a) Los kg de agua evaporados por hora (V)

b) Los kg de vapor de calefacción fresco (S)

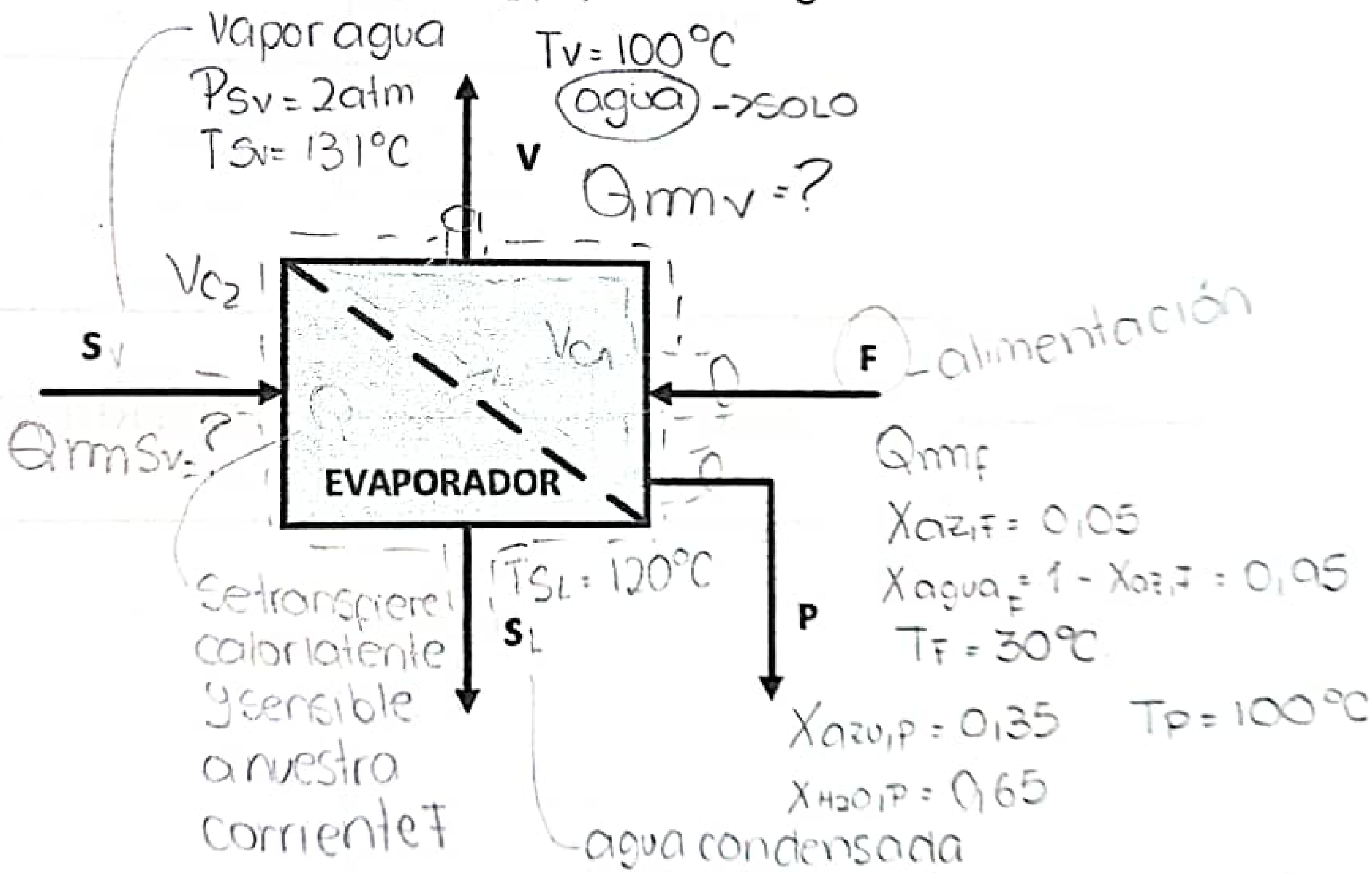
Considérese que el evaporador está perfectamente aislado.

Datos del agua: $cp_v = 0.46$ kcal/kg.°C $cp_l = 1$ kcal/kg. °C

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

Datos de la solución: $cp_{(5\%)} = 0.95$ kcal/kg. °C $cp_{(35\%)} = 0.75$ kcal/kg.°C

evaporador ↳cambio de Face



calor que pierde vapor calor que gana corriente F

PROBLEMA 7

⑥ $Q_{mF} = 1000 \frac{kg}{h}$

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

$X_{az,F} = 0{,}05$
$X_{H_2O,F} = 0{,}95$
$P_{SV} = 2\ atm$
$T_{SV} = 131°C$
$T_{SL} = 120°C$
$T_V = 100°C$
$T_P = 100°C$
$X_{az,P} = 0{,}35$
$X_{H_2O,P} = 0{,}65$

Agua $C_{pv} = 0{,}46\ kcal/kg°C$
$C_{pl} = 1\ kcal/kg°C$
$\lambda(120°) = 525\ kcal/kg$
$\lambda(100°) = 540\ kcal/kg$

Solución $C_{p(5\%)} = 0{,}95\ kcal/kg°C$
$C_{p(35\%)} = 0{,}75\ kcal/kg°C$

$Q_{mV} = ?$
$Q_{mSV} = ?$

Balance de masa para el VC1
Consideraciones → estado estacionario

$$-Q_{mF} + Q_{mV} + Q_{mP} = 0 \quad (1)$$

Balance masa para el H_2O

$$-Q_{mF} \cdot X_{H_2O,F} + Q_{mV} \cdot X_{H_2O,V} + Q_{mP} \cdot X_{H_2O,P} = 0 \quad (2)$$

$$Q_{mV} = Q_{mF} - Q_{mP} \quad (3)$$

Reemplazo 3 en 2

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

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

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

$$Q_{mP} (X_{H_2O,P} - X_{H_2O,V}) = -Q_{mF} (X_{H_2O,V} - X_{H_2O,F})$$

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

$$Q_{mP} = \frac{-1000\ kg/h\ (1 - 0{,}95)}{(0{,}65 - 1)}$$

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

Reemplazo resultado en 1

$$-Q_{mF} + Q_{mV} + Q_{mP} = 0$$

$$Q_{mV} = +Q_{mF} - Q_{mP}$$

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

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

Balance energía para el VC2

Consideraciones

$\frac{\partial W_s}{\partial t} = 0$ $\qquad$ $\frac{\partial W_4}{\partial t} = 0$

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

Análisis de energía

e_c y e_p → suponemos despreciables frente a e_i

$e_i + \frac{P}{\rho} = H$ $\qquad$ $T_F = T_{ref}$ → tomo siempre la de menor valor

$$\iint_{SC} H \underbrace{\rho \vec{V} \cdot \vec{n}\, dA}_{Qm} = 0$$

$$-Qm_F\, h_F - Qm_{sv}\, H_{sv} + Qm_p\, h_p + Qm_v\, H_v + Qm_{sL}\, h_{sL} = 0 \quad (1)$$

Cálculo de las entalpías

$h_F = Cp_F(5\%) \, (T_F - T_{ref})$

$h_F = 0{,}95 \frac{kcal}{kg°C} (30°C - 30°C)$

$h_F = 0$

$H_v = Cp_v (T_p - T_{ref}) + \lambda(100°C) + Cp_l (T_v - T_p)$ $\qquad$ $b \to a$ (liq → vap)

$H_v = 0{,}46 \frac{kcal}{kg°C} (100°C - 30°C) + 540 \frac{kcal}{kg°} + 1 \frac{kcal}{kg°C} (100°C - 100°C)$

$H_v = 572{,}2 \frac{kcal}{kg}$

$b \to a$

$$\underbrace{\frac{\rho_i}{\rho}\left[\bar{c}_{p_{ib}}(T' - T_{ref})\right.}_{\text{Calor sensible}} + \underbrace{\lambda_{i_{ba}}}_{\text{Calor latente}} + \underbrace{\left.\bar{c}_{p_{ia}}(T - T')\right]}_{\text{Calor sensible}}$$

$h_p = Cp(35\%) \, (T_p - T_{ref})$

$h_p = 0{,}75 \frac{kcal}{kg°C} (120°C - 30°C)$

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

$H_{sv} = Cp_l (T_{sL} - T_{ref}) + \lambda(120°C) + Cp_v (T_{sv} - T_{sL})$ $\qquad$ $b \to a$ (vap → liq)

$H_{sv} = 1 \frac{kcal}{kg°C} (120°C - 30°C) + 525 \frac{kcal}{kg} + 0{,}46 \frac{kcal}{kg°C} (131°C - 120°C)$

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

$$h_{SL} = Cp_l \, (T_{SL} - T_{ref})$$

$$h_{SL} = 1 \, \frac{kcal}{kg \, °C} \, (120°C - 30°C)$$

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

$$\underbrace{-Q_{mF} \, h_F}_{0} - Q_{mSV} \, H_{SV} + Q_{mP} \, h_P + Q_{mV} \, H_V + Q_{mSL} \, h_{SL} = 0$$

$$Q_{mSV} = Q_{mSL}$$

$$Q_{mSV} \, (h_{SL} - H_{SV}) + Q_{mP} \, h_P + Q_{mV} \, H_V = 0$$

$$Q_{mSV} \, (h_{SL} - H_{SV}) = -Q_{mP} \, h_P - Q_{mV} \, H_V$$

$$Q_{mSV} = \frac{-Q_{mP} \, h_P - Q_{mV} \, H_V}{(h_{SL} - H_{SV})}$$

$$Q_{mSV} = \frac{-146{,}85 \, kg/h \cdot 575 \, kcal/kg - 857{,}15 \, kg/h \; 572{,}2 \, kcal/kg}{\left(90 \, \frac{kcal}{kg} - 620{,}06 \, \frac{kcal}{kg}\right)}$$

$$\boxed{Q_{mSV} = 944 \, \frac{kg}{h}}$$