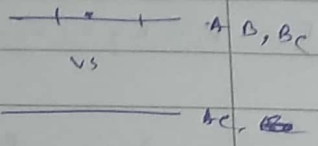
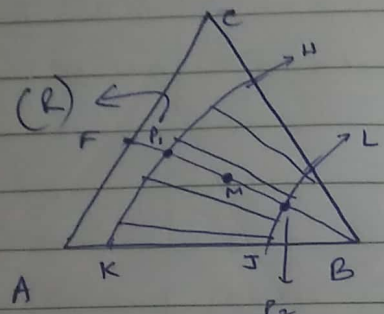
#HappyCollegeDays
What makes you happy?

Now, A-C completely miscible
A-B partially miscible
* B-C also " "





This is merely an engineering need.
If we want to extract A, but we don't have a suitable solvent to get the conventional phase diagram.

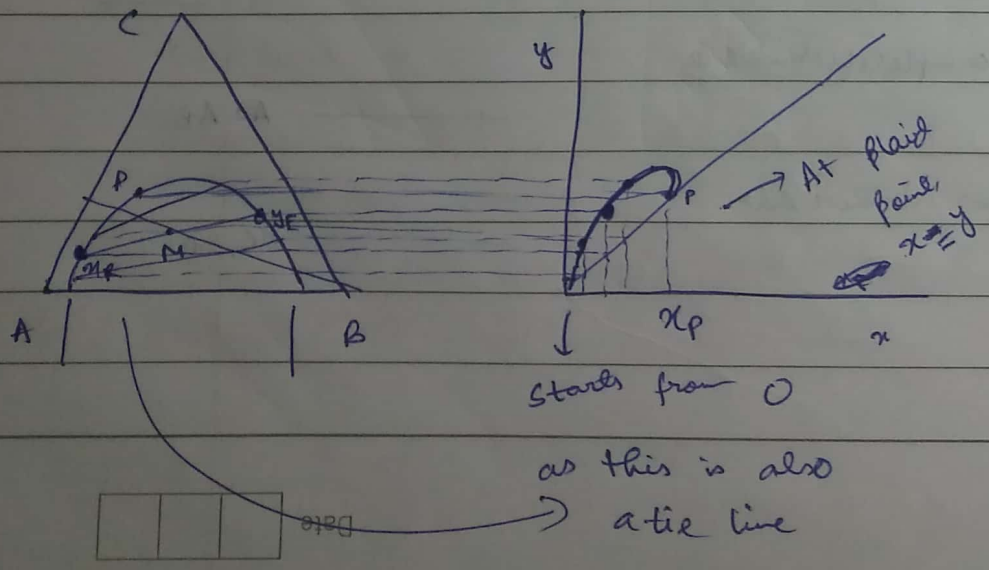
(E) Any composition of A and C can be extracted in this type of a system.

P_2 → Extract P_1 → Raffinate

∵ it is more lean in carrier than P_1

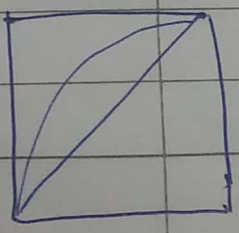
* We take the extract to be the one which is more lean in carrier.

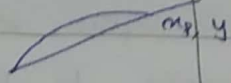
Other Coordinate System

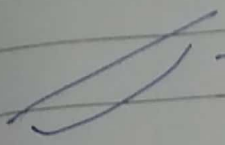


as this is also a tie line

We can get a plot like distillation if A, B, C are completely immiscible.

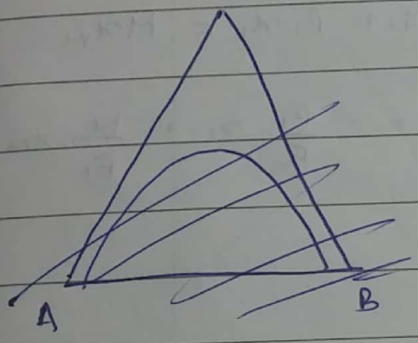


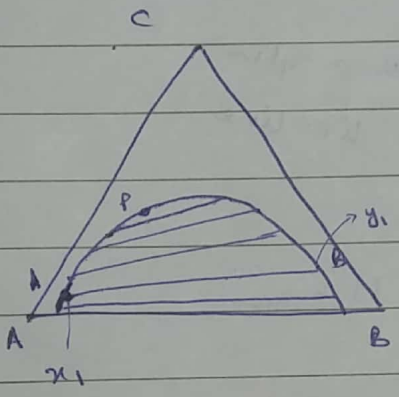
If Plait point and peak point are same → 

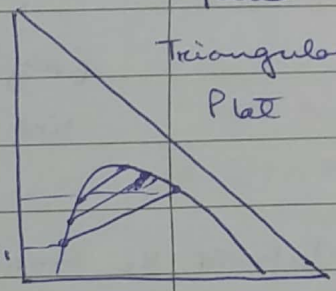
 → for negative slope of tie line (i.e. distribution coefficient > 1)

~~In this kind of an~~

In the x, y plot, we lose the data about composition of the third phase. It only gives how C distributes itself into A and B.







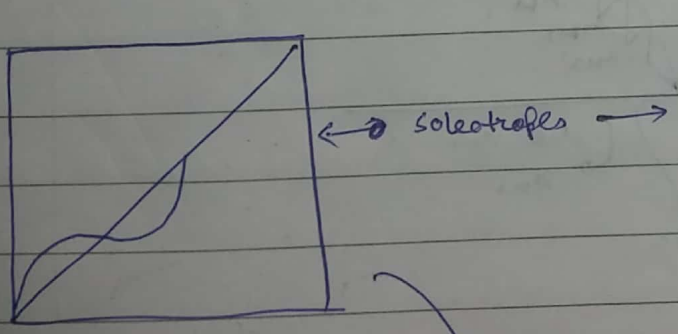
Wt. fraction of B

(Works because $x_A + x_B + x_C = 1$

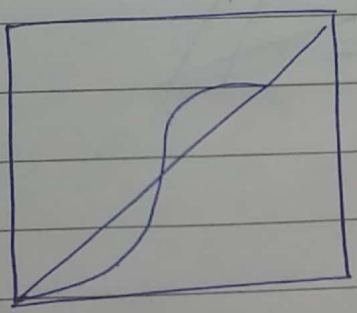
so we have only two independent variables, 3rd is automatically set)

Extract — Solvent Rich Phase

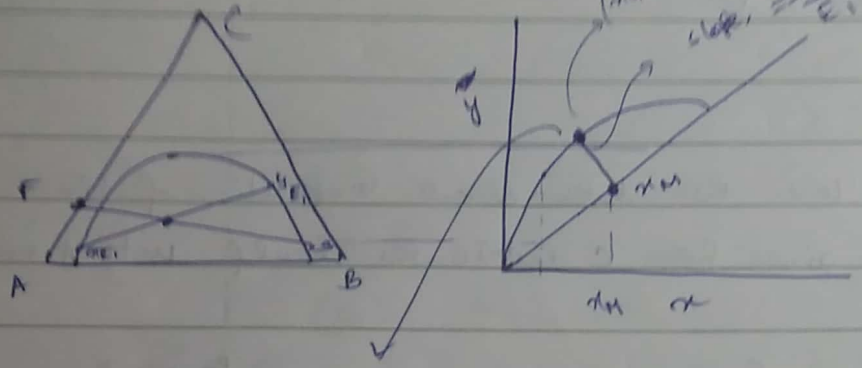
Thus take that phase as extract when the solvent is more in composition.



↔ solvatrophes →



In a solvent free system, one of the phases will converge to the solvent free line



$F + S = M = R_1 + E_1$

$F x_F + S y_S = M x_M$

x_M known

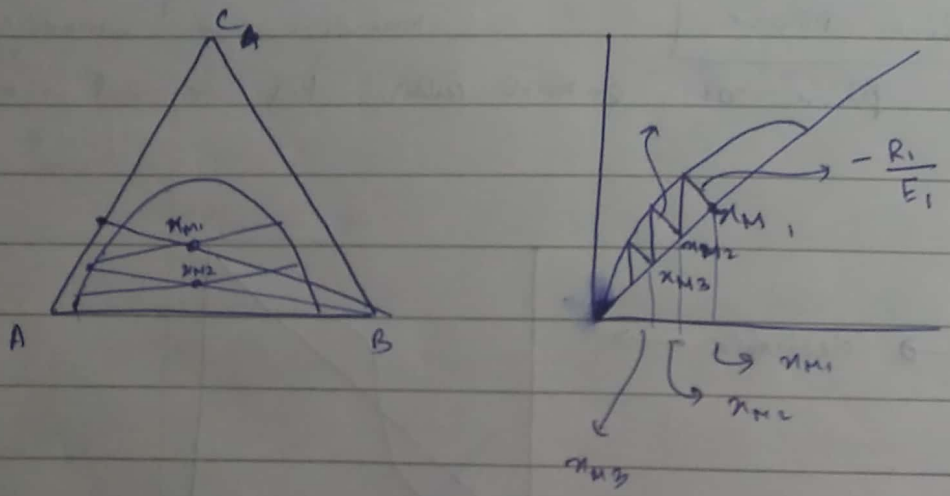
Every point on a rqbm line is a tie-line

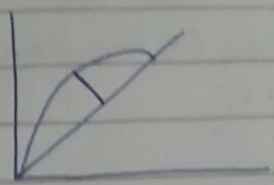
$E_1 y_1 + R_1 x_1 = M x_M$

$y_1 = -\frac{R_1}{E_1} x_1 + \frac{M}{E_1} x_M$

F, S, x_F, y_S, known M known

Multistage Cross flow





Single stage extraction
Analogous to flash distillation

$x \quad x' = \frac{x}{1-x}$

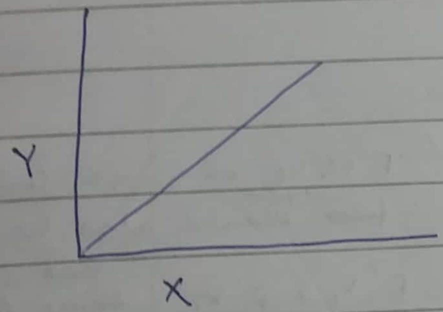
$y \quad y' = y/1-x$

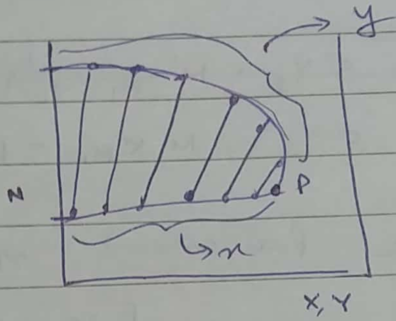
Solute free basis

$X = \frac{C_R}{C_R + A_R}$ $\quad N = \frac{B}{}$ wt. fraction of B on a B free basis

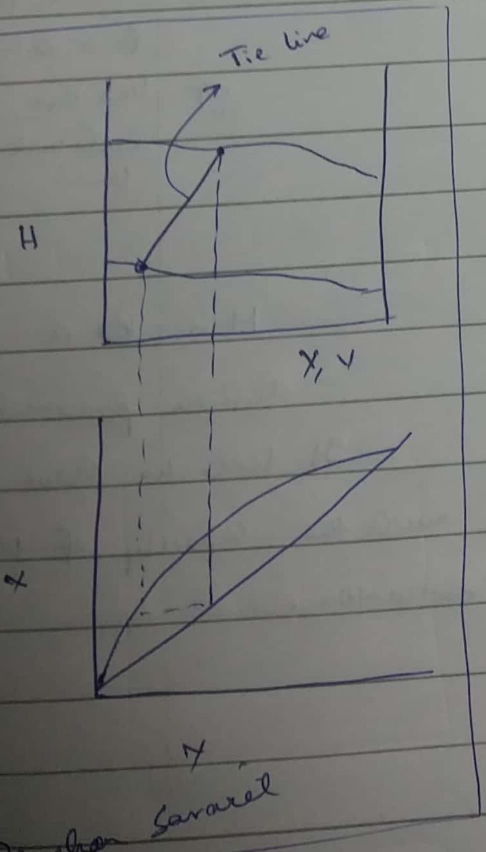
$Y = \frac{C_E}{C_E + A_E}$

Solvent free basis

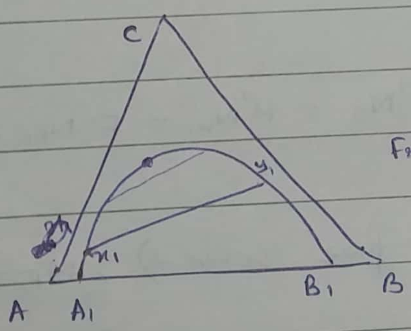




Feed point lies on X-axis
(∵ on X-axis N = 0)



Ponchon Savarit



From definition of solvent
N of y_1 > N of x_1

When we remove B to find X, Y, we get Y > X (∵ larger no. div. by smaller no.)

A_1B_1 will lie on N-axis

Also A_1B_1 is the longest tie-line.

Range of N → (0, ∞)
0 → P+ + A on triangular plot
∞ → only B present.

F X Y

E → total mass flow rate

$F\theta = M' = E_1' + R_1'$

(if feed is solvent free & solvent is pure)

C - balance

~~$F' x_F + S' Y_S = M' x_{M_1} = E' Y_1$~~

$F' X_F + S' Y_S = M' X_{M_1} = E_1' Y_1 + R_1' X_1$

For pure feed, pure solvent $x_F = x_{M_1}$ (∴ F, M lie on same line ∴ ~~feed~~ solvent should also lie on that hence for

$F' X_F = M' X_{M_1} = E_1' Y_1 + R_1' X_1$

#
#

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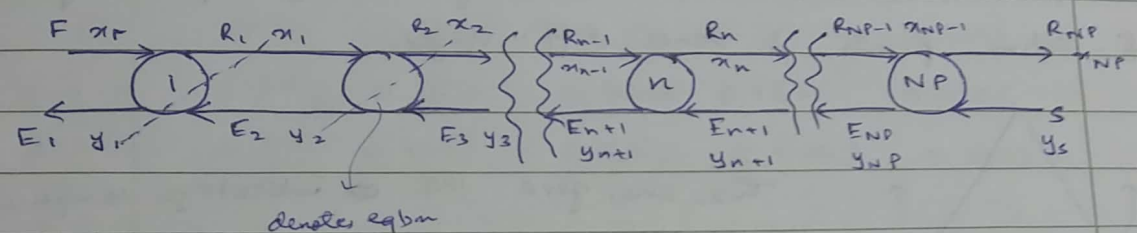
Calculate M'

Calculate x_M → calculate N_{M1} → Plot x_M, N_{M1} → Get the line

Find E, R Sols.

Counter Current Multistage

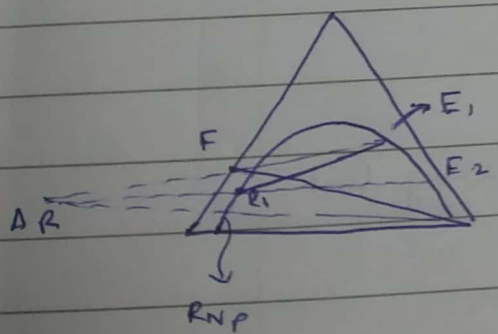


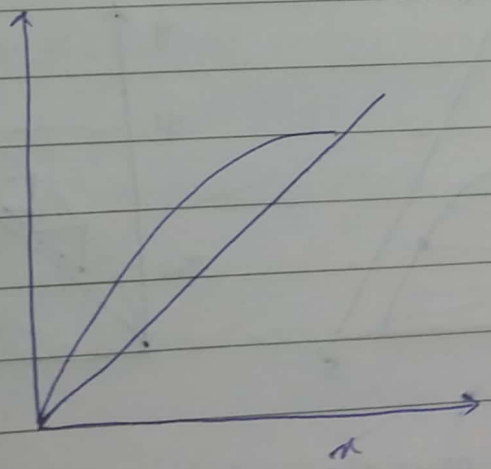
$$F + S = M = E_1 + R_{NP}$$

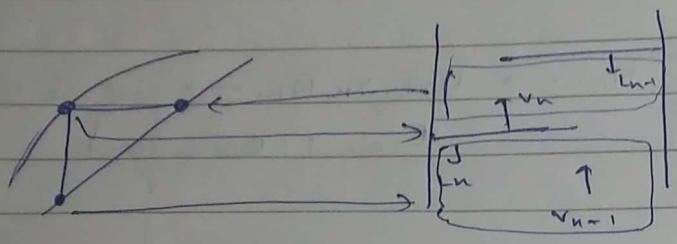
C balance → $F x_F + S y_S = M x_M = E_1 y_1 + R_{NP} x_{NP}$

$R_{NP} - S = F - E_1 = \Delta R$

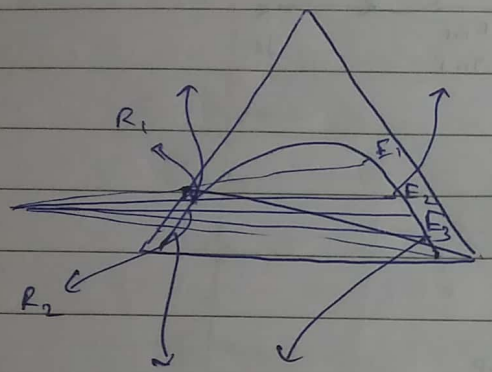
M, x_M calculated







Two diff. distillation columns will give diff. operating lines, diff. eqbm points & hence diff. stages

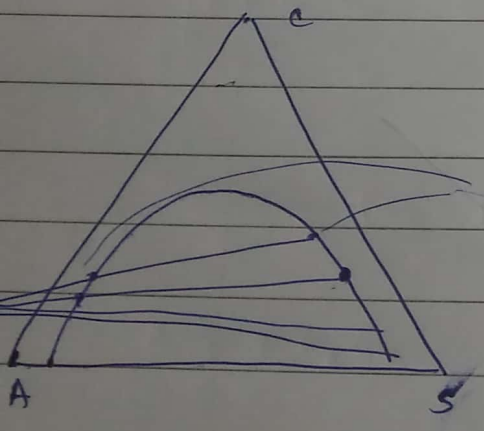


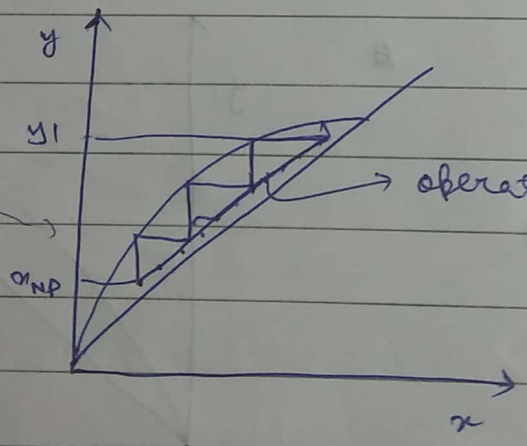
~~used~~ some random interstage comparition.

These lines give the interstage comparitia

~~E_1, R_2~~ $(E_2 R_1)$ $(E_3 R_2)$.

And the lines joining $(E_1 R_1)$ or $E_2 R_2$ are tie lines





Dont consider extra points as they affect the eff

x	y	X	Y	Nx	Ny
0.86	0.12	0	0	0.1628	7.333
0.84	0.10	0.0454	0.4117	0.1364	4.8824
0.80	0.11	0.1111	0.5416	0.1111	3.1667
0.73	0.14	0.198	0.6316	0.0989	1.632
0.67	0.22	0.2637	0.6140	0.0989	0.7544
0.57	0.30	0.3596	0.5588	0.1236	0.4706
0.48	0.35	0.4353	0.5333	0.17647	0.3333

→ $\frac{0.83}{0.17}$

$M x_M = F x_F$ $\quad F + S = M$

$80 \times x_M =$ $\quad M = 80$

$X_M = X_F = 0.4$

$F' = M' = 50\ kg/hr$

$F' N_F + S' N_S = M' N_{M1}$

$\uparrow 0$

$F' N_F + B = M' N_{M1}$

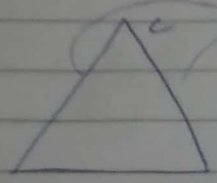
$50 \times 0 + 30 = 50 \times N_{M1}$

$\therefore N_{M1} = 0.6$

Scanned by CamScanner

X, Y can be used to solve any type of system

of A & B are completely insoluble

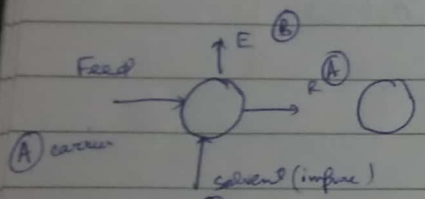


this is the system shown

For this type of a system, x', y' are used (solute free bases)

$$y' = \frac{y}{1-y}, \quad x' = \frac{x}{1-x}$$

A → carrier, B → solvent



Total carrier goes to raffinate and total solvent (pure) goes to the extract

The impurity in the solvent will only be a solute.

A & B will separate to R & E respectively since A & B are completely insoluble

Solute Free (c) Balance:

$$A x_F' + B_s y_s' = B_s y_1' + A x_1'$$

A → Amount of carrier in feed

B → Amount of solvent in solvent stream

$$x_F = \frac{A}{A+C} \qquad 1 - x_F = \frac{A}{A+C}$$

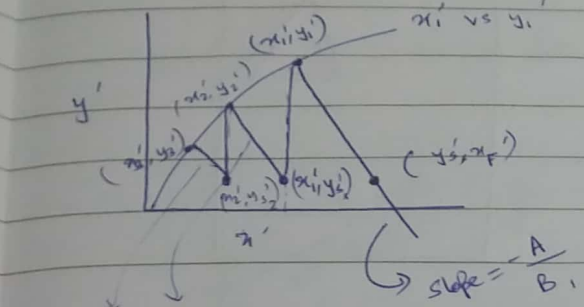
$$\Rightarrow -\frac{A}{B_1} = \frac{y_s' - y_1'}{x_F' - x_1'}$$

$$x_F' = \frac{C}{A}$$

$$y_s = \frac{C}{B+C}$$

$$1 - y_s = \frac{B}{B+C} \qquad y_s' = C/B$$

Date



x_1', y_1' will lie on this eqbm curve.

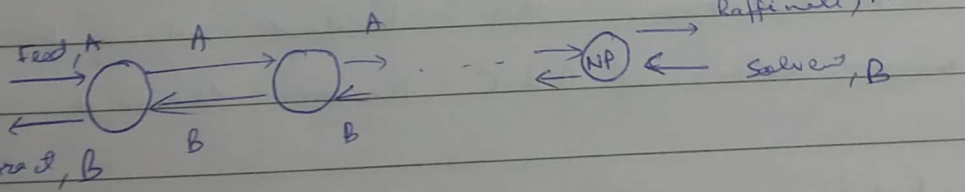
General with stage eqn.

$$A x_{n-1}' + B_n y_{sn}' = B_n y_n' + A x_n'$$

x'	0	0.001011	0.00246	0.00502	0.00751	0.00998	0.0204
y'	0	0.000807	0.001961	0.00456	0.00686	0.00913	0.01870

Nicotine (C) in a water soln. (A) is to be extracted with kerosene. Water and kerosene are eventially insoluble.

1000 kg/hr of nicotine-water soln. with 1% nicotine is to be counter currently extracted with kerosene to reduce the nicotine content to 0.1%. Determine the no. of stages if 1150 kg/hr of kerosene is used.



∵ carrier & solvent are completely insoluble

$$B y_s' + A x_F' = A x_{NP}' + B y_1'$$

$$x_{NP}' = \frac{0.001}{1 - 0.001} = 0.001001$$

$$A/B = \frac{y_1' - y_s'}{x_F' - x_{NP}'}$$

$y_s' = 0$

$x_F' = 0.0101$

$A = 990$ ($\because$ 1% nicotine)

$B = 1150$

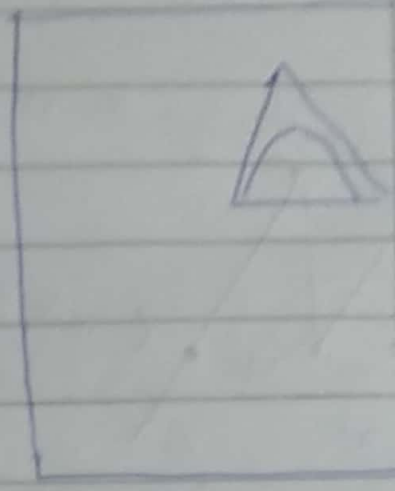
$A/B \simeq 0.8608$

↳ slope of operating line

Date

Tray bed Ex - 10.1 (Worked out)

Acetic Acid - Water - Isopropyl Ether



Q: 8000 kg/hr of an AA – Water containing 30% acid is counter currently extracted with Isopropyl ether to reduce acid conc. to 2% in the solvent free raffinate from Determine the no. of theoretical stages. if 20000 kg/hr is used.

C A B

$F = 8000$ kg/hr $\quad x_F = 0.3$

$$x_M = \frac{F x_F}{F + B} = \frac{8000 \times 0.3}{28000} = 0.0857 \approx 0.086$$

#
#

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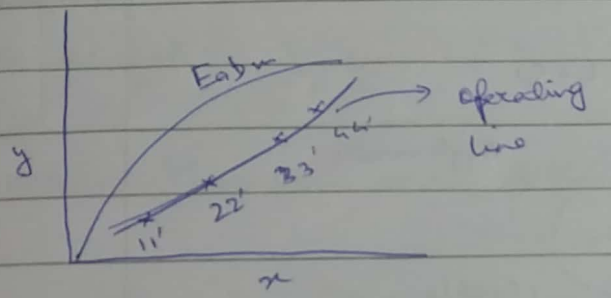
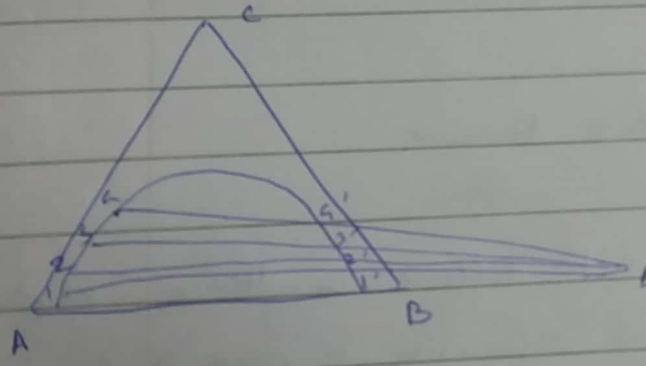
To convert to x, y data, we already have the data (x in water layer & y in 'cofrafye other) . We can plot it on



This is advantageous when we want to show 8-9 countercurrent stages.

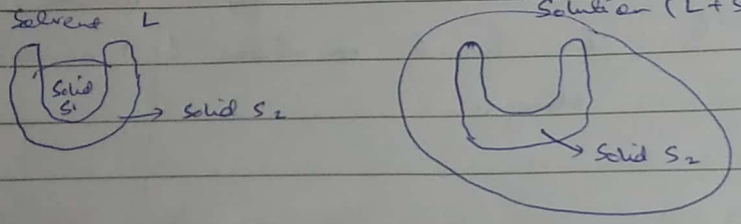
Joining any extract to AR to get another raffinate → these gives component balance of each stage → operating line.



We generate data by taking pts on the dome and connecting to AR to get the data points. Plotting these give us the operating line. Now, we can draw the no. of stages.

Leaching

Using a liquid solvent to extract a solid solute from an insoluble solid



Choice of solvent —

① Dissolves S_1 & does not dissolve S_2.

Leaching is favoured at high temperature because

① solubility ↑ with temperature

② if S_2 is porous, ∞ solvent has to diffuse in. Hence, high temperature is favourable, so that diffusivity is also high.

Leaching / Percolation

↓ continuous media is solvent

↳ continuous media is porous solid.

Liquation → leaching of alkali from wood ash.

Decoction - Leaching operation with the solvent at its boiling temperature.

Not vapour since vapour phase solubility lower than liquid phase solubility

Date

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~~Extraction or elution~~

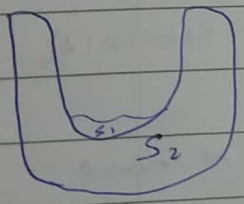
Diffn of vap & liq ≃ 100:1
Solubility of " " ≃ 1:10

Leaching
↳ Diffusion
↳ Dissolution
↳ Diffusion

Dissolution changes one liq. diffusion step to a vap. diffusion step.

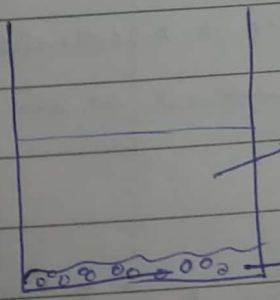
Elutriation or Elution : the solute is stuck only on the surface of the insoluble ~~solute~~ solid.

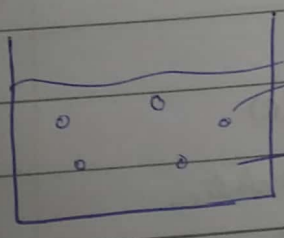
Solution mining : repeated percolation.



Happens if
① Solvent is saturated
② Contact time ⓐ reqd. is very large
③ Dissolution is not instantaneous (unlike extraction)

Successful stage -
① • Solid S_2 agglomerates if pieces are large enough for body force to be more





Dispersion of S_2 in a solution of S_1.

Date

Practical stage –

(1) size of solid S_2 is a parameter for operation.

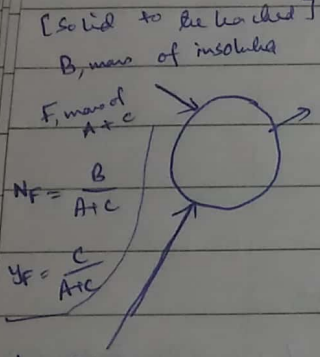
(2) solid S_2 withdrawn will contain some entrapped liquid

(3) composition of extracted and entrapped solution is same. Hence, in a B-free basis calculation (N v/s x, y), the tie lines will be completely vertical.

(2) Low solubility of S_2 in solvent

(4) some solvent molecule will preferentially adsorb on the solid surface.

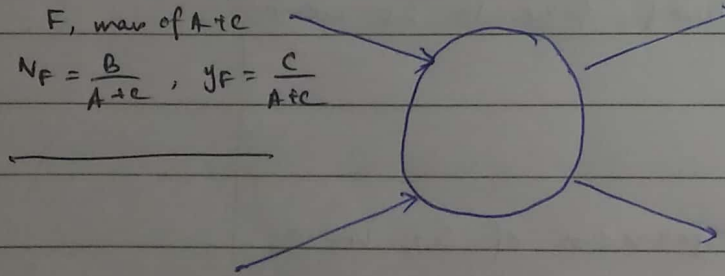
(5) contact time is an important parameter



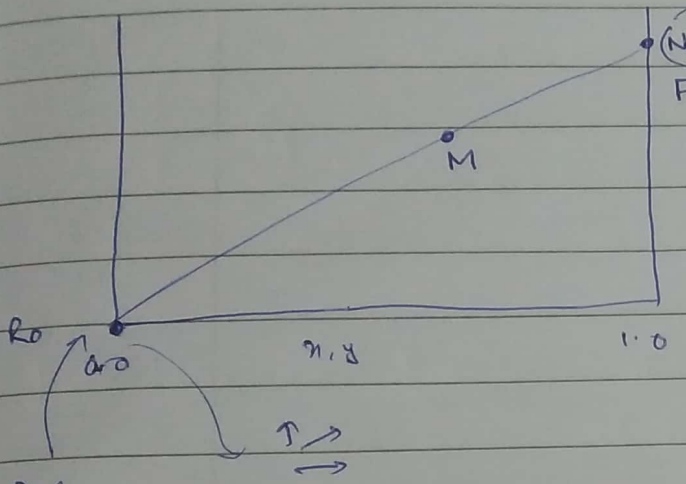
B → Insoluble

Soyabean Oil (C)
- Soyabean Meat (B)
- hexane (A)

A → Solvent
B → Insoluble
C → Soluble
A+C → Dissolvable material or soln.



If some liquid is entrapped in leached solid then only $(N_1 \neq \infty)$



for ~~Pure solvent~~ dry feed (no solvent)

For If feed ~~is~~ contains some solvent, F will shift a bit ~~down~~ down in a slant manner.