Wednesday

21 APRIL 2021 MODULE 4 F. MORRISON ①

CM3120

Requests for today?

2Ap21 · 4.3 (see also Example 5 Module 4 Lecture II)

16Ap21 · 4.A

· 4.8 EMCD

Today 21 Ap 2021 · 4.11 devise Heissler chart

· 4.12

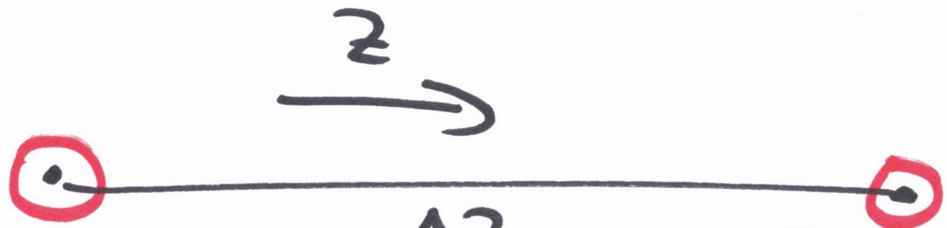
· 4.16

4.4

4.8

WATER A
AIR B

steady
EMCD
$N_A = -N_B$
$T = 298\,K$



$\Delta z = 1.0 \times 10^{-2}\ m$

$c_A = 0.0050 \dfrac{kmol\ A}{m^3}$

$c_B = 0.0360 \dfrac{kmol\ B}{m^3}$

$c_A = 0.0045 \dfrac{kmol\ A}{m^3}$

$c_B = 0.0365 \dfrac{kmol\ B}{m^3}$

What is N_{Az} $[=]$ $\dfrac{kmol}{m^2 s}$

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We know $\frac{\Delta x_A}{\Delta z}$ $\Rightarrow$ we can use Fick's Law (xport law) to obtain N_{Az}

$$N_{Az} = x_A(\underbrace{N_{Az} + N_{Bz}}_{\substack{= -N_{Bz} \\ =0 \\ \text{EMCD}}}) - c D_{AB} \frac{dx_A}{dz}$$

Table 6.2-1 (packet) = 0.260

$$N_{Az} = -c D_{AB} \frac{dx_A}{dz} = -D_{AB} \frac{\Delta C_A}{\Delta z}$$

IDEAL GAS: $PV = nRT$

$$\frac{n}{V} = \frac{P}{RT}$$

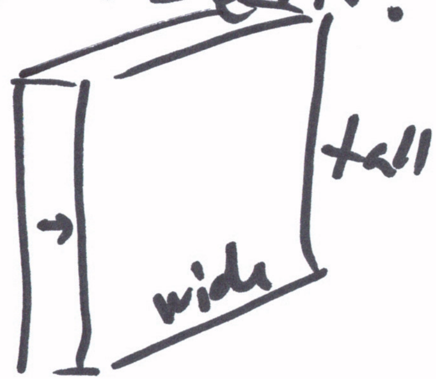
4.11

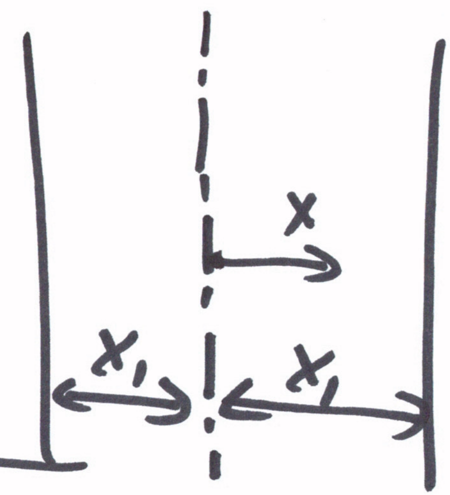
What mass xfr problem looks like a Heissler (heat-xfr) problem?

Initially

sponge wet

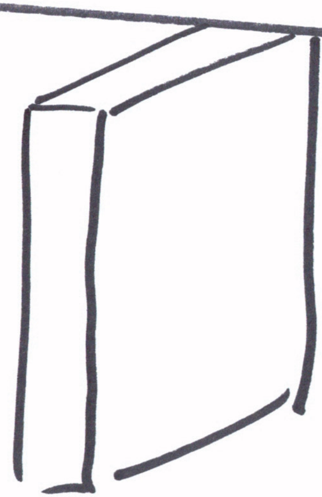
$w_A = w_{A0}$
$\forall x \quad t<0$





Suddenly

submerged in an environment w_{Ab}



sponge drains

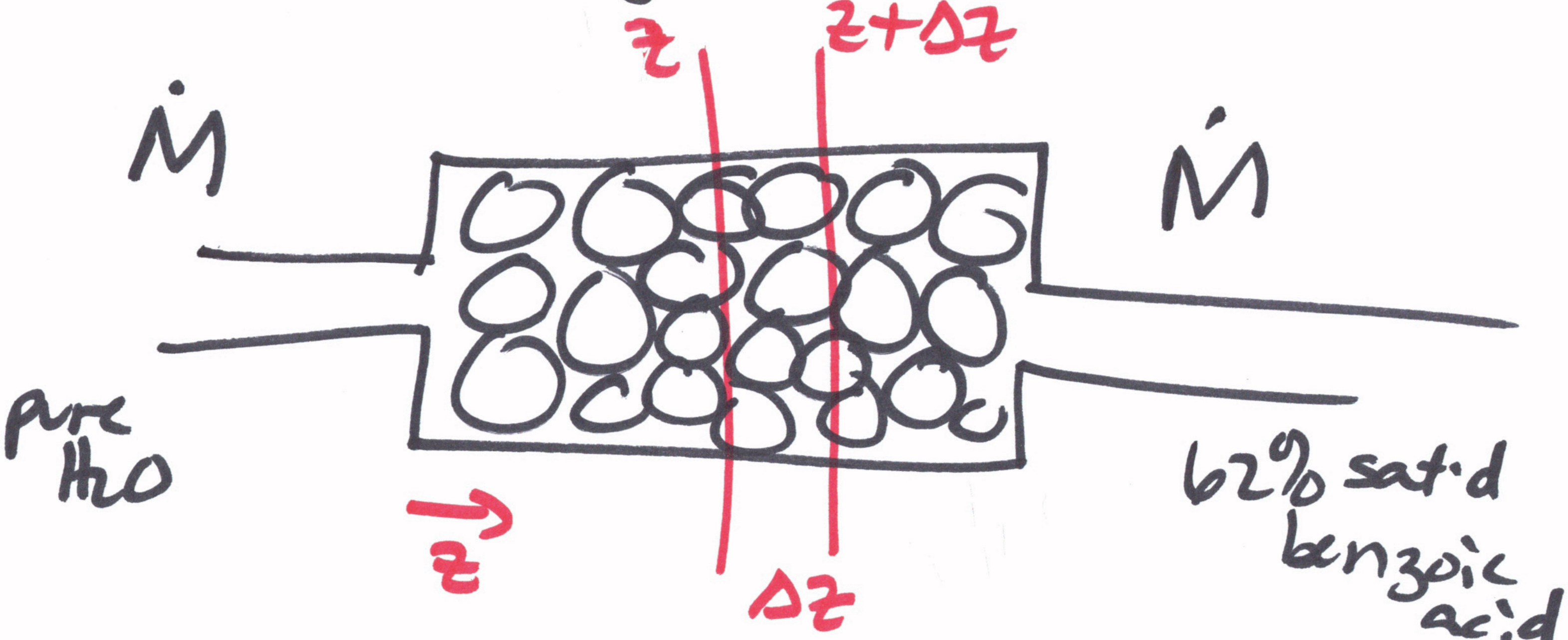
4.12

$a = 23 \frac{cm^2}{cm^3}$

volumetric flow rate of liquid

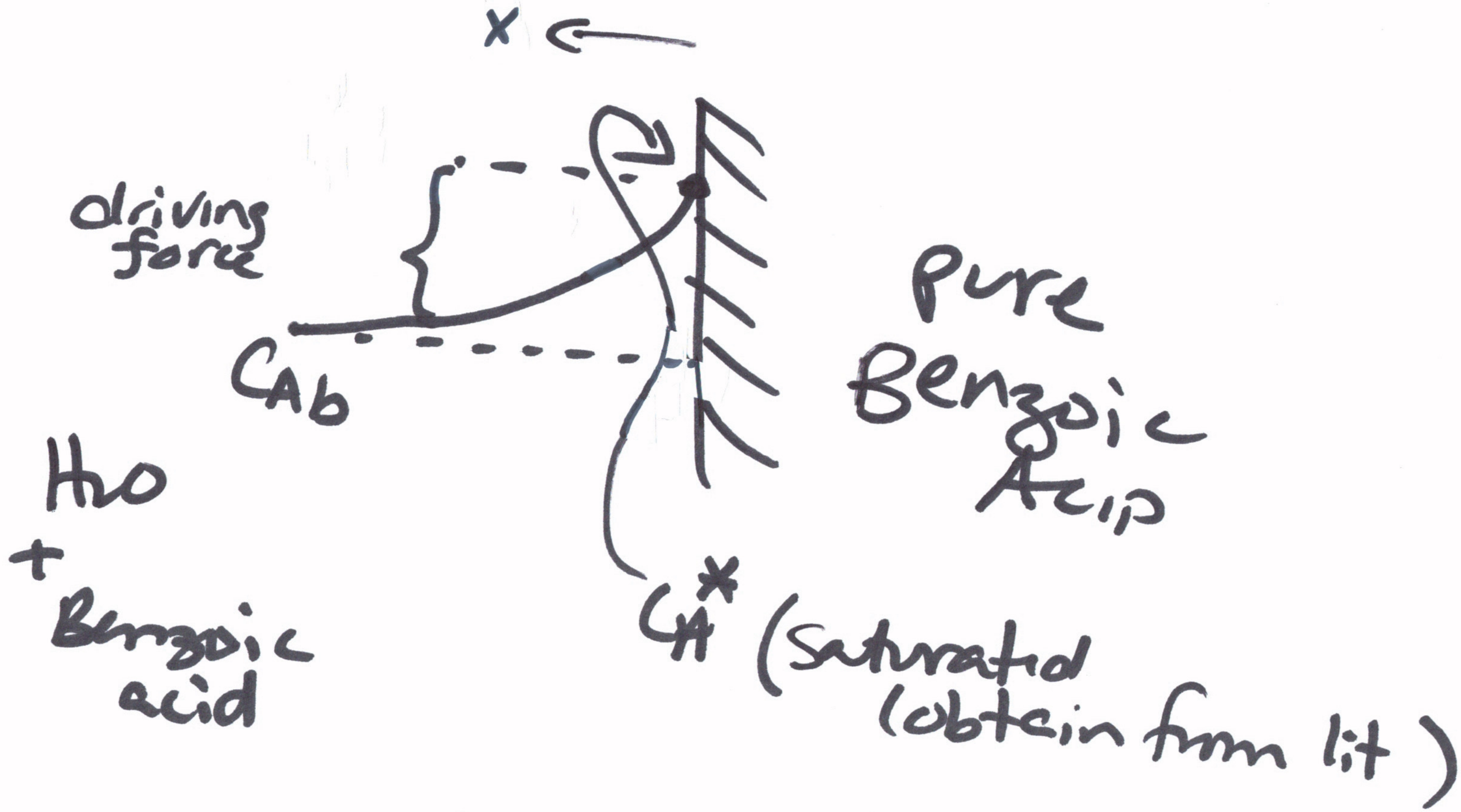
superficial velocity

$V^0 = 5.0 \frac{cm}{s} = \frac{\dot{V}}{A_{xs}}$



C.V. : $A_{xs} \Delta z$

A_{xs} = cross section of bed



$$N_{A_x} = k_c \left(C_A^* - C_{Ab} \right)$$

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MOLES

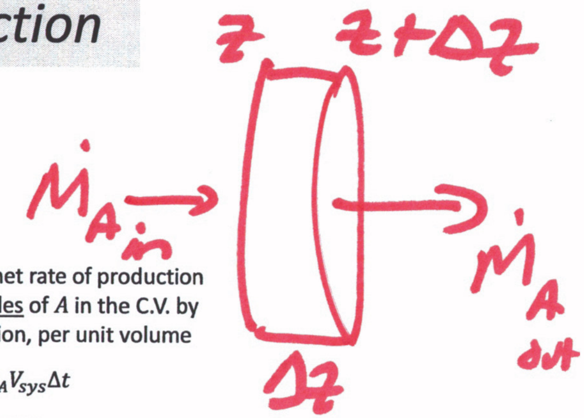
Unsteady Macroscopic Species A Mass Balance

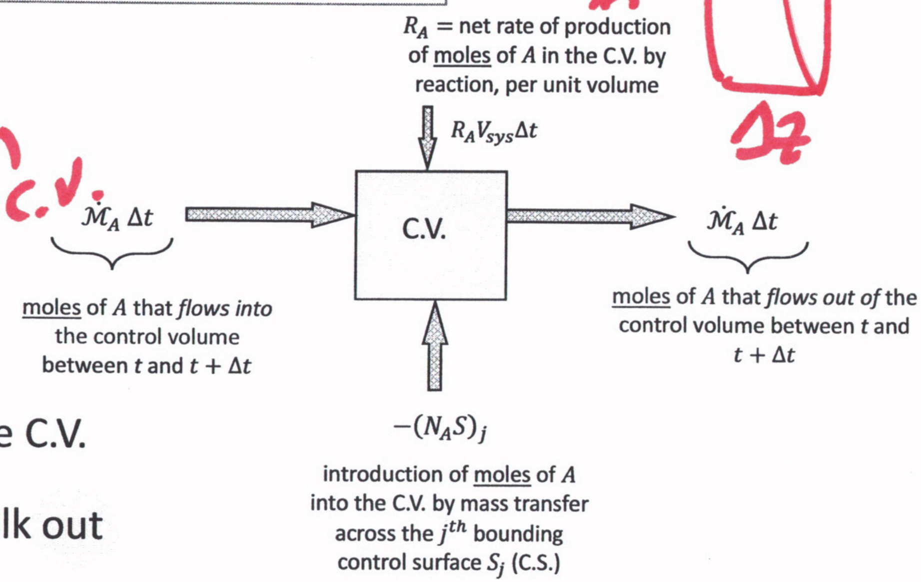
accumulation = net flow in + production + introduction

$$\frac{d}{dt}\left(\mathcal{M}_{A,sys}\right) = -\Delta\dot{\mathcal{M}}_A + R_A V_{sys} - \sum_j (N_A S)_j$$

pseudo steady state

no rxn in C.V.





$\dot{V}^o A_{xs} C_A\big|_z$

$\mathcal{M}_{A,sys} = c_A V_{sys}$ = total moles of A in the C.V.

$\Delta\dot{\mathcal{M}}_A = \sum_{j,outs} \dot{\mathcal{M}}_{A,j} - \sum_{j,ins} \dot{\mathcal{M}}_{A,j}$ = bulk out

R_A = net rate of production of moles of A in the C.V. by reaction, per unit volume

$(\dot{V}^o A_{xs}) C_A\big|_{z+\Delta z}$

V_{sys} = system volume

$N_{A_j} = K\Delta c_{df}$ = molar flux of A out through the j^{th} C.S.

$N_A = k_c (C_A^* - C_A)$

$S = a A_{xs} \Delta z$

$S_{sys} = \sum_j S_j$

Δ is "out"- "in"

C.S. = control surface

C.V. = control volume

$$0 = -\left(V^0 \cancel{A_{xs}} C_A \Big|_{z+\Delta z} - V^0 \cancel{A_{xs}} C_A \Big|_{z} \right) + k_c\, a\, \cancel{A_{xs}}\, \Delta z\, (C_A^* - C_A)$$

$$\lim_{\Delta z \to 0} \frac{C_A\big|_{z+\Delta z} - C_A\big|_{z}}{\Delta z} = \frac{k_c a}{V^0} (C_A^* - C_A)$$

$$\frac{dC_A}{dz} = \frac{k_c a}{V^0} (C_A^* - C_A)$$

$$(-1)\int_0^{C_{AL}} \frac{-dC_A}{C_A^* - C_A} = \int_0^{L} \frac{k_c a}{V^0}\, dz$$

assume k_c = const

- $C_{AL} = 0.62\, C_A^*$
- integrate
- solve for k_c

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