

- a) Los kg de agua evaporados por hora (V)
- b) Los kg de vapor de calefacción fresco (S)

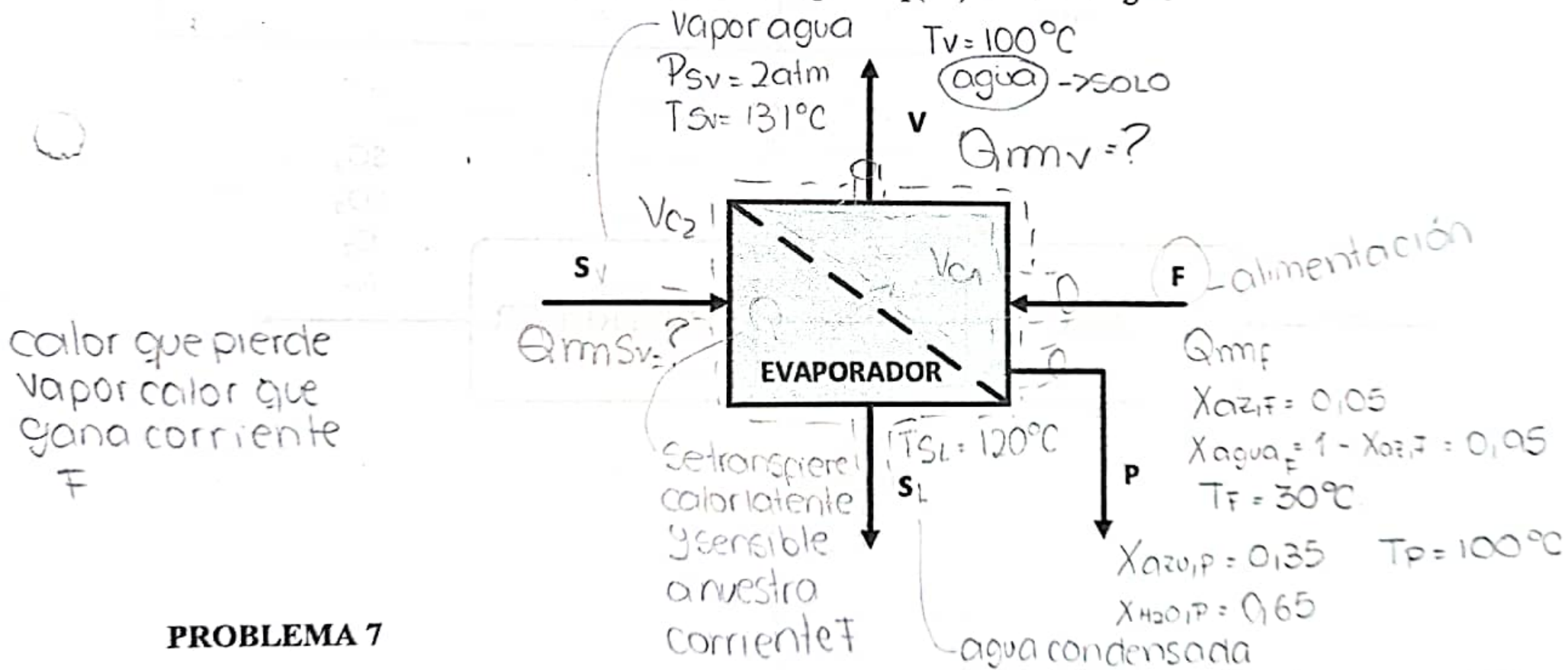
evaporador
↳ cambio de fase

Considérese que el evaporador está perfectamente aislado.

Datos del agua: $c_{pv} = 0.46 \text{ kcal/kg.}^\circ\text{C}$ $c_{pl} = 1 \text{ kcal/kg.}^\circ\text{C}$

$\lambda_{(120^\circ\text{C})} = 525 \text{ kcal/kg}$ $\lambda_{(100^\circ\text{C})} = 540 \text{ kcal/kg}$

Datos de la solución: $c_{p(5\%)} = 0.95 \text{ kcal/kg.}^\circ\text{C}$ $c_{p(35\%)} = 0.75 \text{ kcal/kg.}^\circ\text{C}$



PROBLEMA 7

⑥ $Q_{mf} = 1000 \frac{kg}{h}$

→ Evaporador de contacto indirecto
 S y F separados, solo hay intercambio energía

- $X_{O_2,F} = 0,05$
- $X_{H_2O,F} = 0,95$
- $P_{sv} = 2 \text{ atm}$
- $T_{sv} = 131^\circ\text{C}$
- $T_{SL} = 120^\circ\text{C}$
- $T_v = 100^\circ\text{C}$
- $T_p = 100^\circ\text{C}$
- $X_{H_2O,P} = 0,35$
- $X_{H_2O,V} = 0,65$

- Agua $C_{pv} = 0,46 \text{ kcal/kg}^\circ\text{C}$
- $C_{pl} = 1 \text{ kcal/kg}^\circ\text{C}$
- $\lambda_{vapor} = 525 \text{ kcal/kg}$
- $\lambda_{licuaci} = 540 \text{ kcal/kg}$

- Solución $C_{p(25\%)} = 0,95 \text{ kcal/kg}^\circ\text{C}$
- $C_{p(35\%)} = 0,75 \text{ kcal/kg}^\circ\text{C}$

$Q_{mv} = ?$
 $Q_{msv} = ?$

Balances de masa para el V_2
 Consideraciones → estado estacionario

$-Q_{mf} + Q_{mv} + Q_{mp} = 0$ ①

Balances masa para el H_2O
 $-Q_{mf} \cdot X_{H_2O,F} + Q_{mv} \cdot X_{H_2O,V} + Q_{mp} \cdot X_{H_2O,P} = 0$ ②

$Q_{mv} = Q_{mf} - Q_{mp}$ ③

Reemplazo 3 en 2:

$-Q_{mf} \cdot X_{H_2O,F} + (Q_{mf} - Q_{mp}) X_{H_2O,V} + Q_{mp} \cdot X_{H_2O,P} = 0$

$-Q_{mf} \cdot X_{H_2O,F} + Q_{mf} \cdot X_{H_2O,V} - Q_{mp} X_{H_2O,V} + Q_{mp} X_{H_2O,P} = 0$

$Q_{mf} (X_{H_2O,V} - X_{H_2O,F}) + Q_{mp} (X_{H_2O,P} - X_{H_2O,V}) = 0$

$Q_{mp} (X_{H_2O,P} - X_{H_2O,V}) = -Q_{mf} (X_{H_2O,V} - X_{H_2O,F})$

$Q_{mp} = \frac{-Q_{mf} (X_{H_2O,V} - X_{H_2O,F})}{(X_{H_2O,P} - X_{H_2O,V})}$

$Q_{mp} = \frac{-1000 \text{ kg/h} (1 - 0,05)}{(0,65 - 1)}$

$Q_{mp} = 142,85 \frac{kg}{h}$

Reemplazo resultado en 1

$-Q_{mf} + Q_{mv} + Q_{mp} = 0$

$Q_{mv} = +Q_{mf} - Q_{mp}$

$Q_{mv} = 1000 \frac{kg}{h} - 142,85 \frac{kg}{h}$

$Q_{mv} = 857,15 \text{ kg/h}$

Balanza energía para el H_2O

Consideraciones

$$\frac{\partial W_s}{\partial t} = 0$$

$$\frac{\partial W_y}{\partial t} = 0$$

$$\frac{\partial Q}{\partial t} = 0$$

Análisis de energía

E_c y $E_p \rightarrow$ suponemos despreciables frente a E_i

$$E_i + P = H$$

$T_F = T_{ref} \rightarrow$ tomo siempre la de menor valor

$$\iint_{s.c} \frac{H \rho V \cdot n \, dA}{G_{mm}} = 0$$

$$-G_{mf} h_F - G_{msv} h_{sv} + G_{mp} h_p + G_{mv} h_v + G_{msL} h_{sL} = 0 \quad (1)$$

Cálculo de las entalpías

$$h_f = C_{pF}(s\%) (T_F - T_{ref})$$

$$h_f = 0,95 \frac{\text{kcal}}{\text{kg}^\circ\text{C}} (30^\circ\text{C} - 30^\circ\text{C})$$

$$h_f = 0$$

$$h_v = C_{pv} (T_p - T_{ref}) + \lambda_{100^\circ\text{C}} + C_{pl} (T_v - T_p)$$

b \rightarrow a
lig \rightarrow vap

$$h_v = 0,46 \frac{\text{kcal}}{\text{kg}^\circ\text{C}} (100^\circ\text{C} - 30^\circ\text{C}) + 540 \frac{\text{kcal}}{\text{kg}^\circ\text{C}} + 1 \frac{\text{kcal}}{\text{kg}^\circ\text{C}} (100^\circ\text{C} - 100^\circ\text{C})$$

$$h_v = 572,2 \frac{\text{kcal}}{\text{kg}}$$

$$h_p = C_{p(35\%)} (T_p - T_{ref})$$

$$h_p = 0,75 \frac{\text{kcal}}{\text{kg}^\circ\text{C}} (20^\circ\text{C} - 30^\circ\text{C})$$

$$h_p = 67,5 \frac{\text{kcal}}{\text{kg}}$$

$$h_{sv} = C_{pl} (T_{sL} - T_{ref}) + \lambda_{100^\circ\text{C}} + C_{pv} (T_{sv} - T_{sL})$$

b \rightarrow a
vap \rightarrow lig

$$h_{sv} = 1 \frac{\text{kcal}}{\text{kg}^\circ\text{C}} (120^\circ\text{C} - 30^\circ\text{C}) + 525 \frac{\text{kcal}}{\text{kg}^\circ\text{C}} + 0,46 \frac{\text{kcal}}{\text{kg}^\circ\text{C}} (131^\circ\text{C} - 120^\circ\text{C})$$

$$h_{sv} = 620,06 \text{ kcal/kg}$$

$$h_{SL} = C_p (T_{SL} - T_{ref})$$

$$h_{SL} = 1 \frac{\text{kcal}}{\text{kg} \cdot ^\circ\text{C}} (120^\circ\text{C} - 30^\circ\text{C})$$

$$h_{SL} = 90 \frac{\text{kcal}}{\text{kg}}$$

$$- \underbrace{Q_{msv}}_{0} h_{SL} - Q_{msv} H_{sv} + Q_{mp} h_p + Q_{mv} H_v + Q_{msL} h_{SL} = 0$$

$$Q_{msv} = Q_{msL}$$

$$Q_{msv} (h_{SL} - H_{sv}) + Q_{mp} h_p + Q_{mv} H_v = 0$$

$$Q_{msv} (h_{SL} - H_{sv}) = -Q_{mp} h_p - Q_{mv} H_v$$

$$Q_{msv} = \frac{-Q_{mp} h_p - Q_{mv} H_v}{(h_{SL} - H_{sv})}$$

$$Q_{msv} = \frac{-146,85 \frac{\text{kg}}{\text{h}} \cdot 679 \frac{\text{kcal}}{\text{kg}} - 257,19 \frac{\text{kg}}{\text{h}} \cdot 572,2 \frac{\text{kcal}}{\text{kg}}}{(90 \frac{\text{kcal}}{\text{kg}} - 620,06 \frac{\text{kcal}}{\text{kg}})}$$

$$Q_{msv} = 944 \frac{\text{kg}}{\text{h}}$$