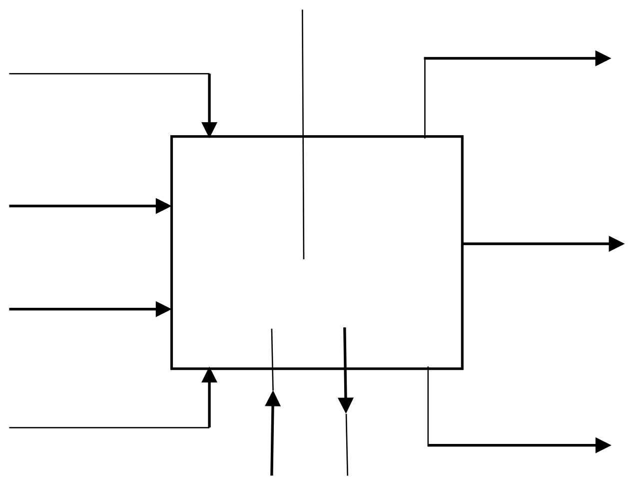
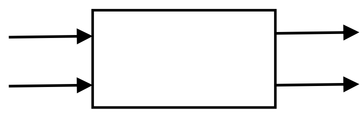
Equilibrium Stages

- It is a theoretical concept representing the contact of two phases for sufficient time until they reach equilibrium
- The number of equilibrium stages represents the theoretical number of contacts required for a desired separation
- The use of stage efficiencies (based on mass transfer rates) and the number of equilibrium stages can be used to determine the number of the actual stages required for the separation.



Single Stage

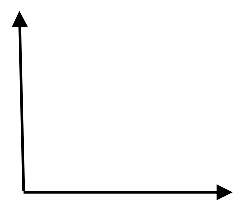
Effectively it is a concurrent operation. If the stage were ideal, the exit streams would be at equilibrium.



Stage efficiency

It is an expression of the fractional approach to equilibrium which a real stage produces.

Possible definitions:



- $\frac{\text{Line Qp}}{\text{Line Tp}}$
- $\frac{\text{Actual solute transfer}}{\text{Equilibrium solute transfer}}$

Murphree stage efficiency

E-phase

$$E_{ME} = \frac{Y_2 - Y_1}{Y_2^* - Y_1}$$

R-phase

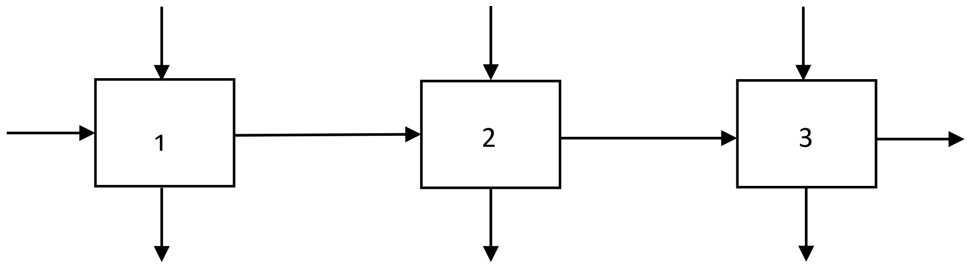
$$E_{MR} = \frac{X_1 - X_2}{X_1 - X_2^*}$$

Y_2^* : in equilibrium with X_2

X_2^* : in equilibrium with Y_2

- This is an arbitrary definition since Y_2 will never be greater than Y_e and X_2 will never be lower than X_e
- $E_{ME} \neq E_{MR}$

Cross Flow



Material balances for each stage are the same as for a single stage.