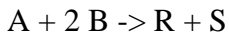


Problem 4.2

Since this is an aqueous system, the volume is assumed to be constant.



From the stoichiometry, for every mole of A reacted, 2 moles of B are reacted.

Therefore,

$$X_B = 2 * X_A * C_{A0} / C_{B0}$$

Since C_A and C_{A0} are given, $X_A = 1 - C_A / C_{A0} = 1 - 20 / 100 = 0.80$.

Therefore, $X_B = 2 * 0.80 * 100 / 100 = 1.60$.

Clearly, this is not possible, since the maximum value of X_B is 1.0.

Therefore, **the problem setup is in error and X_B cannot be determined.**

The point of this problem is for the students to recognize that the numerical answer obtained by applying the equations is not physically possible and therefore the setup/assumptions must be in error.

Problem 5.4

For an MFR $\tau = (C_0 - C) / (-r)$

If $r = -k C^{1.5}$, then $\tau = (C_0 - C) / k C^{1.5}$

Given 70% conversion, $C = C_0 (1 - X) = 10 (1 - 0.7) = 3.0$

So, $\tau = (C_0 - C) / k C^{1.5} = 1.34715 / k$

If new reactor has twice the volume, $\tau_2 = 2 \tau_1 = 2.6943 / k = (C_0 - C) / k C^{1.5}$

$\tau_2 = 2.6943 / k = (C_0 - C) / k C^{1.5}$

$2.6943 = (C_0 - C) / C^{1.5}$

Given answer: Solving for $C = 2.83$ so $X = 0.717$

(I used excel solver to get $C_A = 2.056$ $X = 0.79$)

Problem 5.8

For an MFR in which a reversible reaction occurs,

$$k_1 \tau = X_A X_E / (X_E - X_A)$$

Since we know from the reaction model, $-r_A = 0.04 C_A - 0.01 C_R$.

At equilibrium, $r_A = 0$, so $C_{Aeq} / C_{Req} = 0.01 / 0.04 = 0.25$ or $C_{Req} = 4 C_{Aeq}$.

Since by mass balance, $C_A + C_R = C_{A0} = 100$, $C_{Aeq} = 20$ and $C_{Req} = 80$ mmol/L.

$$X_E = (C_{A0} - C_A) / C_{A0} = 100 - 20 / 100 = 0.80$$

Plugging this into the above equation, with $k_1 = 0.04$, $\tau = 20$

$$0.04 * 20 = X_A (0.8) / (0.80 - X_A)$$

Solving for **$X_A = 0.40$** .

Problem 5.9

Integrating the M-M equation gives,

$$\tau = K_m / V_m \ln (1 / (1 - X)) + 1 / V_m (C_0 X)$$

Plugging in $X = 0.95$, $V_m = 0.2$, $K_m = 2.0$ gives

$$\tau = 39.46 = V / q \quad \mathbf{V = 986.43 \text{ L}}$$

Problem 5.11

For an MFR in which a M-M reaction occurs,

$$\tau = (C_0 - C)/-r$$

Substituting in the M-M equation and re-arranging,

$$C^2 + \{K_m + \tau V_m - C_0\}C - K_m C_0 = 0$$

For 95% conversion, $C = 0.05 C_0$.

Substituting this in with C_0 , K_m and V_m values gives

$$\tau = 199.5 \text{ min} = V/q \text{ so } V = 199.5 * 25 = 4987.5 \text{ L}$$

Problem 5.21

For this one, you need to plot $1/r$ vs. C

and integrate under the data curve to
get the space-time parameter.

Integrating $1/r$ vs. C between 0.3 and
1.3 gives $t = 12.75 \text{ min}$.