Exercise 1

Question 1

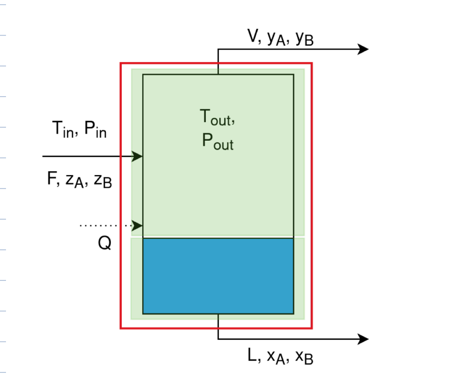
a) extensive variables are dependant of the extent of the system. Ie. if you halv the system you halv the value of the variable

Intensive variable are not dependent on the extent of the system

and can change value within the system

Volume is an extensive variable as it depends on the extent of the system. Changing the system boundaries can change the volume

b)



Case 1 gives an overview of the tank and what enter and leaves the tank but can not describe beaviour inside the tank or phase specific detail. wich can be described in case 2

c) this simplifying assumption is Liquid-Vapor equilibrium (VLE). wich is the assumption that th liquid and vapor is given enough time to reach equilibrium between the phases. were the composition in the phase could be computed by a equilibrum constant.

This is usually reasnable in systems where thes system is close to equilibrem, seperation and absoblion trays

d) yes this can be done.

e) dead volume could mean that th composition changes throught the volume wich would mean an assumption of well mixed does not hold. also can 2 could not capture the effect of a dead volume on the system

f) addin plates when each stage could be seen as a flash would mean that more balance volumes would be necessary to keep the VLE assumption

Question 2

a) $V \frac{dC_A}{dt} = F_{in}(C_{Ain} - C_A) - kC_A V$ use C_{Ain} F_{in} V constant

$\Rightarrow \frac{V}{F_{in}} \frac{dC_A}{dt} = (C_{Ain} - C_A) - \frac{kC_A V}{F_{in}}$

$\bar{C}_A = \frac{C_A}{C_{Ain}} \Rightarrow C_A = \bar{C}_A C_{Ain}$

$\frac{V}{F_{in}} = \tau \Rightarrow \frac{t}{\tau} = \bar{t} = \frac{t}{\frac{V}{F_{in}}} \Rightarrow t = \bar{t} \cdot \frac{V}{F_{in}}$

$\Rightarrow \frac{V}{F_{in}} \frac{dC_A}{dt} = C_{Ain}\left(1 - \frac{C_A}{C_{Ain}}\right) - \frac{kV}{F_{in}} C_A$

$\Rightarrow \frac{V}{F_{in} C_{Ain}} \frac{dC_A}{dt} = \left(1 - \frac{C_A}{C_{Ain}}\right) - \frac{kV}{F_{in}} \frac{C_A}{C_{Ain}} = 1 - \bar{C}_A - \overbrace{\frac{kV}{F_{in}}}^{D} \bar{C}_A$

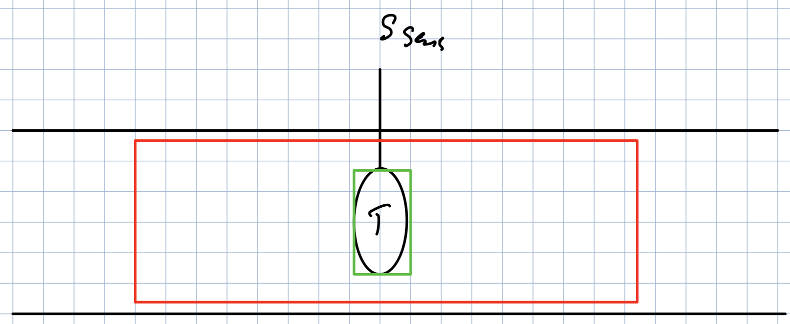
$\cancel{\frac{V}{F_{in}}} \cancel{\frac{1}{C_{Ain}}} \frac{d\bar{C}_A \cancel{C_{Ain}}}{d\bar{t}\, \cancel{\frac{V}{F_{in}}}} = 1 - \bar{C}_A - D\bar{C}_A$

$\Rightarrow \frac{d\bar{C}_A}{d\bar{t}} = 1 - \bar{C}_A - D\bar{C}_A$

b) from above $D = \frac{kV}{F_{in}} = k\bar{t}$

Question 3

a)



Assumptions

well mixed

steady state

heat transfer through convection

b) Balance volumes

Entire fluid

sensor itself

Extensive variables

fluid temperature T_f

Sensor temperature T

heat transfer Q