① Datos

Aire humedo a contracorriente $H_2SO_4$

Agua

Hum rel 1 = 50%

Hum rel 2 = 10%

$H_2SO_4$

$W_2$ = 67% Peso

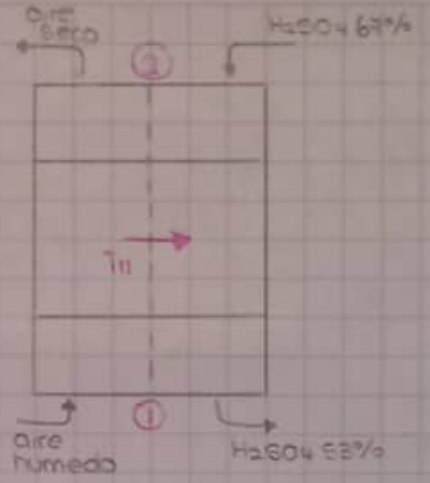
$W_1$ = 53% Peso

$K_G$ = 2,09 $\frac{lb\ mol}{h\ ft^2\ atm}$

$K_L$ = 0,068 $\frac{lbmol\ H_2O}{h\ ft^2\ \frac{lbm}{ft^3}}$ } c/e

Atrans = $1 ft^2$

T = 25°C




$N_A$ = ?

% Peso c/ coc = ?

$P_{AL}$, $C_{AL}$ = ?

$K_G$, $K_L$ = ?

$\rho_{H_2SO_4(53\%)} = 88,11\ \frac{lbm\ sol}{ft^3\ sol}$

$\rho_{H_2SO_4(67\%)} = 98,18\ \frac{lbm\ sol}{ft^3\ sol}$

$P_{AG} = \frac{hum\ rel}{100} P^*_{H_2O}$ Hum rel → $P_{AG}$

% Peso $H_2SO_4$ suponemos masa 100 lbm

$m_{H_2O}$ = 100 − % Peso $H_2SO_3$ → $n_{H_2O} = \frac{m_{H_2O}}{PM_{H_2O}}$ lb [lbmol]

↳ 18 $\frac{lb}{lbmol}$

$V_{sol} = \frac{100\ lbm}{\rho_{sol}\ \frac{lbm}{ft^3}}$ $C_{AL} = \frac{n_{H_2O}}{V_{sol}} \left[\frac{lbm}{ft^3}\right]$

$N_A$ = $\frac{\text{fuerza impulsora}}{\text{Resistencia}} \left[\frac{lbmol}{h}\right]$

Ubicación de los puntos

Punto 1 $(C_{AL1}; P_{AG1}) = (2,116; 0,01565)$

Hum rel 1 = 50%

$(W_2)_{H_2SO_4}$ = 53% ⇒ $(W_2)_{H_2O}$ = 47%

$P^*_{H_2O\ 25°C}$ = 0,0313 atm

$\rho_{H_2SO_4\ (53\%)}$ = 88,11 $\frac{lbm}{ft^3}$

$P_{AG1} = \frac{\text{Hum relativa}_1}{100} \cdot P^*_{H_2O} = \frac{50}{100}$ 0,0313 atm

$P_{AG1}$ = 0,01565 atm

Suponemos 100 lbm

$m_{H_2O}$ = 47 lbm → $n_{H_2O} = \frac{m_{H_2O}}{PM_{H_2O}} = \frac{47\ lbm}{18\ \frac{lbm}{lbmol}}$ → $n_{H_2O}$ = 2,61 lbmol

$V_{sol} = \frac{m_{sol}}{\rho_{sol}} = \frac{100\,lbm}{81,11\,\frac{lbm}{ft^3}} \rightarrow V_{sol} = 1,233\,ft^3$

$C_{AL1} = \frac{n_{H_2O}}{V_{sol}} = \frac{2,61\,lbmol}{1,233\,ft^3}$

$C_{AL1} = 2,116\,\frac{lbmol}{ft^3}$

Punto 2

Hum rel 2 = 10%

$W_{1\,H_2SO_4} = 67\% \rightarrow W_{1\,H_2O} = 33\%$

$P^v_{H_2O}\ 25°C = 0,0313\,atm$

$\rho_{H_2SO_4\,(67\%)} = 98,18\,\frac{lbm}{ft^3}$

$(C_{AL2}, P_{AG2}) = (1,79;\ 0,00313)$

$P_{AG2} = \frac{Hum\ relativa\ 2}{100} P^v_{H_2O} = \frac{10}{100} . 0,0313\,atm$

$P_{AG2} = 0,00313\,atm$

Suponemos 100 lbm

$m_{H_2O} = 33\,lbm \rightarrow n_{H_2O} = \frac{m_{H_2O}}{PM_{H_2O}} = \frac{33\,lbm}{18\,\frac{lbm}{lbmol}} \rightarrow n_{H_2O} = 1,83\,lbmol$

$V_{sol} = \frac{m_{sol}}{\rho_{sol}} = \frac{100\,lbm}{98,18\,\frac{lbm}{ft^3}} \rightarrow V_{sol} = 1,018\,ft^3$

$C_{AL2} = \frac{n_{H_2O}}{V_{sol}} = \frac{1,83\,lbmol}{1,018\,ft^3}$

$C_{AL2} = 1,79\,\frac{lbmol}{ft^3}$

$Pendiente = -\frac{K_L}{K_G} = -\frac{0,068}{2,09}$

$Pendiente = -0,0325$

Punto 1 (2,116; 0,01565)

$y - y_1 = P(X - X_1)$

$y = P(X - X_1) + y_1$

$y = -0,0325(X - 2,116) + 0,01565$

$y = -0,0325X + 0,06877 + 0,01565$

$y = -0,0325X + 0,08442$

cuando $y = 0$

$0,0325X = 0,08442$

$X = 2,59$

Punto 2 (1,79 ; 0,00313)

$y - y_1 = P(x - x_1)$

$y = P(x - x_1) + y_1$

$y = -0,0325\,(x - 1,79) + 0,00313$

$y = -0,0325x + 0,058175 + 0,00313$

$y = -0,0325x + 0,061305$

cuando $y = 0$

$0,0325x = 0,061305$

$x = 1,88$

Punto 1

$P_{AG1} = 0,01565$ $\quad C_{AL1} = 2,116$

$P_{Ai1} = 0,010$ $\quad C_{Ai1} = 2,315$

$P_{A^*1} = 0,007$ $\quad C_{A^*1} = 2,62$

Punto 2

$P_{AG2} = 0,00313$ $\quad C_{AL2} = 1,79$

$P_{Ai2} = 0,00225$ $\quad C_{Ai2} = 1,81$

$P_{A^*2} = 0,002$ $\quad C_{A^*2} = 1,89$

a. $N_{A1} = \dfrac{-(P_{Ai1} - P_{AG1})}{\frac{1}{A\,K_G}} = \dfrac{-(0,010 - 0,01565)\ atm}{\frac{1}{1\,ft^2 \cdot 2,09\ \frac{lbmol}{h\,ft^2\,atm}}}$

$N_{A1} = 0,01180\ \dfrac{lbmol}{h}$ con presiones

$N_{A1} = \dfrac{-(C_{AL} - C_{Ai})}{\frac{1}{A\,K_L}} = \dfrac{-(2,116 - 2,315)\ \frac{lbmol}{ft^3}}{\frac{1}{1\,ft^2 \cdot 0,068\ \frac{lbmol}{h\,ft^2\,\frac{lbmol}{ft^3}}}}$

$N_{A1} = 0,0135\ \dfrac{lbmol}{h}$ con concentraciones

$N_{A2} = \dfrac{-(P_{Ai2} - P_{AG2})}{\frac{1}{A\,K_G}} = \dfrac{-(0,00225 - 0,00313)\ atm}{\frac{1}{1\,ft^2 \cdot 2,09\ \frac{lbmol}{h\,ft^2\,atm}}}$

$N_{A2} = 0,00194\ \dfrac{lbmol}{h}$ con presiones

$$N_{A2} = \frac{-(C_{AL2} - C_{AL2})}{\frac{1}{A\,k_L}} = \frac{-(1{,}179 - 1{,}81)\ \frac{lbmol}{ft^3}}{\frac{1}{1ft^2\ 0{,}068\ \frac{lbmol}{h\,ft^2\ \frac{lbmol}{ft^3}}}}$$

$$N_{A2} = 0{,}00136\ \frac{lbmol}{h}$$ con concentraciones

b. Punto 1

$$\%\ Resis\ P_{G1} = \frac{\Delta P_{G1}}{\Delta P_{TOTAL}} \cdot 100 = \frac{P_{AG1} - P_{AL1}}{P_{AG1} - P_{A1}^*} \cdot 100 = \frac{0{,}01565 - 0{,}010}{0{,}01565 - 0{,}007} \cdot 100$$

$$\%\ Resis\ P_{G1} = 65{,}32\%$$

$$\%\ Resis\ C_{L1} = \frac{\Delta C_{L1}}{\Delta C_{TOTAL}} \cdot 100 = \frac{C_{AL1} - C_{AL1}}{C_{AL1} - C_{A1}^*} \cdot 100 = \frac{2{,}116 - 2{,}315}{2{,}116 - 2{,}62} \cdot 100$$

$$\%\ Resis\ C_{L1} = 39{,}5\%$$

Punto 2

$$\%\ Resis\ P_{G2} = \frac{\Delta P_{G2}}{\Delta P_{TOTAL}} \cdot 100 = \frac{P_{AG2} - P_{AL2}}{P_{AG2} - P_{A2}^*} \cdot 100 = \frac{0{,}00313 - 0{,}0022}{0{,}00313 - 0{,}002} \cdot 100$$

$$\%\ Resis\ P_{G2} = 82{,}30\%$$

$$\%\ Resis\ C_{L2} = \frac{\Delta C_{L2}}{\Delta C_{TOTAL}} \cdot 100 = \frac{C_{AL2} - C_{AL2}}{C_{AL2} - C_{A2}^*} \cdot 100 = \frac{1{,}79 - 1{,}81}{1{,}79 - 1{,}89} \cdot 100$$

$$\%\ Resis\ C_{L2} = 20\%$$

Podemos observar que la fase dominante es la gaseosa en ambos puntos.

c. $P_{AL1} = 0{,}010$ $\quad P_{AL2} = 0{,}0022$
$C_{AL1} = 2{,}315$ $\quad C_{AL2} = 1{,}81$

d. $$N_{A1} = \frac{-(P_{A1}^* - P_{AG})}{\frac{1}{A\,K_G}}$$

$$N_{A1} = (P_{AG1} - P_{A1}^*) \cdot A \cdot K_G$$

$$K_{G1} = \frac{N_{A1}}{(P_{AG1} - P_{A1}^*) \cdot A} = \frac{0{,}01180\ \frac{lbmol}{h}}{(0{,}01565 - 0{,}007)\,atm \cdot 1ft^2}$$

$$K_{G1} = 1{,}36\ \frac{lbmol}{h\,ft^2\,atm}$$

$$N_{A1} = \frac{-(C_{AL1} - C_{A1}^*)}{\frac{1}{AKL}}$$

$$N_{A1} = (C_{A1}^* - C_{AL1}) \cdot A \cdot KL$$

$$KL_1 = \frac{N_{A1}}{(C_{A1}^* - C_{AL1}) \cdot A} = \frac{0{,}0135 \ \frac{lbmol}{h}}{(2{,}62 - 2{,}116) \ \frac{lbmol}{ft^3} \cdot 1ft^2}$$

$$KL_1 = 0{,}026 \ \frac{lbmol}{h ft^2 \ \frac{lbmol}{ft^3}}$$

$$N_{A2} = \frac{-(P_{A2}^* - P_{AG2})}{\frac{1}{AKG}}$$

$$N_{A2} = (P_{AG2} - P_{A2}^*) \cdot A \cdot KG$$

$$KG_2 = \frac{N_{A2}}{(P_{AG2} - P_{A2}^*) \cdot A} = \frac{0{,}00194 \ \frac{lbmol}{h}}{(0{,}00313 - 0{,}002) \ atm \ 1ft^2}$$

$$KG_2 = 1{,}71 \ \frac{lbmol}{h ft^2 atm}$$

$$N_{A2} = \frac{-(C_{AL2} - C_{A2}^*)}{\frac{1}{AKL}}$$

$$N_{A2} = (C_{A2}^* - C_{AL2}) \ AKL$$

$$KL_2 = \frac{N_{A2}}{(C_{A2}^* - C_{AL2})A} \quad \frac{0{,}00136 \ \frac{lbmol}{h}}{(1{,}89 - 1{,}79) \ \frac{lbmol}{ft^3} \cdot 1ft^2}$$

$$KL_2 = 0{,}0136 \ \frac{lbmol}{h ft^2 \ \frac{lbmol}{ft^3}}$$