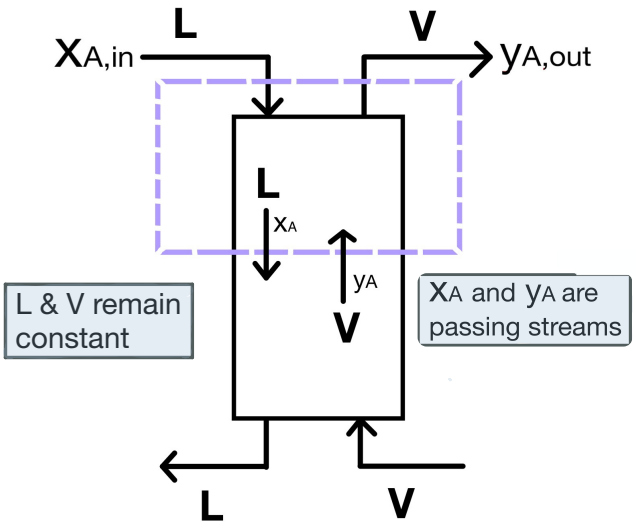
ENCH 445: Basic Principles for Staged & Continuous Contactors

1. Location of equilibrium and operating lines are the same for staged and continuous contactors



NUP_i
net upward product of i

Constant at any horizontal plane

$NUP_i = y_{out}V - x_{in}L$

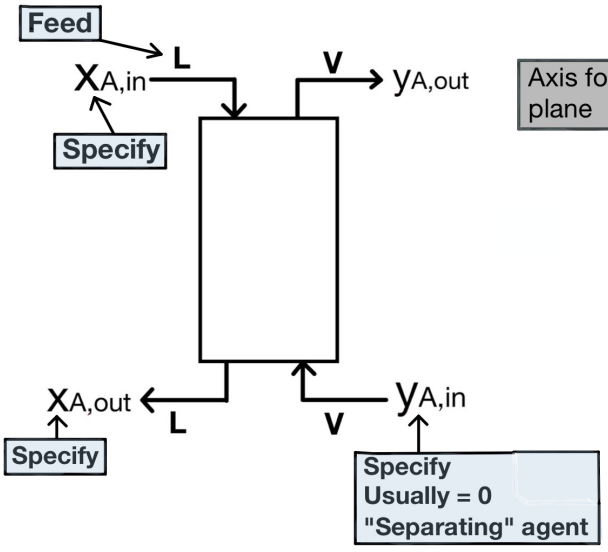
$NUP_A = y_AV - Lx_A$

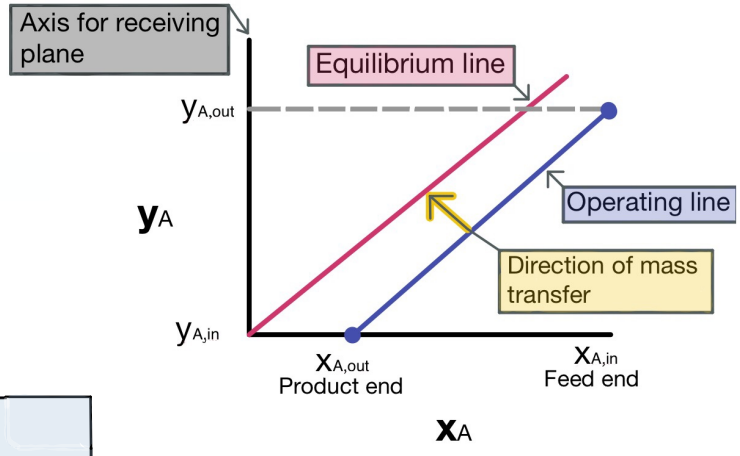
Intercept

$$y_A = \underbrace{\frac{L}{V}}_{\text{Slope}} x_A + \frac{NUP_A}{V}$$

2. Equilibrium Line is always between the operating line and the axis for receiving phase.

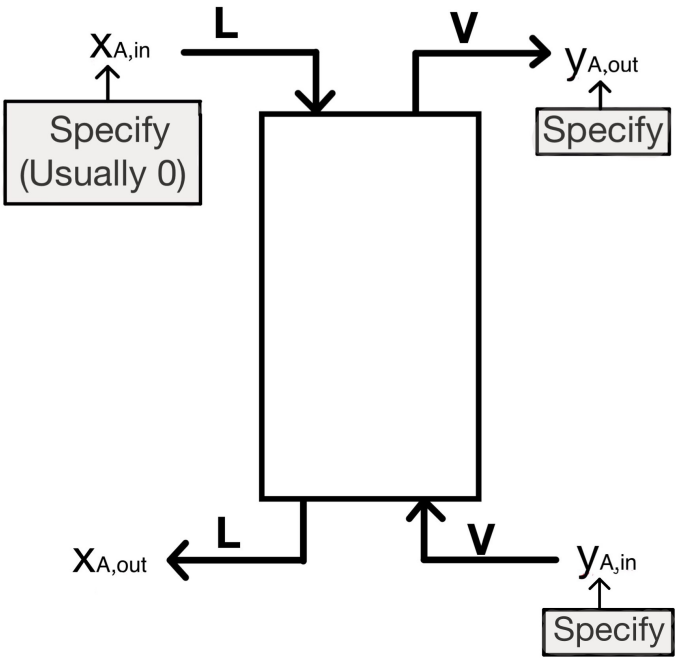
Stripper

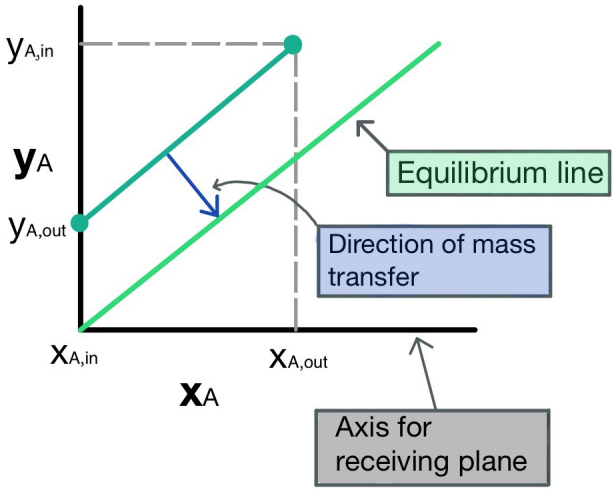




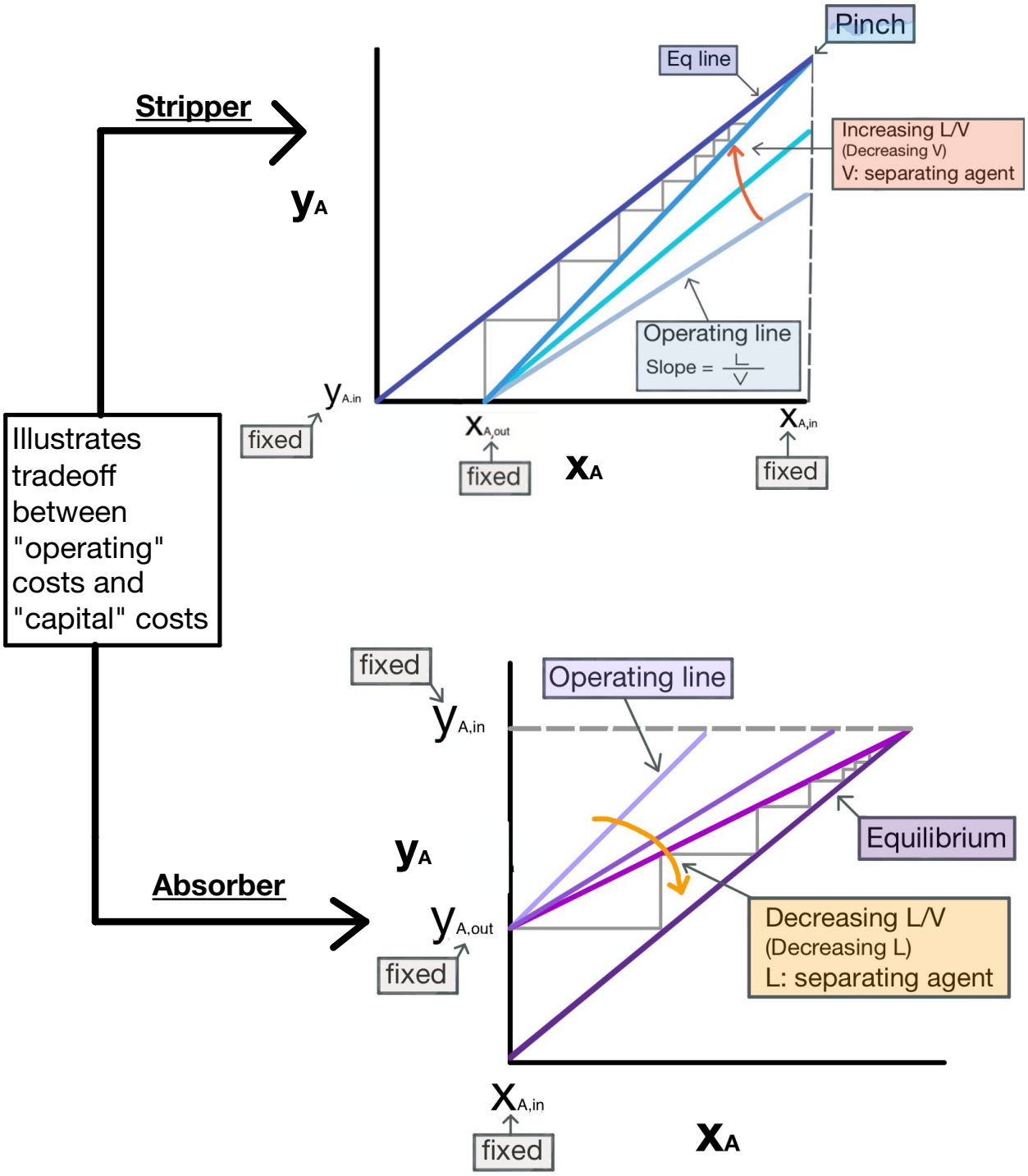
🔍 x_A decreases as y_A increases

Absorber


$x_{A,in}$
L
V
$y_{A,out}$
Specify
(Usually 0)
Specify
$x_{A,out}$
L
V
$y_{A,in}$
Specify

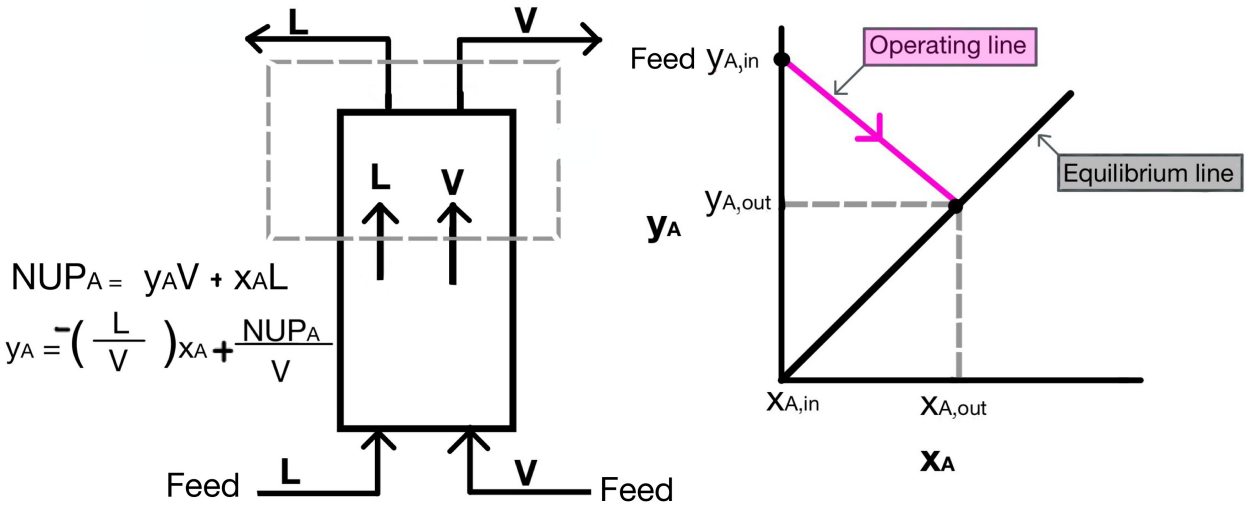

$y_{A,in}$
y_A
$y_{A,out}$
Equilibrium line
Direction of mass transfer
$x_{A,in}$
$x_{A,out}$
x_A
Axis for receiving plane

3. Minimum flow of "separating agent" corresponds to an infinite number of plates (staged) or infinite column height (continuous) and to a "pinch" at the feed end.



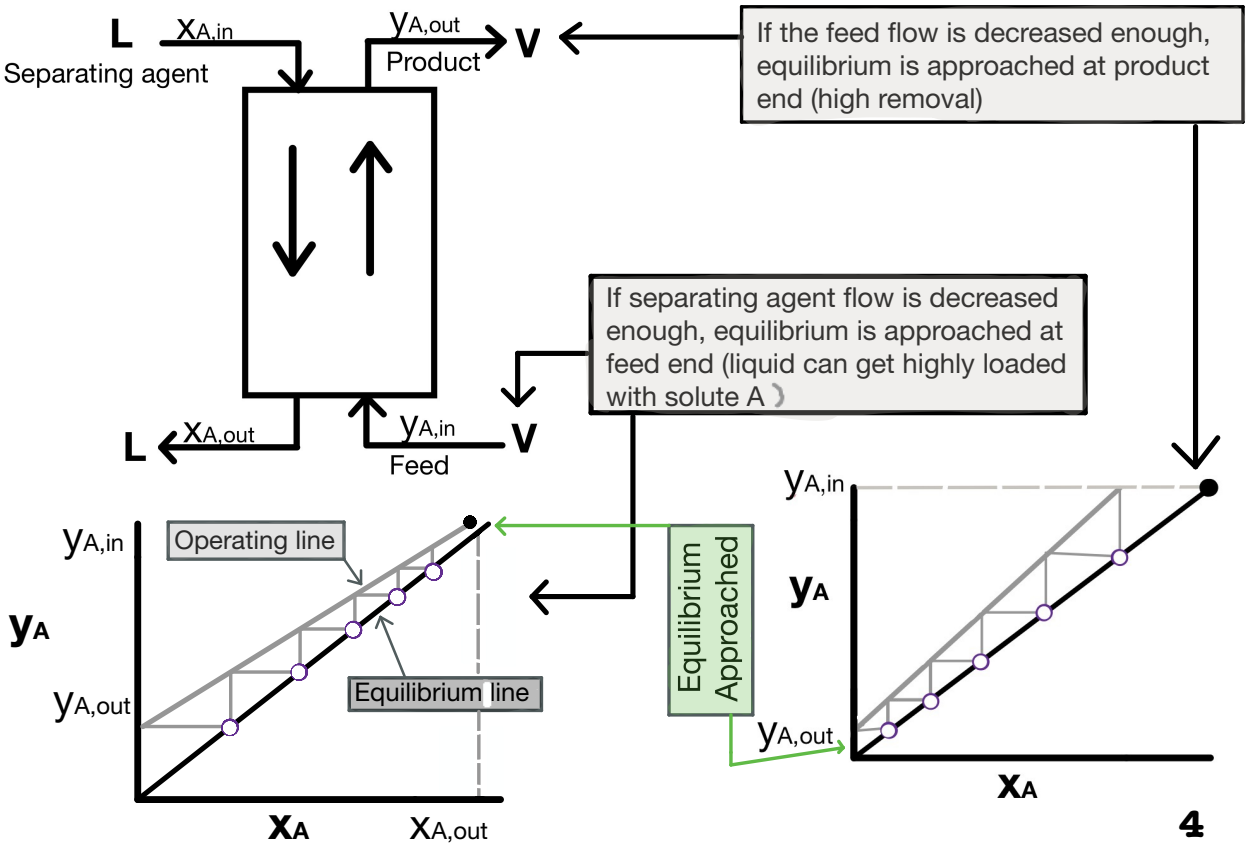
4. Counter current flow is more efficient than co-current flow since in the former, an inlet stream can come to equilibrium with an outlet stream

Co-Current Absorber



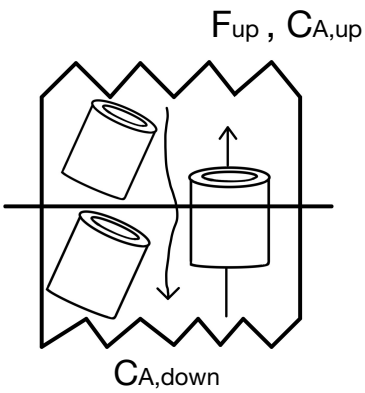
Maximum amount of mass transfer is when outlet streams come to equilibrium

Counter-Current Absorber

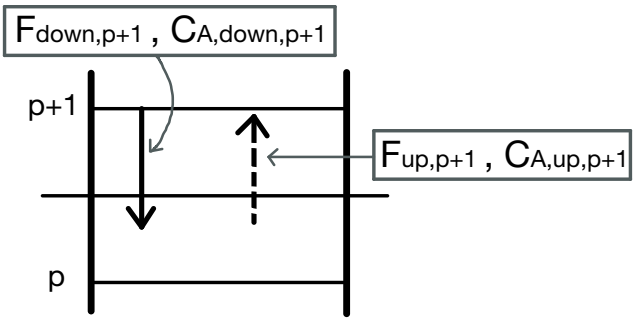


5. Straight operating lines are convenient because they can be located by two points

General operating line:



or



NUP_i = quantity of i flowing upward

F = general flow
C = general quantity

} F.C = flow of i (moles per second)

Examples:
F = mol/s , C = mol fraction
F = vol/s , C = mol/vol

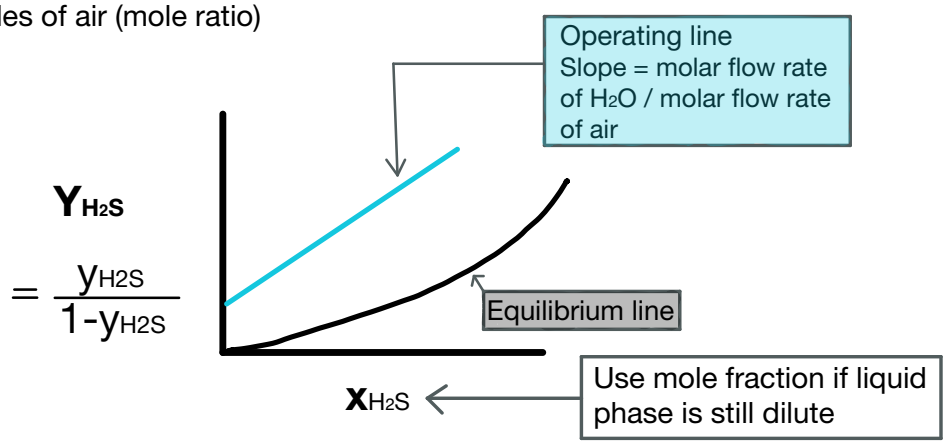
<u>Operating Line:</u>

$$NUP_A = F_{up}\, C_{A,up} - F_{down}\, C_{A,down}$$

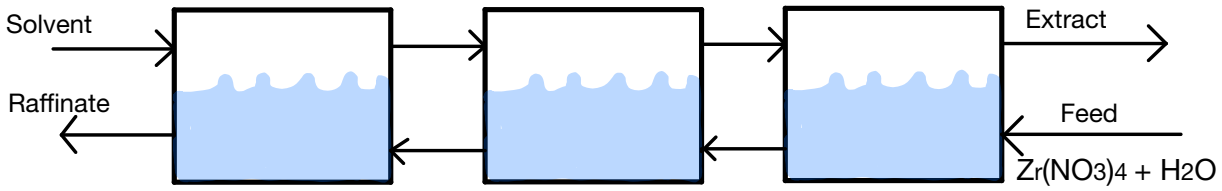
$$C_{A,up} = \frac{F_{down}}{F_{up}} C_{A,down} + \frac{NUP_A}{F_{up}}$$

Select F's to be constant. This determines the form of the C's.

Example: Absorption of H_2S from a gas mixture which is 50% H_2S and 50% air. Assuming air is inert (not absorbed), let **Fup** = flow of air and **Cup** =moles of H_2S per moles of air (mole ratio)



Example: Extraction using tributal phosphate in kerosine for recovery of $Zr(NO_3)_4$ from aqueous solution



Specify
1. Solvent is Zr free and 2M TBP
2. Recover 90% of Zr
3. Feed has 0.120 mol Zr / liter

Find
1. Minimum solvent required
2. Number of stages if $\frac{\text{solvent}}{\text{feed}} = \frac{0.90\ \text{L}}{\text{L}}$

Solution
Since phases are immiscible and transferred solute is dilute, total flow of each phase is constant. In terms of volume: