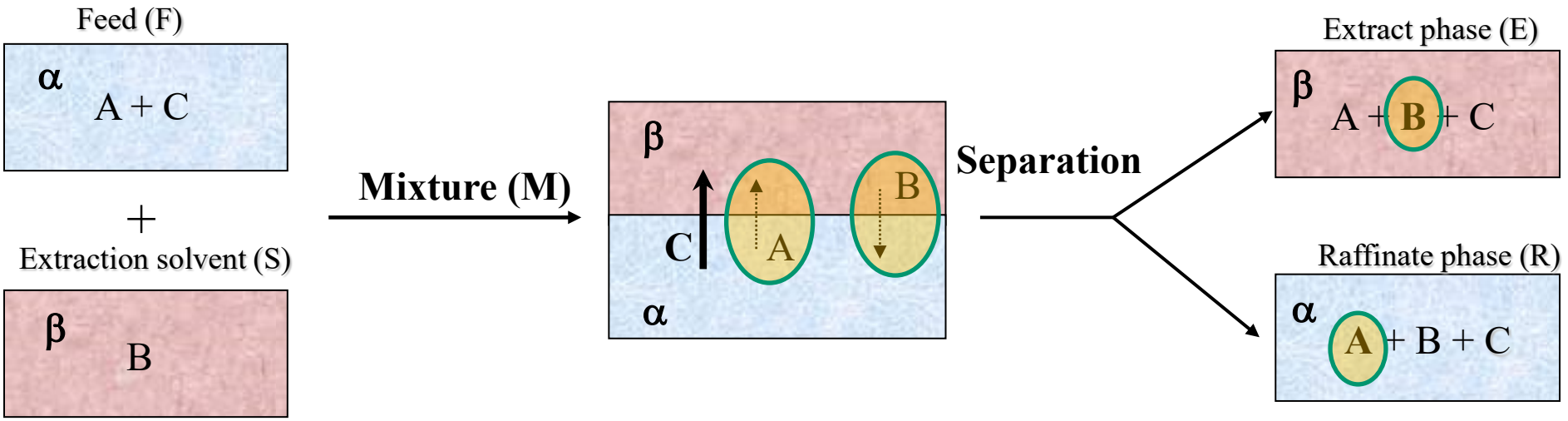
Liquid – Liquid Extraction

Processos de Separação

LEQB

2023/2024

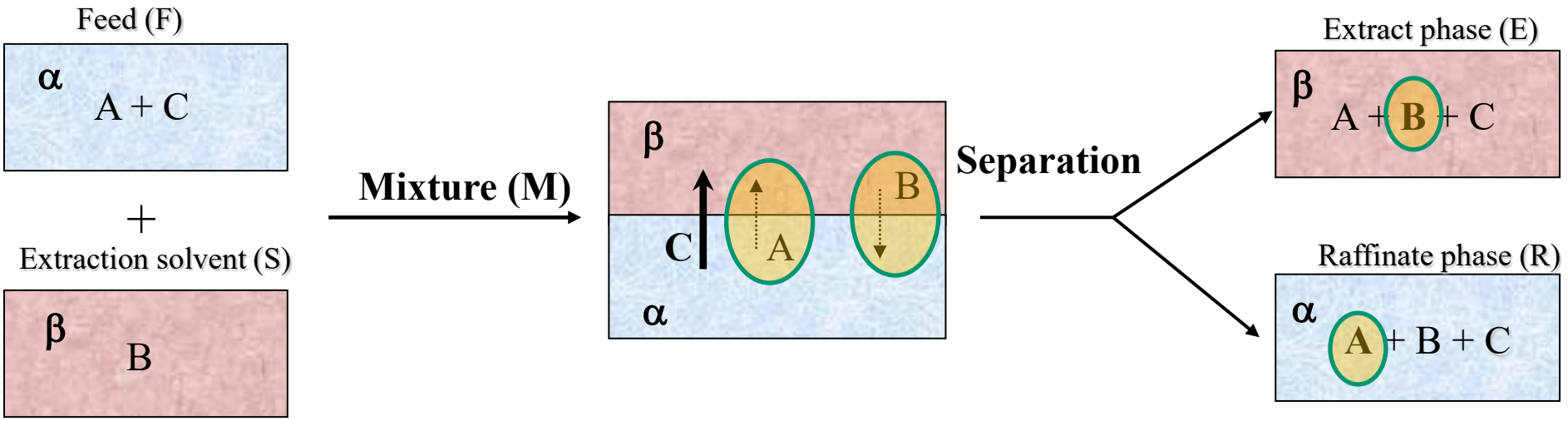


Solvents *A* and *B* are **partially** miscible

A: Water (diluent)

C: Acetone (solute)

B: *n*-Hexane (solvent)



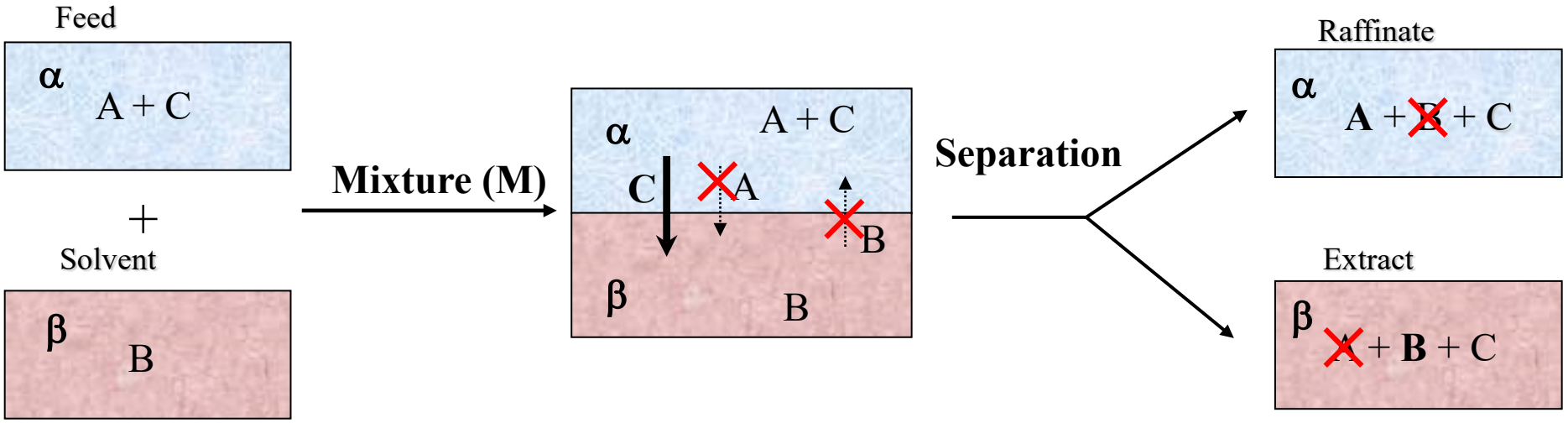
A: Water (diluent)

C: Acetone (solute)

B: *n*-Hexane (solvent)

What if the solvents were "totally" immiscible?

Solvents "totally" immiscible



A – Water (diluent)

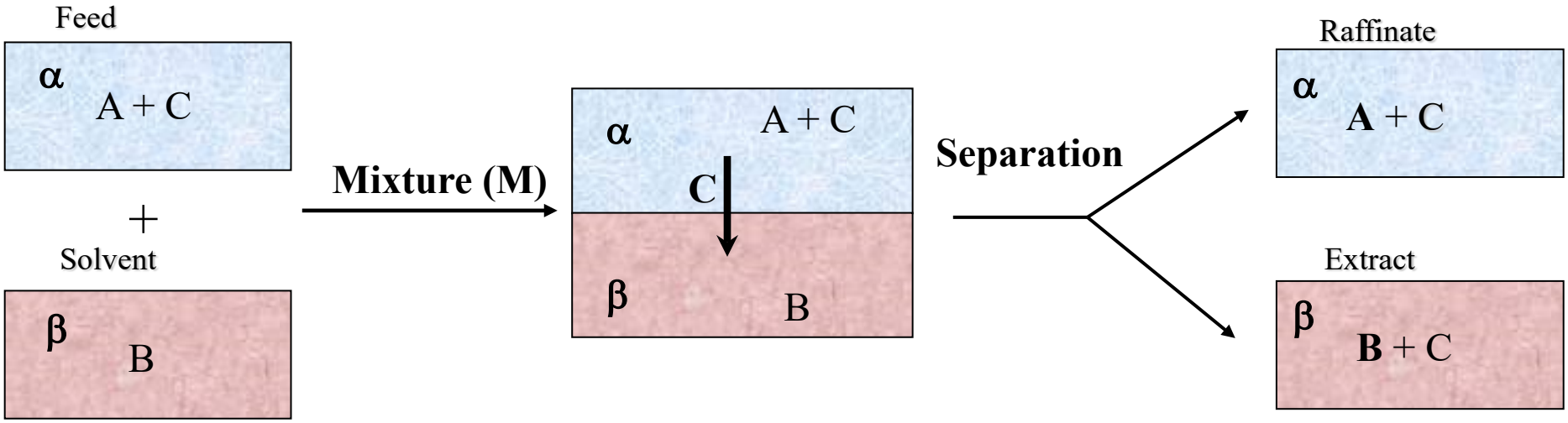
C – Nicotine (solute)

B – Kerosene (solvent)

Water / kerosene: **immiscible**

The generic term "kerosene" is used to describe the fraction of crude oil that boils approximately in the range of 302 to 554 °F (150 to 290°C) and consists of hydrocarbons approximately in the range of C9-C16

Solvents "totally" immiscible



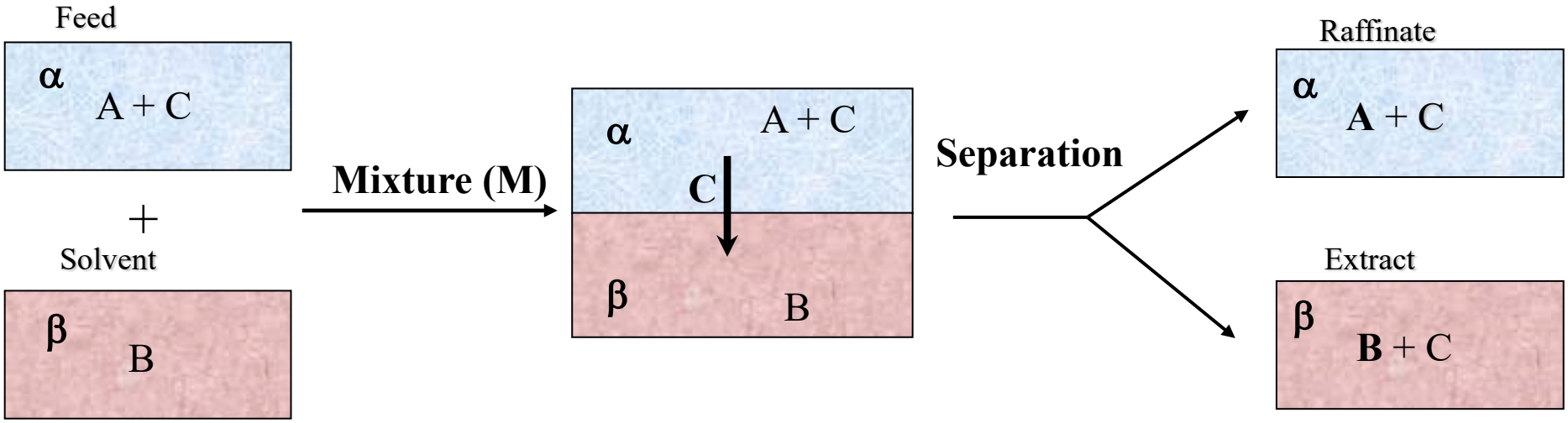
A – Water (diluent)

C – Nicotine (solute)

B – Kerosene (solvent)

Water / kerosene: **immiscible**

Solvents "totally" immiscible



A – Water (diluent)

C – Nicotine (solute)

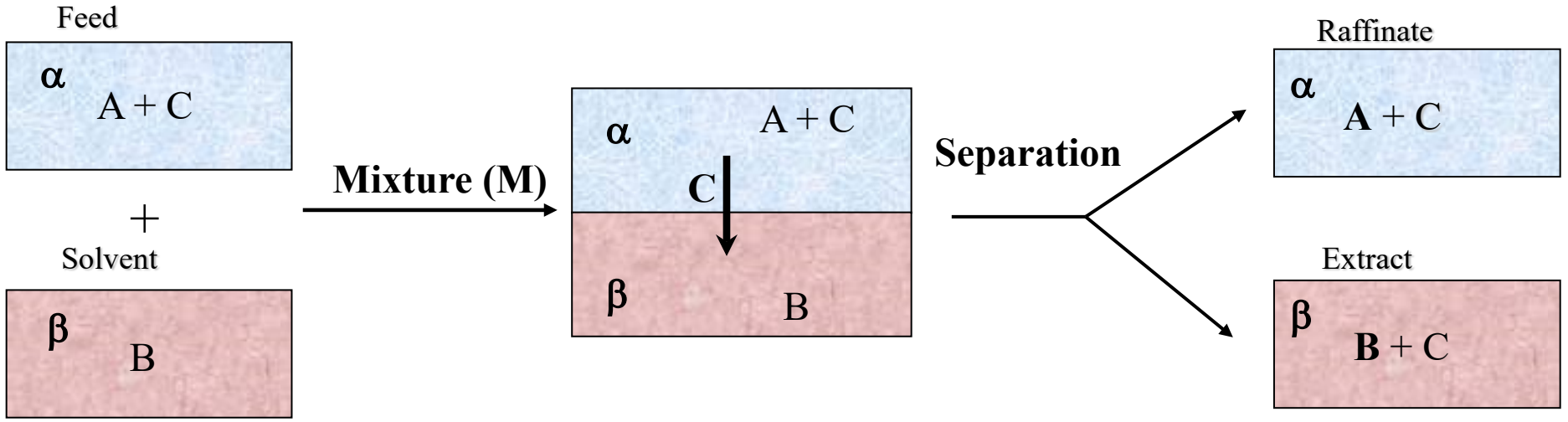
B – Kerosene (solvent)

Solute-free compositions

$$x', y' = \frac{m_C}{(m_A + m_B)}$$

Solute-free flowrates

Solvents "totally" immiscible



A – Water (diluent)

C – Nicotine (solute)

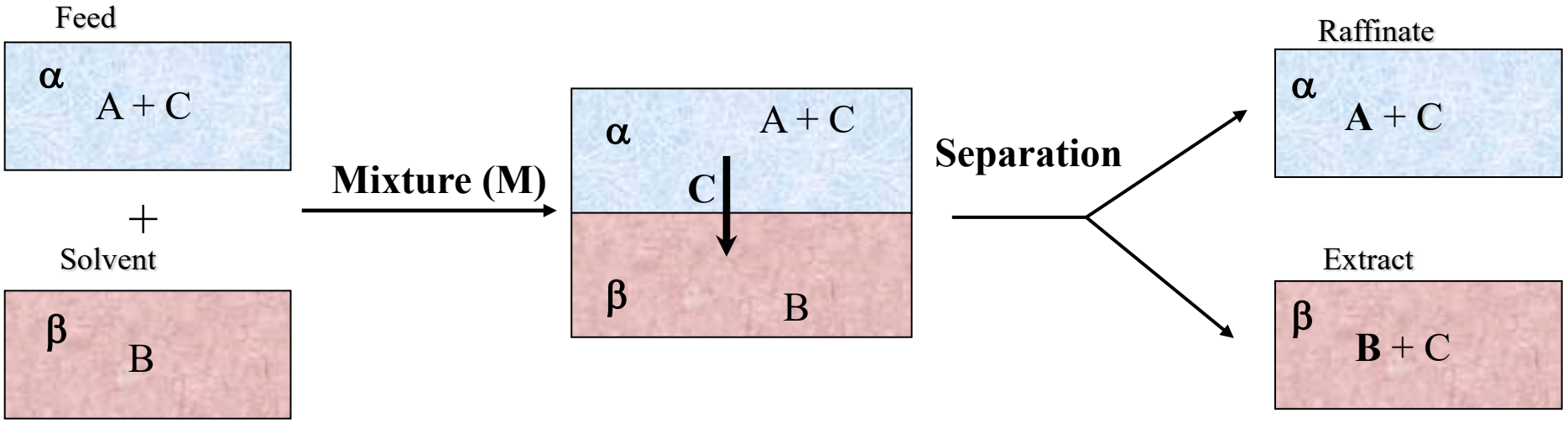
B – Kerosene (solvent)

Solute-free compositions

$$x' = \left.\frac{m_C}{(m_A + \cancel{m_B}^{\,=0})}\right|_{raffinate} \qquad y' = \left.\frac{m_C}{(\cancel{m_A}^{\,=0} + m_B)}\right|_{extract}$$

Solute-free flowrates

Solvents "totally" immiscible



A – Water (diluent)

C – Nicotine (solute)

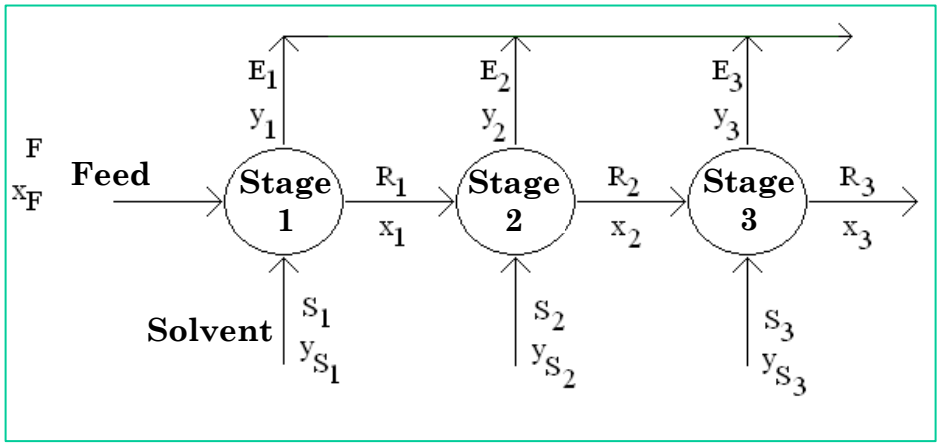
B – Kerosene (solvent)

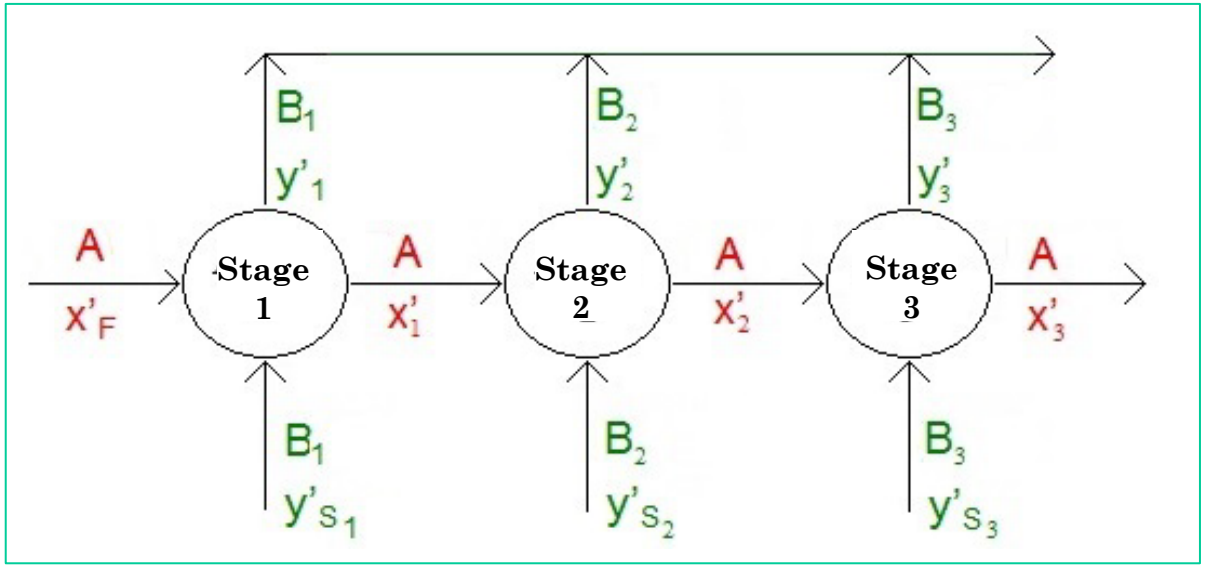
Solute-free compositions

$$x' = \left.\frac{m_C}{m_A}\right|_{raffinate} \qquad y' = \left.\frac{m_C}{m_B}\right|_{extract}$$

Solute-free flowrates

Cross flow extraction - A and B totally immiscible



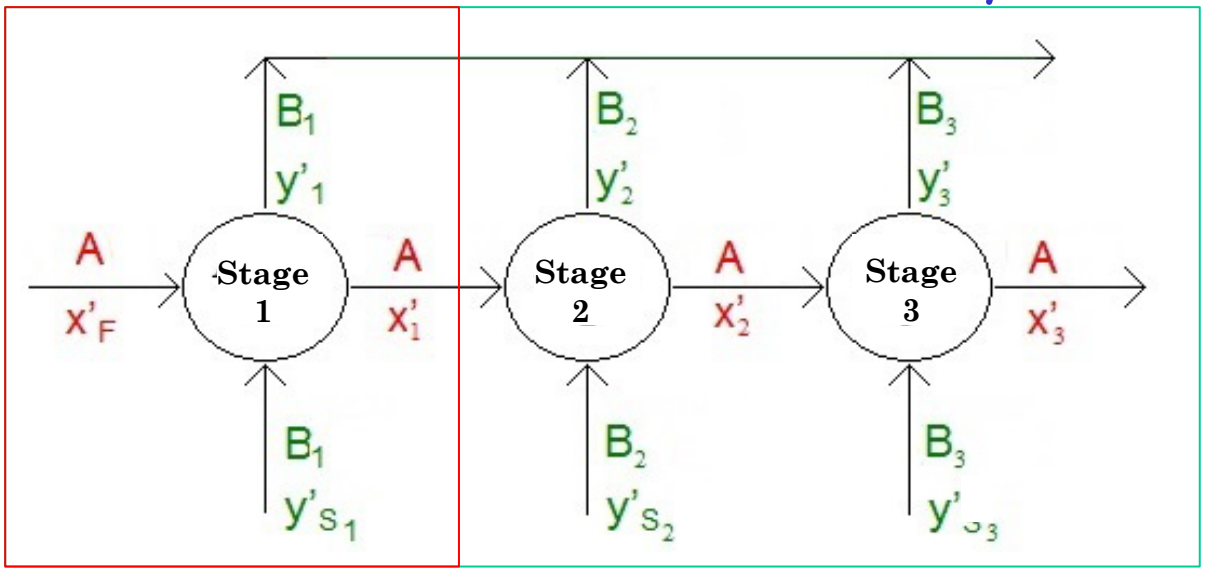


A: <u>solute-free</u> raffinate phase flowrates (kg_A/h)

B_n: <u>solute-free</u> extract phase flowrates (kg_B/h)

$$x' = \frac{m_C}{m_A} \qquad y' = \frac{m_C}{m_B}$$

Cross flow extraction - A and B totally immiscible



$$x' = \frac{m_C}{m_A}$$

$$y' = \frac{m_C}{m_B}$$

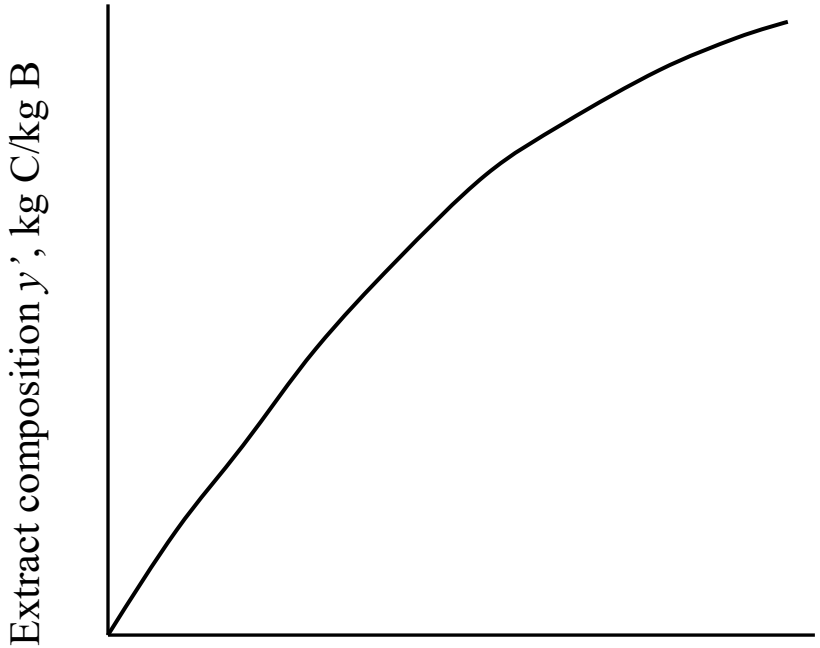
Material balance to solute (**stage 1**)

Solute-free compositions:

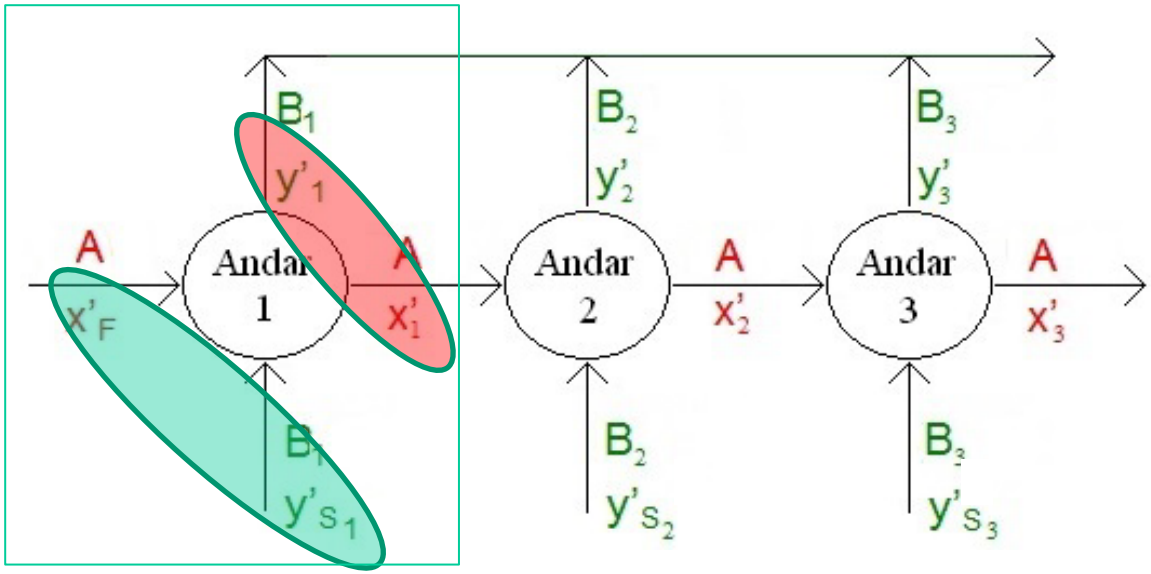
$$A\,x'_F + B_1\,y'_S = A\,x'_1 + B_1\,y'_1$$

$$\Rightarrow \quad -\frac{A}{B_1} = \frac{y'_S - y'_1}{x'_F - x'_1}$$

Operating line



Cross flow extraction - A and B totally immiscible



$$x' = \frac{m_C}{m_A}$$

$$y' = \frac{m_C}{m_B}$$

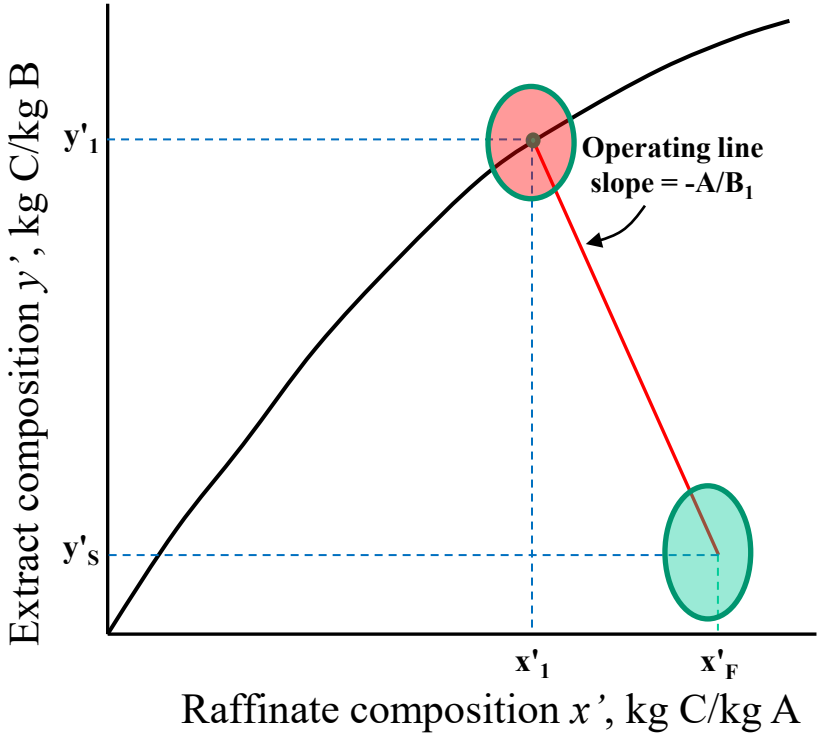
Material balance to solute (**stage 1**)

Solute-free compositions:

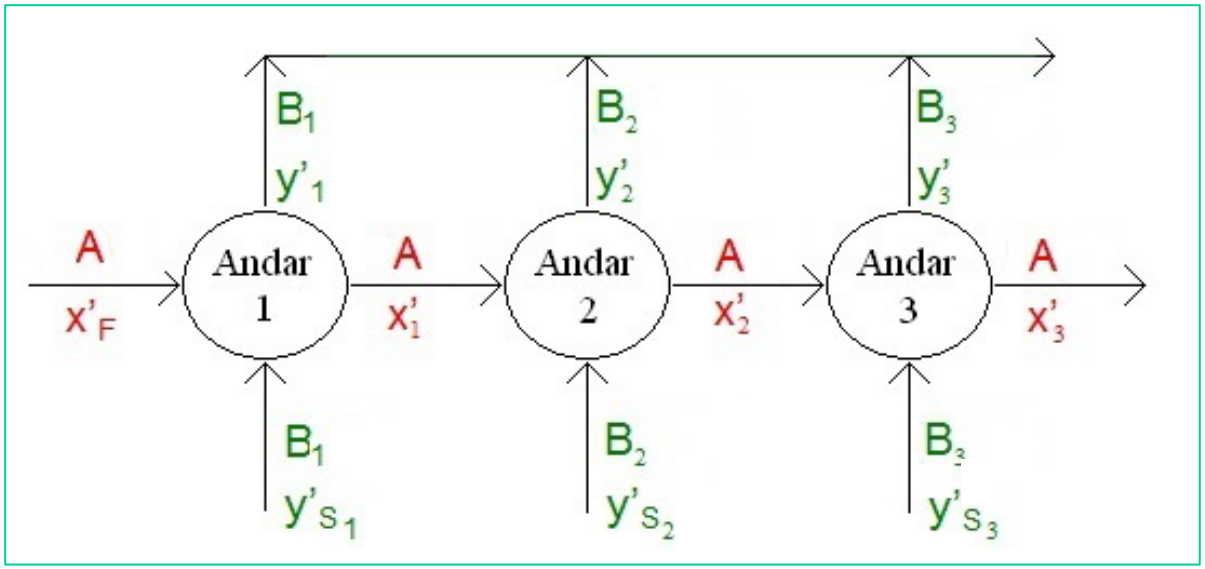
$$A\,x'_F + B_1\,y'_S = A\,x'_1 + B_1\,y'_1$$

$$\Rightarrow \quad -\frac{A}{B_1} = \frac{y'_S - y'_1}{x'_F - x'_1}$$

Operating line



Cross flow extraction - A and B totally immiscible



$$x' = \frac{m_C}{m_A}$$

$$y' = \frac{m_C}{m_B}$$

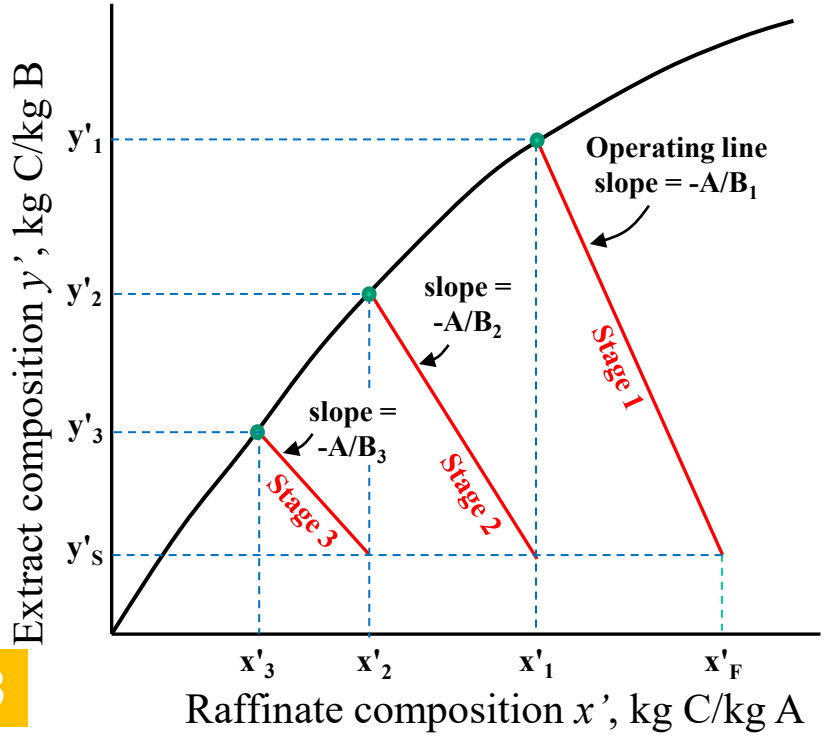
Material balance to solute (**stage 1**)

Solute-free compositions:

$$A\,x'_F + B_1\,y'_S = A\,x'_1 + B_1\,y'_1$$

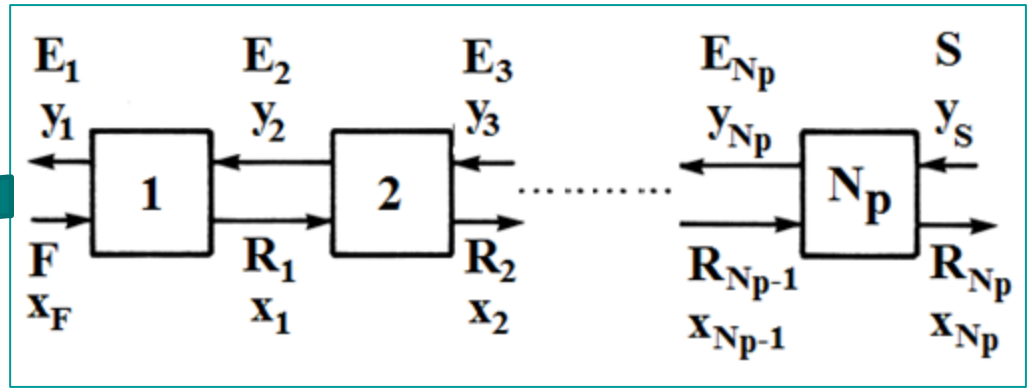
$$\Rightarrow \quad -\frac{A}{B_1} = \frac{y'_S - y'_1}{x'_F - x'_1}$$

Operating line



PROBLEM 3

3. Countercurrent extraction

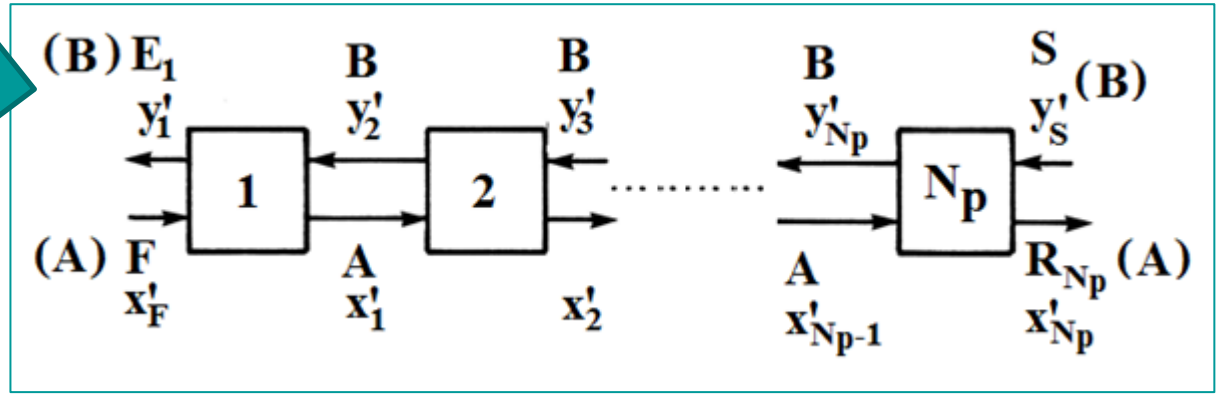


Solvents partially miscible

A: solute-free raffinate phase flowrates (kg_A/h)

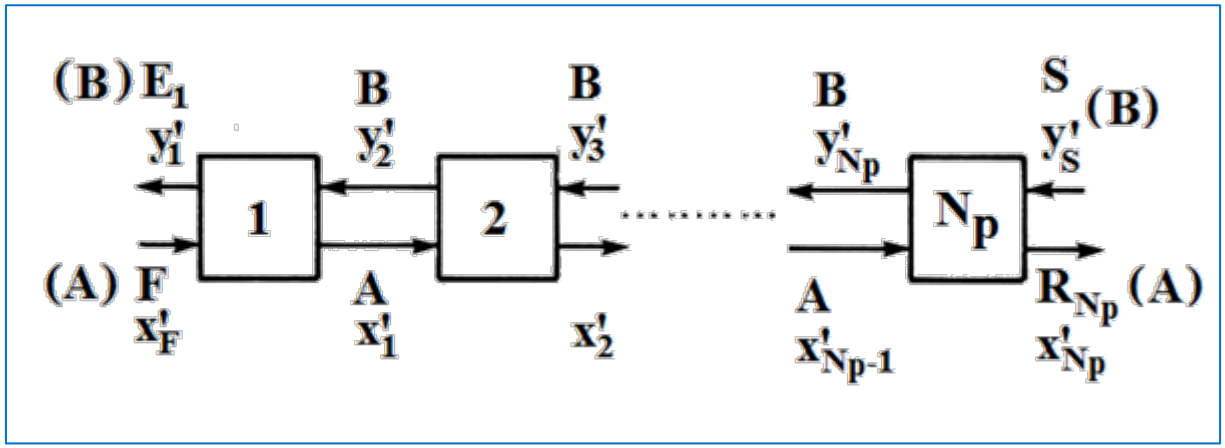
B_n: solute-free extract phase flowrates (kg_B/h)

Solute-free compositions



Solvents "totally" immiscible

3. Countercurrent extraction



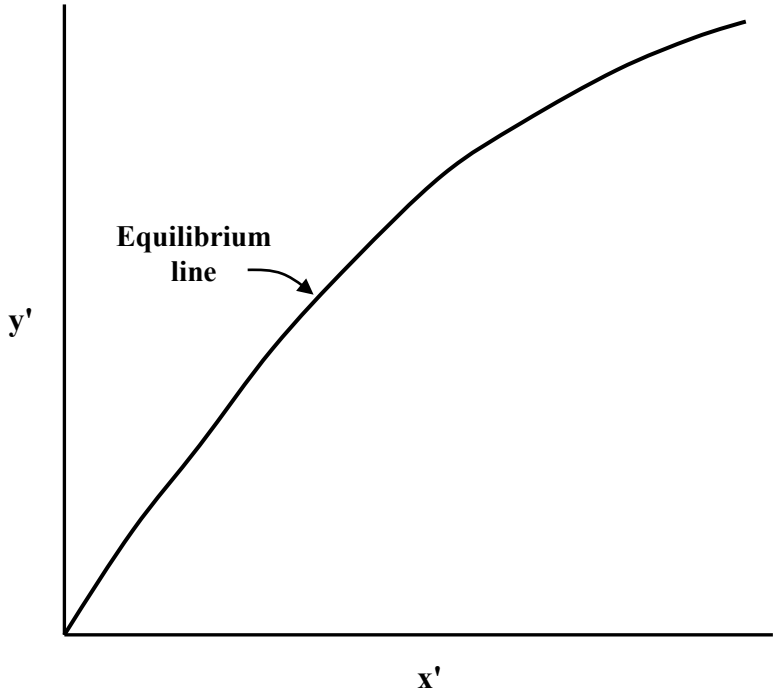
Overall material balance to solute

Solute-free compositions:

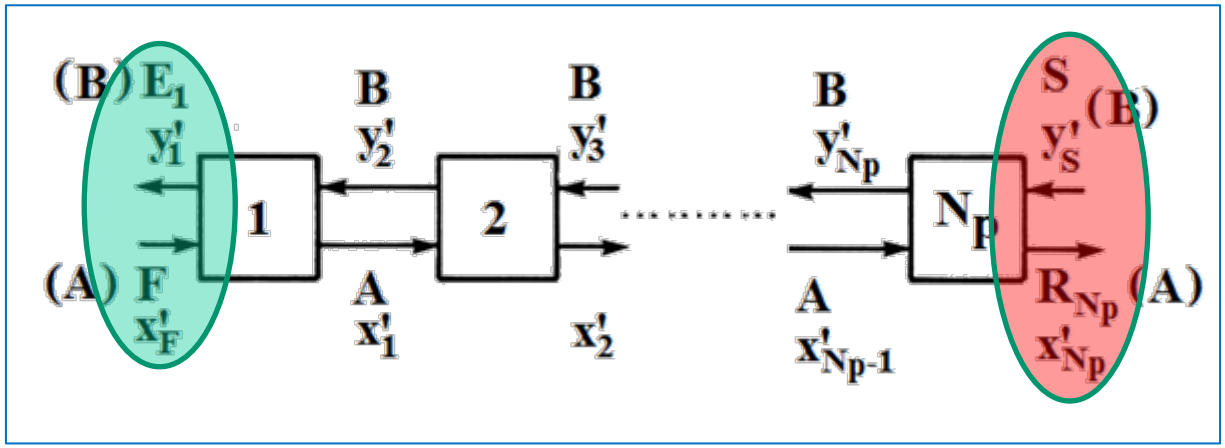
$$A x'_F + B y'_S = A x'_N + B y'_1$$

=> Operating line

$$\frac{A}{B} = \frac{y'_1 - y'_S}{x'_F - x'_N}$$



3. Countercurrent extraction



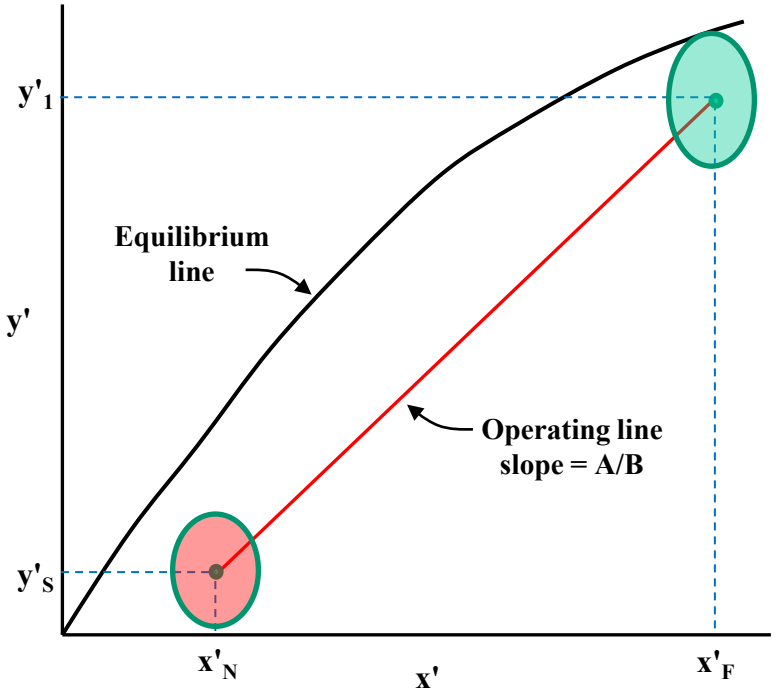
Overall material balance to solute

Solute-free compositions:

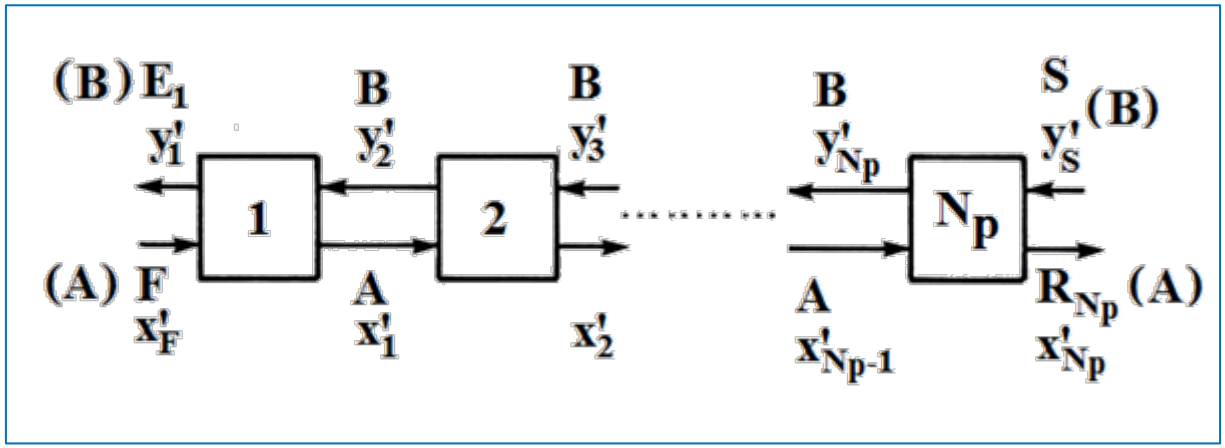
$$A\,x'_F + B\,y'_S = A\,x'_N + B\,y'_1$$

=> Operating line

$$\frac{A}{B} = \frac{y'_1 - y'_S}{x'_F - x'_N}$$



3. Countercurrent extraction



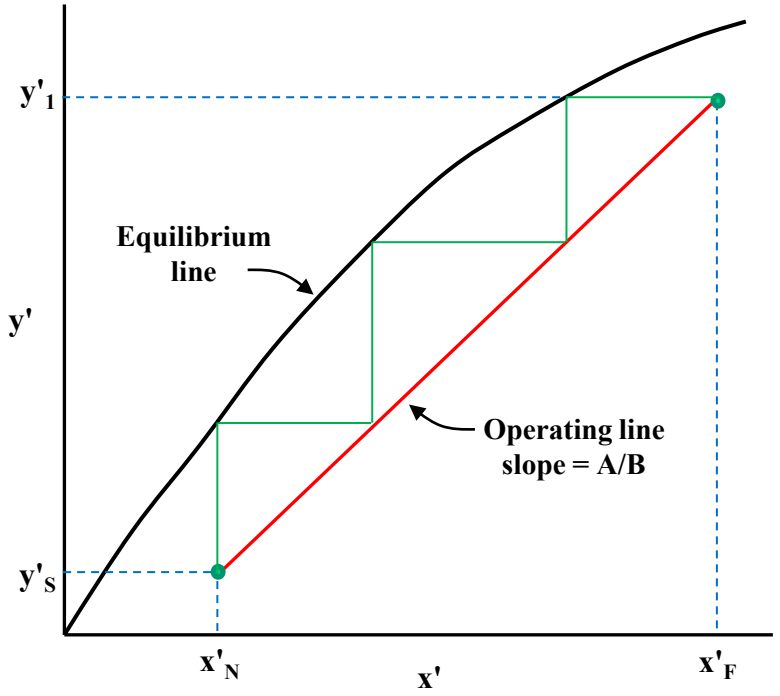
Overall material balance to solute

Solute-free compositions:

$$A\,x'_F + B\,y'_S = A\,x'_N + B\,y'_1$$

=> Operating line

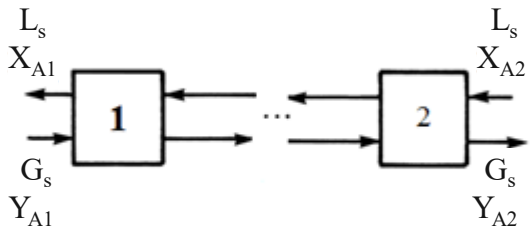
$$\frac{A}{B} = \frac{y'_1 - y'_S}{x'_F - x'_N}$$

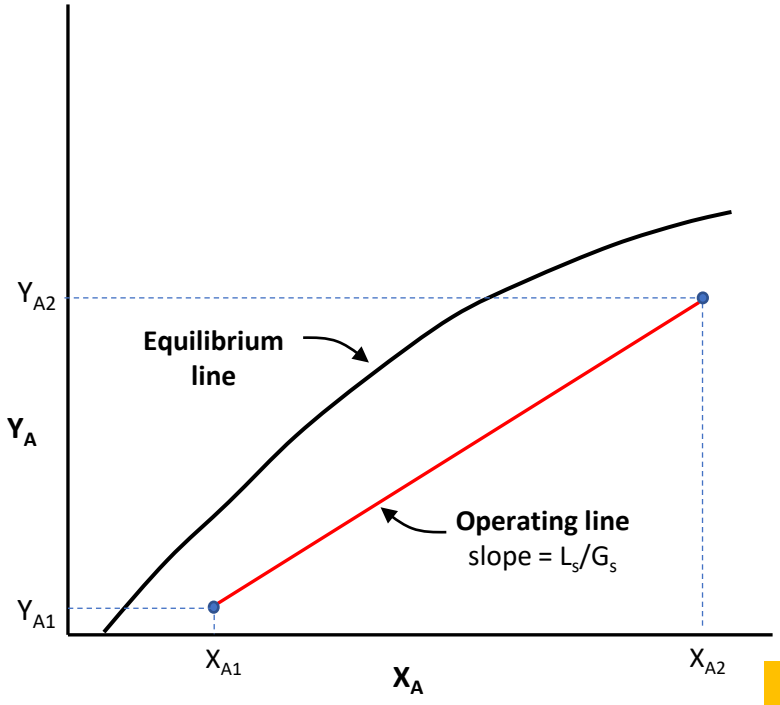


Gas absorption - **Stripping**

Operating line

$$\frac{L_s}{G_S} = \frac{Y_{A1} - Y_{A2}}{X_{A1} - X_{A2}}$$

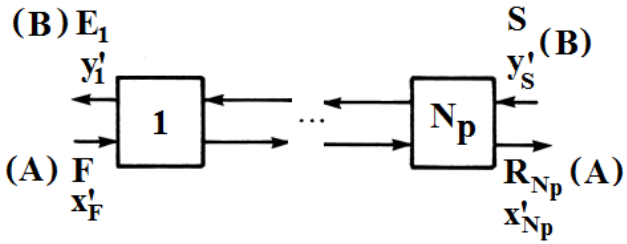


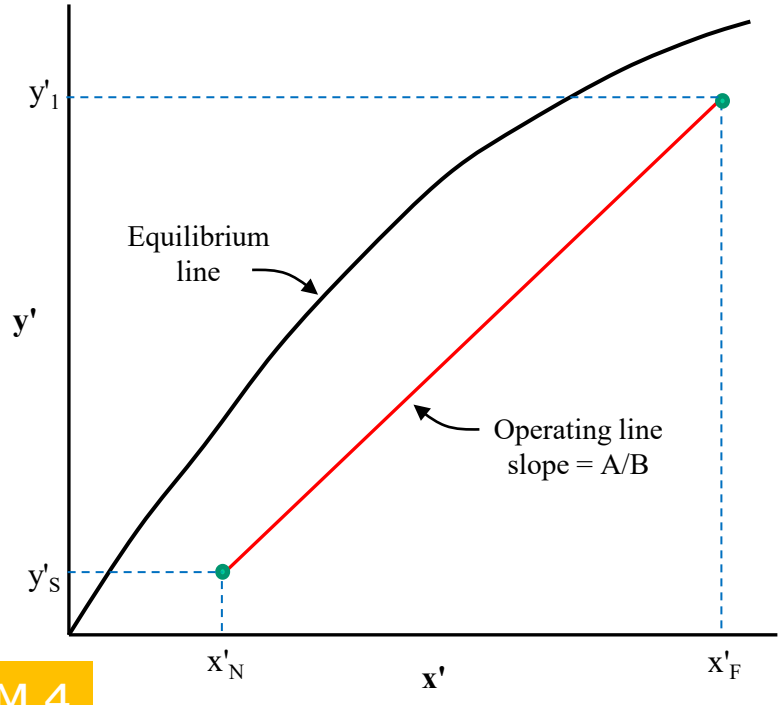


Countercurrent extraction

Operating line

$$\frac{A}{B} = \frac{y'_1 - y'_S}{x'_F - x'_N}$$

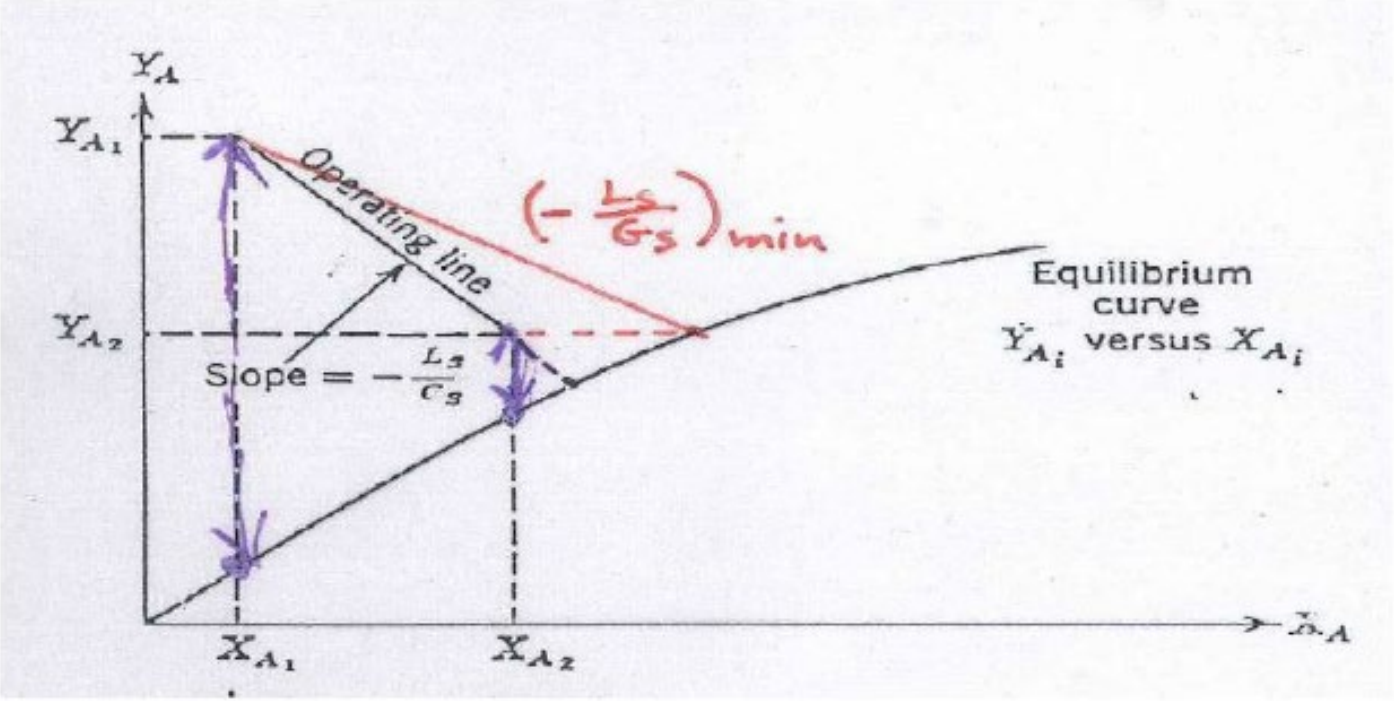




PROBLEM 4

Absorção - Caudal mínimo

Fluxo em cocorrente



Absorção Gasosa

Fluxo em contracorrente