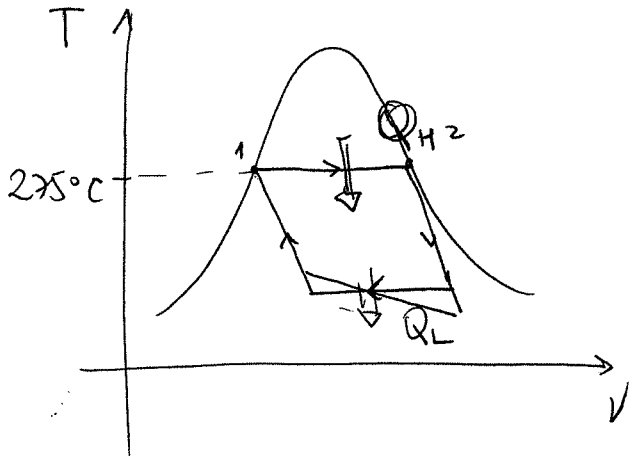
b) $COP = \frac{\dot{Q}_L}{\dot{Q}_H - \dot{Q}_L} = \frac{1}{\frac{\dot{Q}_H}{\dot{Q}_L} - 1} \overset{\text{Carnot}}{=} \frac{1}{\left(\frac{T_H}{T_L} - 1\right)}$

13. Carnot

$\eta_t = 0.3$

Carnot fase líquido a 275°C
agua

$\dot{m} = 3 \frac{kg}{s}$



Entre 1 y 2:

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

$= \dot{m}\, h_{fg@275°C}$

270	$h_{fg} = 1605.2$	275°C → 1574.4	$\frac{kJ}{kg}$
280	$h_{fg} = 1543.6$		

$\dot{Q}_H = 3 \times 1574.4 = 4723.2$ kW

$\eta_t = 0.3$

$\dot{W}_{net,out} = \eta_{th} \dot{Q}_H = 1417$ kW

8) a) $\left(\frac{Q_H}{Q_L}\right)_{rev} = \frac{T_H}{T_L}$

$\rightarrow T_H = \left(\frac{Q_H}{Q_L}\right)_{rev} T_L$

$= 772.2\ K$

b) $\eta_{th,C} = 1 - \frac{T_L}{T_H}$

$= 0.615$

9) $\eta_{th,C} = 1 - \frac{T_L}{T_H} = 1 - \frac{300}{400} = 0.25$

$\eta_{inventor} = \frac{W_{net}}{Q_H} = \frac{250}{750} = 0.33$

Falso → no se puede $\eta_{inventor} > \eta_{th,C}$

12) $\eta_{th\,I} = 1 - \frac{T}{T_H}$ $\quad \eta_{th,II} = 1 - \frac{T_L}{T}$

y $\eta_I = \eta_{II} \Rightarrow T = \sqrt{T_H T_L}$

13) $T_H = 750\ K$, $T_L = 300\ K$ $\rightarrow \dot{W}_{out}$ hace funcionar un refrigerador de Carnot

$T_L' = -15°C = 258\ K$

$\dot{Q}_L' = 400\ \frac{kJ}{min}$

$T_H' = 300\ K$

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

$COP_R \rightarrow$ carnot $\Rightarrow COP_R = \frac{1}{\frac{T_H'}{T_L'} - 1}$

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

$\eta_c = 1 - \frac{T_L}{T_H} \Rightarrow \eta_c = \frac{\dot{W}_{out}}{\dot{Q}_H} \Rightarrow \dot{Q}_H = \frac{\dot{W}_{out}}{\eta_c}$

b) Maquina carnot:

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

Refrigerador Carnot

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

Entonces

$$\dot{Q}_{ambiente} = \dot{Q}_H + \dot{Q}_H'$$

14. $T_1 = 10\,^\circ C$ $\quad T_2 = 50\,^\circ C$

$\dot{V} = 0.02\ m^3/min = 0.002\ \frac{m^3}{60} = 3.33 \times 10^{-4}\ \frac{m^3}{s}$

$T_L = 0\,^\circ C = 273\ K$

a) $\dot{Q} = \dot{m} C_{H_2O} \Delta T$ $\quad \rho = 1000\ \frac{kg}{m^3}$

$\dot{Q} = \rho \dot{V} C \Delta T = 1000 \times 3.33 \times 10^{-4} \times 4186 \times 40$

$= 55.76\ kW$

b) $T_H = 30\,^\circ C = 303\ K$

$T_L = 0\,^\circ C = 273\ K$

COP_{max} maxima $\rightarrow$ carnot $\quad COP_{max} = \frac{1}{1 - \frac{T_L}{T_H}} = 10.1$

$\dot{W}_{in,minimo} = \frac{\dot{Q}_H}{COP_{max}} = \frac{55.76}{10.1} = 5.52\ kW$