

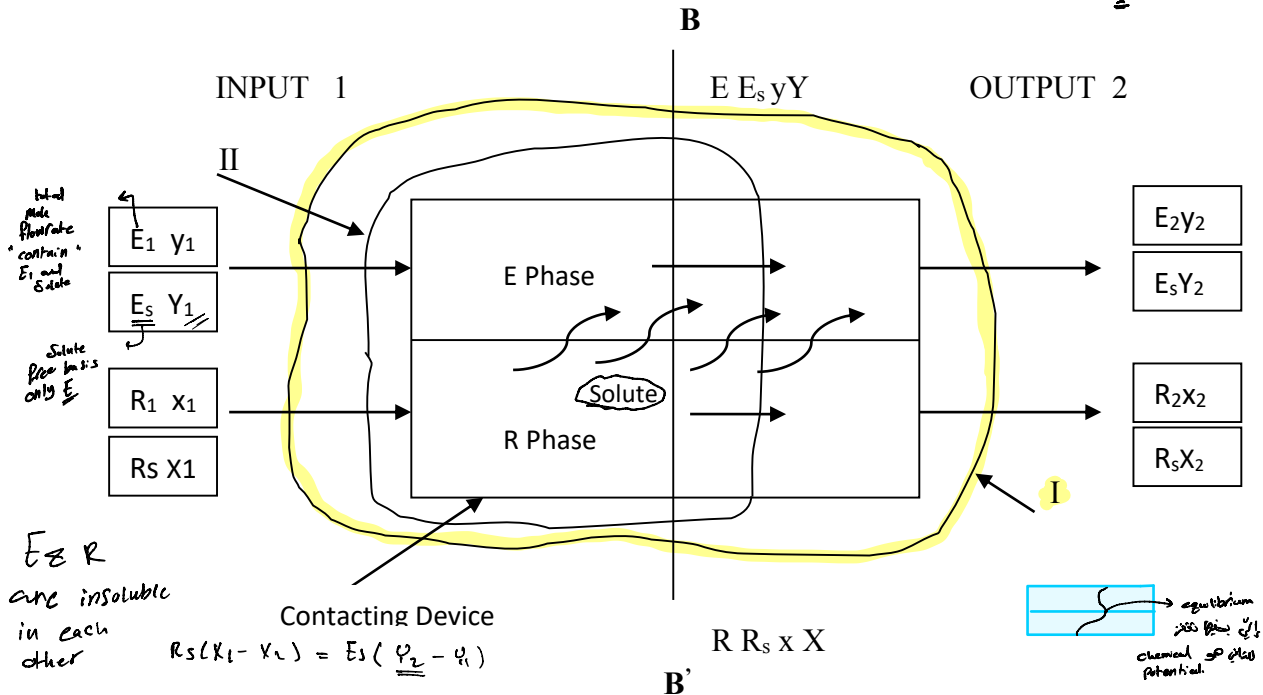
Material Balances:

System: two insoluble phases E and R and single solute transferring from phase R to Phase E

Steady State Contacting Processes

Co Current Process:

④ transferring of solute by driving force to the entrance than to the plate 2



R_i, E_i : moles total material/time ; R_s, E_s : moles non diffusing material/time (constant)
 x_i, y_i : mole fractions of solute in stream i ; X_i, Y_i : mole ratios of solute in stream i
 i : stream number

Solute Material Balance

Envelope I (overall)

$$\begin{aligned} \text{IN} &= R_1 x_1 + E_1 y_1 \\ \text{OUT} &= R_2 x_2 + E_2 y_2 \\ \text{OR} & R_1 x_1 - R_2 x_2 = E_2 y_2 - E_1 y_1 \end{aligned}$$

$$\begin{aligned} R_i x_i &= R_s \frac{x_i}{1 - x_i} = R_s X_i \\ E_i y_i &= E_s \frac{y_i}{1 - y_i} = E_s Y_i \end{aligned}$$

$$R_s (X_1 - X_2) = E_s (Y_2 - Y_1)$$

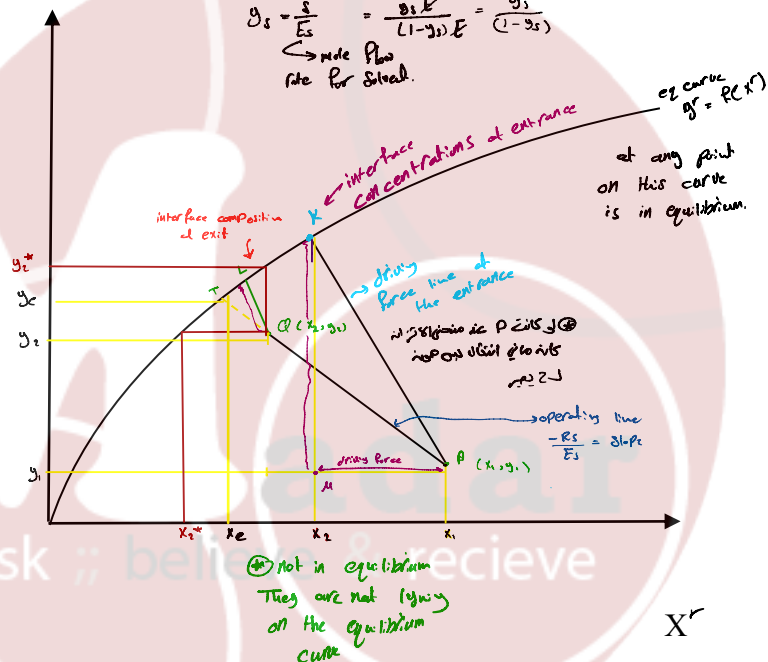
Straight line with slope = $-\frac{R_s}{E_s}$ (line PQ)

$$R_i x_i = R_s \frac{x_i (1 - x_i)}{(1 - x_i)}$$

$$R_i x_i = R_s X_i$$

$Y = \frac{\text{moles solute}}{\text{moles of carrier}}$ e.g. system of S and E $Y_s = \frac{S}{E+S}$

$$Y_s = \frac{S}{E+S} = \frac{Y_s E}{(1 - Y_s) E} = \frac{Y_s}{(1 - Y_s)}$$



change of the concentration from the start point until any point.
Envelope II (General Balance)

On solute free basis

$$R_s (X_1 - \bar{X}) = E_s (Y - Y_1)$$

Straight line: slope = $-\frac{R_s}{E_s}$ (Same as line PQ)



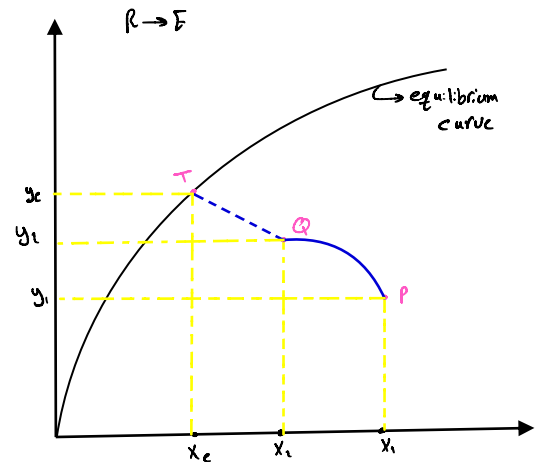
- ✓ General expression relating compositions of phases in equipment at any distance from entrance Points P and Q represent inlet and exit concentrations
- ✓ This straight line is called operating line
- ✓ KP driving force line at entrance
K: interface composition at interface
KM, MP driving forces in E-phase (KM) and R-phase (MP) at entrance conditions
- ✓ LQ : driving force line at exit
L : interface composition
- ✓ Point T represents equilibrium compositions (X_e, Y_e) if the equipment were long enough. At this point the driving force is zero.

Representation using other units

$$R_1 x_1 - R x = E y - E_1 y_1 \quad \text{Operating curve}$$

$$E y = R_1 x_1 + E_1 y_1 - R x$$

$$y = \frac{R_1 x_1 + E_1 y_1}{E} - \frac{R}{E} x \quad \text{Operating Curve}$$



② $\frac{R_1 x_1 + E_1 y_1}{E} - \frac{R}{E} x$ \rightarrow general \rightarrow $\frac{R}{E}$ \rightarrow slope of the operating curve
③ $\frac{R_1 x_1 + E_1 y_1}{E} - \frac{R}{E} x$ \rightarrow envelope \rightarrow $\frac{R}{E}$ \rightarrow slope of the envelope

Note: If

$$E_1 = E_2 = E$$

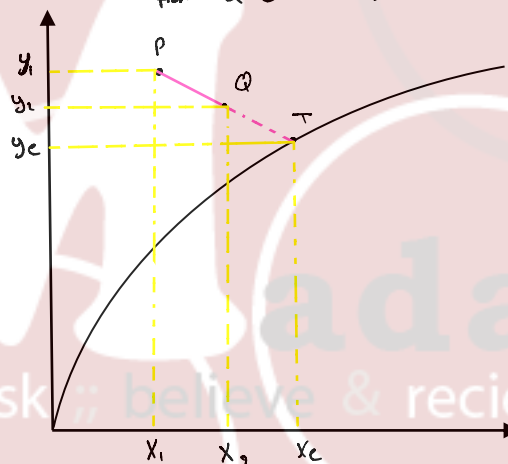
$$R_1 = R_2 = R$$

When the solute is very low (diluted system) \Rightarrow because the transfer is very low.

Straight line operating line in terms of mole fractions

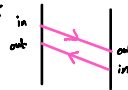
Solute transferring from E \rightarrow R

\rightarrow how much the concentration of the solute will change from a certain reference (usually the entrance) \neq one. \rightarrow because I know the comp. the comp. \neq one.



2
توليد جوده كانه اقل
التركيب على اقترابا انه
توليد جوده كانه اقل
E-1

⊕ in co-current
The driving force
remain constant during
the process



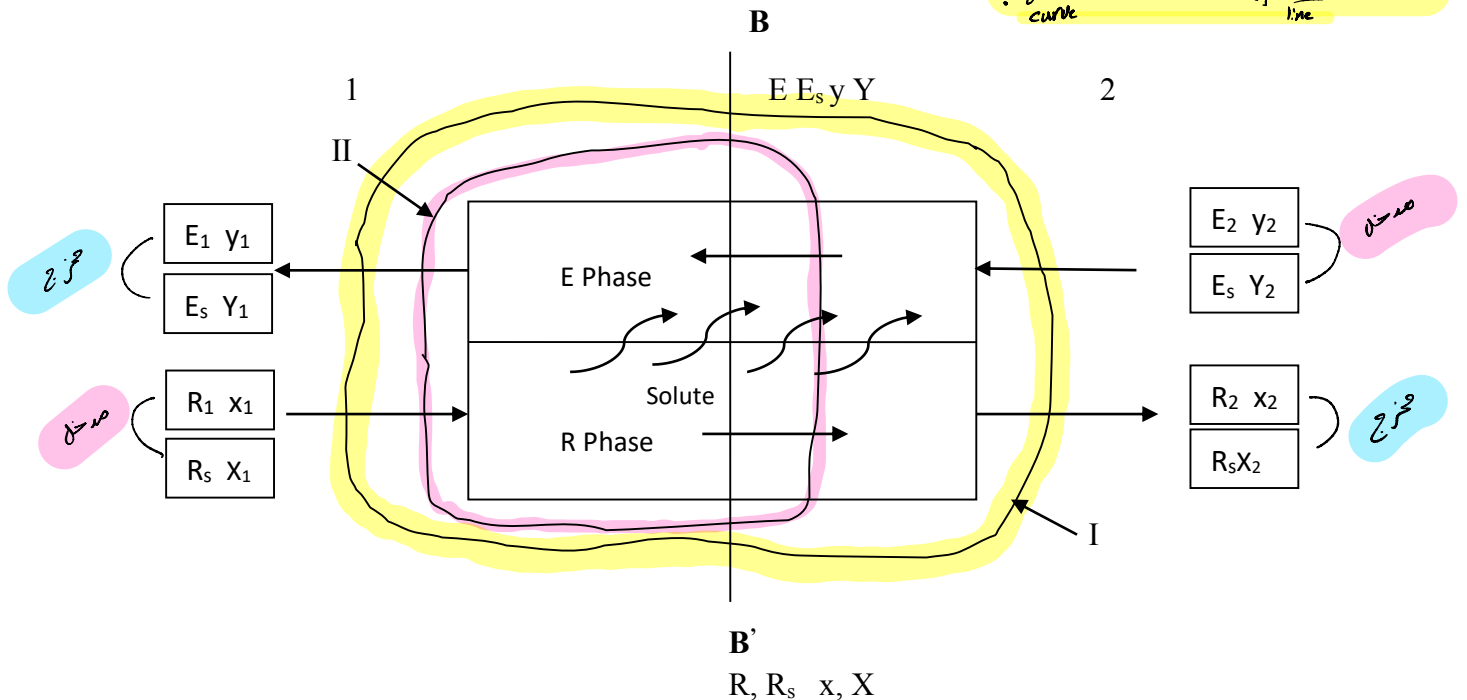
Material Balances:

Steady State Contacting Processes

System: two insoluble phases E and R and single solute transferring from phase R to Phase E

Counter Current Process:

⊕ القوة دافعة بالمرحلة (R → E) تزداد (E → R) :
كل موقع أو نقطة إذا كانت تحت أو فوق
equilibrium curve line



R_i, E_i : moles total material/time ; R_s, E_s : moles non diffusing material/time (constant)
 x_i, y_i : mole fractions of solute in stream i ; X_i, Y_i : mole ratios of solute in stream i
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Solute diffusing from $R \rightarrow E$

Solute Material balance

Envelop I (overall)

$$\begin{array}{c} \text{Input} \\ R_1 x_1 + E_2 y_2 \end{array} = \begin{array}{c} \text{Output} \\ R_2 x_2 + E_1 y_1 \end{array} \quad \text{mole fractions}$$

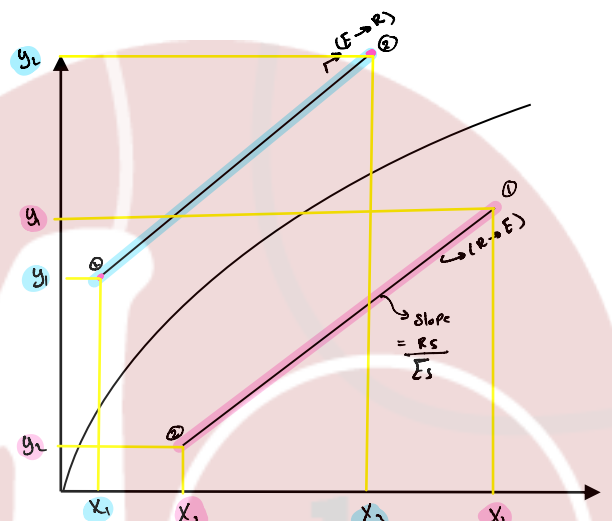
$$R_i x_i = R_s X_i$$

$$E_i y_i = E_s Y_i$$

$$R_s(X_1 - X_2) = E_s(Y_1 - Y_2)$$

mole ratios

This is a straight line equation with slope $+\frac{R_s}{E_s}$



هذه العلاقة بين الانفعال من (R → E) خطية
هذا يكون هذا المعادلة لأن مع الزمن ومع انتقال في
من R → E مع نسبة كمية لا مع الوقت د في تزايد

Envelop II (General) operating lines

In terms of mole fractions:

$$\overbrace{R_1 x_1 + E y}^{\text{Input}} = \overbrace{R x + E_1 y_1}^{\text{Output}} \quad \text{mole fractions}$$

$$E y = R x + E_1 y_1 - R_1 x_1$$

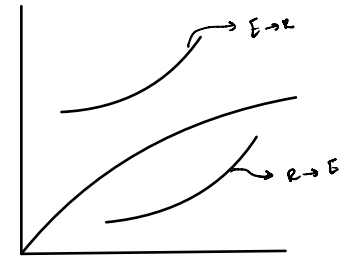
$$y = \frac{R}{E} x + \frac{(E_1 y_1 - R_1 x_1)}{E} \quad \text{operating curve}$$

In terms of mole ratios (solute free basis)

$$R_S (X_1 - X) = E_S (Y_1 - Y)$$

$$E_S Y = R_S X - R_S X_1 + E_S Y_1$$

$$Y = \frac{R_S}{E_S} X - \frac{(R_S X_1 - E_S Y_1)}{E_S} \quad \text{straight line operating line slope} = + \frac{R_S}{E_S}$$



Counter current

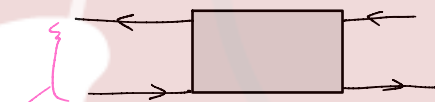
$$y = -\frac{R_1 x_1 + E_1 y_1}{E} + \frac{R_S}{E_S} x$$

Co-current

$$y = +\frac{R_1 x_1 + E_1 y_1}{E} - \frac{R_S}{E_S} x$$

In the case where the solute is passing from $E \rightarrow R$, the operating line will be above the equilibrium curve.

- The operating line represents the material balance passing from point at one end to the point at the other end.
- A point on the operating line represents bulk concentrations of passing streams
- Lines such as PM indicate driving force



passing streams

→ inlet bulk conc

→ outlet bulk conc

(Material balance)

$$E y - R x = E y_1 - R_1 x_1 = \text{constant}$$

ask ; believe & recieve