Guía 5

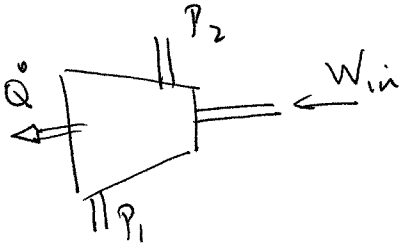
1. $\dot{W}_{in} = 12\ kW$ $\quad P_1 < P_2$

$T = 25°C$ constante

medio $T_L = 10°C$

aire → gas ideal, despreciamos $\Delta ec = \Delta ep$

Compresor → proceso internamente reversible isotérmico



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

$$\dot{W}_{in} = \dot{Q}_{out} \Rightarrow$$

$$\Delta \dot{S}_{aire} = -\frac{\dot{Q}_{out}}{T} = -\frac{12\ kW}{(25+273)}$$

2. Ciclo Carnot

ingresan 900 kJ al fluido trabajo desde fuente 400 °C

a) $\Delta S_{fluido} = \dfrac{Q_{in,\,fluido}}{T_{fluido}}$

b) $\Delta S_{fuente} = -\dfrac{Q_{out,\,fuente}}{T_{fuente}}$

c) $S_{gen} = \Delta S_{fluido} + \Delta S_{fuente} = 0$

3) $m = 2\ kg$

vapor - líquido saturado → $P_1 = 100\ kPa = 0.1\ MPa$
agua

$m_f = \frac{3}{4} m \quad m_g = \frac{1}{4} m$ → inicial

→ $x = 0.25$

$P_1 = 100\ kPa$, $x = 0.25$ { $s_f = 1.3029\ \frac{kJ}{kg\,K}$, $s_{fg} = 6.0573\ \frac{kJ}{kg\,K}$ } $s_1 = s_f + x s_{fg} = \ldots$

↳ { $v_f = 0.001043\ m^3/kg$, $v_g = 1.694\ m^3/kg$ } $v_1 = v_f + x(v_g - v_f)$ $= 0.42428$

Se evapora todo [illegible]

[illegible] → $s_2 = s_g$

$v_2 = v_1 = 0.42428\ m^3/kg$

Table: $P = 0.4\ MPa$ $v_g = 0.4625$ $s_g = 6.8967$

$P = 0.6\ MPa$ $v_g = 0.3157$ $s_g = 6.7609$

Se interpola para sacar s_g a $v_2 = 0.4243$

y después $\Delta S = m(s_2 - s_1)$

4) $P_1 = 300\ kPa$, $T_1 = 60°C$ $\Rightarrow$ $v_1 \simeq v_{f@60°C} = 0.001017$

$s_1 \simeq s_{f@60°C} = 0.8310$

$P_2 = 15\ kPa = 0.015\ MPa$ $\rightarrow$ $v_f = 0.001014$, $v_g = 10.0615$, $v_{fg} = 10.060486$

$v_2 = 2v_1 = 0.002034$

Interpolar

Calculo x

Luego $s_f = 0,7542$ $\quad s_{fg} = 7.2559$

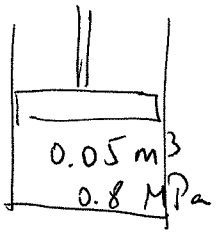
$s_g = 8.01005$

Calculo $s_2 = s_f + x\, s_{fg}$

Como $m = 1.5\ kg$ $\rightarrow$ FALTABA ESTE DATO!

$\Delta S = m(s_2 - s_1)$

5.



$V_1 = 0.05\ m^3$

$P_1 = 0.8\ MPa$

Se expande reversiblemente $P_2 = 0.4\ MPa$

despreciamos cambios energía cinética y potencial

Cilindro bien aislado → no hay cambio de calor.

~~paso~~.

a) proceso adiabático ⇒ proceso isoentrópico

$P_1 = 0.8\ MPa$ vapor saturado

$v_1 = v_{g@0.8MPa} = 0.025621\ m^3/kg$ (0.0255)

$u_1 = u_{g@0.8MPa} = 246.79\ kJ/kg$ (243.78)

$s_1 = s_{g@0.8MPa} = 0.91835$ (0.9066)

Calculamos

$$m = \frac{V_1}{v_1} = \frac{0.05}{0.0255} = 1.95\ kg$$

$P_2 = 0.4\ MPa$ → $s_f = 0.2395$, $s_g = 0.9145$

$s_2 = s_1$

$$s_2 = s_f + x_2 (s_g - s_f)$$

$$x_2 = \frac{s_2 - s_f}{s_g - s_f} =$$

$$\Rightarrow u_2 = u_f + x_2(u_g - u_f)$$

5 (continuación)

a) $T = T_{sat@0.4\,MPa} = 8.93\,^{\circ}C$

b) $\Delta E_{sistema} = E_{in} - E_{out}$

$m(u_2 - u_1) = \cancel{0} - W_{out}$

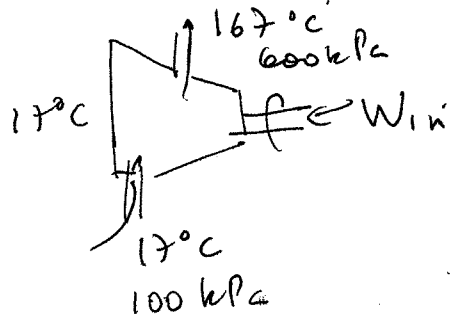
$W_{out} = m(u_1 - u_2)$

c) Compresor $5\,kW = \dot{W}_{in}$

$P_1 = 100\,kPa$, $T_1 = 17^{\circ}C$ $\rightarrow$ $P_2 = 600\,kPa$, $T_2 = 167^{\circ}C$

$\dot{m} = 1.6\ \frac{kg}{min}$

Sale calor al medio que está a 17°C.



$P_1 = 100\,kPa$, $T_1 = 290\,K$ $\rightarrow$ $s_1^{\circ} = 1.66802$

$273 + 17 = 290$

$= 1.6$

$P_1 = 600\,kPa$, $T_2 = 167^{\circ}C = 440\,K$ $\rightarrow$ s_2° 2.08870

$$S_2 - S_1 = \int_1^2 C(T)\frac{dT}{T} = \underbrace{\int_0^2 \frac{C(T)dT}{T}} - \int_0^1 \frac{C(T)\,dT}{T}$$

$$= S_2^\circ - S_2^1$$

$$\Delta S = \dot{m}\,\Delta s$$
$$= \dot{m}\,(s_2^\circ - s_1^\circ) \leftarrow -R\ln\left(\frac{P_2}{P_1}\right)$$

6) $m = 5\ kg$

vapor de agua saturado 100 °C

Se enfría hasta 25° C

a) $T_1 = 100\ °C$

$x_1 = 1$

$v_g = 1.673\ \frac{m^3}{kg} = v_1$

$u_g = 2506.5\ \frac{kJ}{kg}$

$s_g = 7.3557\ \frac{kJ}{kg\,K}$

$T_2 = 25°C$

$v_2 = v_1$

$v_f = 0.001003$ $\quad u_f = 104.9$ $\quad s_f = 0.3672$

$v_g = 43.36$ $\quad u_g = 2409.8$ $\quad s_{fg} = 8.1916$

$s_g =$

$$v_2 = v_f + x(v_g - v_f)$$

$$x = \frac{v_2 - v_f}{v_g - v_f} = \frac{1.673 - 0.001003}{43.36 - 0.001003} = 0.0386$$

$u_2 = 193.87\ \frac{kJ}{kg} = u_f + x(u_g - u_f)$

$s_2 = s_f + x\,s_{fg} =$ 0.683 $\frac{kJ}{kg\,K}$ discrepancia con el libro...

$\Delta S = m(s_2 - s_1) = 5 \times (0.683 - 7.3557)$

$\Delta S = -33.36\ \frac{kJ}{K}$ → resultado con nuestras tablas

b) $E_{in} - E_{out} = \Delta E_{sist}$

$-Q_{out} = m(u_2 - u_1)$

$Q_{out} = 5(2506.5 - 193.87) = 2312.63 \times 5$

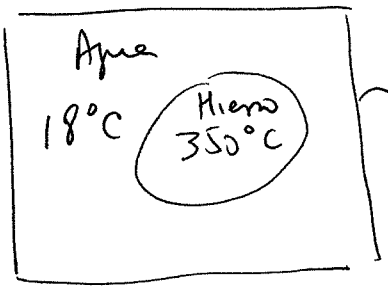
$= 11563.2\ J$

$S_{ger} = \Delta S_{agua} + \frac{Q_{out}}{T_{entorno}}$

$= -33.36 + \frac{11563.2}{(25+273)}$

$S_{ger.} = 5.44\ \frac{kJ}{K}$

7.



$C_{Hierro} = 0.45 \frac{kJ}{kg\,K}$

$C_{Agua} = 4.186 \frac{kJ}{kg\,K}$

$$\Delta U_{Hierro} + \Delta U_{agua} = 0$$

$$\left[mc\,(T_2 - T_1) \right]_{Hierro} + mc\left[(T_2 - T_1) \right]_{Agua} = 0$$

$T_2 = 26.7°$ → temp. final sistema

$$\Delta S_{Hierro} = m\,C_{Hierro} \ln \left(\frac{T_2}{T_1} \right)_{Hierro}$$

$$\Delta S_{Agua} = m\,C_{Agua} \ln \left(\frac{T_2}{T_1} \right)_{agua}$$

$$S_{gen} = \Delta S_{Hierro} + \Delta S_{agua}$$

8) aire → gas ideal $R = 0.287 \frac{kJ}{kg\,K}$, $C_p = 1.02 \frac{kJ}{kg\,K}$

↓ se calienta $\Delta t = 15$ min con $\dot{W} = 200$ W

$V_1 = 300$ L → volumen

$P_1 = 120$ kPa

$T_1 = 17°C$

Calculo la masa de aire $m = \frac{P_1 V_1}{R T_1} = 0.4325$ kg.

El calor que entrega el aire por trabajo eléctrico

$$W_{e,in} = \dot{W} \Delta t$$

1er ley: $\Delta U = W_{e,in} - W_{frontera,out}$

↓ Cambio energía interna aire

$\Delta U + W_{frontera} = \Delta H$ si P es constante

$\Rightarrow W_{e,in} = \Delta H = m(h_2 - h_1) = m C_p (T_2 - T_1)$

$T_2 = T_1 + \frac{W_{e,in}}{m C_p} = 698$ K

$\Delta S_{sis} = m(s_2 - s_1) = m C_p \ln\left(\frac{T_2}{T_1}\right) = 0.387$ kJ/K

10)

$m = 45\ kg$ → agua líquida a $95°C$

$C_a = 4.186\ \frac{kJ}{kg\ °K}$

$V = 90\ m^3$ aire → gas ideal a $12°C$

→ esta a presión atmosférica $P = 101.3\ kPa$

→ la habitación está aislada.

→ $R = 0.287\ \frac{kJ}{kg\ K}$

→ Calor específico aire $C_v = 0.718\ \frac{kJ}{kg\ K}$

Calculo masa aire: $m = \frac{P_1 V_1}{R T_1}$

Calculo temperatura equilibrio del sistema

$$0 = m_a C_a (T_2^* - T_{a_1}) + m_{aire} C_{aire} (T_2^* - T_{aire_1})$$

$$T_2 = 70.2\ °C$$

Calor transferido al aire

$$Q = m C_v (T_2 - T_{aire_1}) = 4660\ kJ$$

La generación de entropía:

agua: $\Delta S_{agua} = m_a C_a \ln\left(\frac{T_2}{T_{a_1}}\right)$

aire:

$$P_2 = \frac{m_{aire} R T_2}{V}$$

y calculo

$$\Delta S_{aire} = m_a \left(C_p \ln \frac{T_2}{T_{aire_1}} - R \ln \left(\frac{P_2}{P_1} \right) \right)$$

Por ultimo

$$S_{gen} = \Delta S_{agua} + \Delta S_{aire}$$