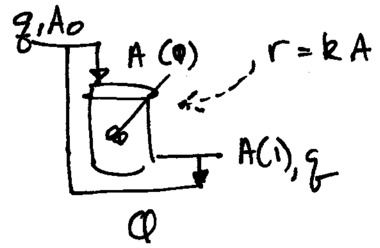
EXAM #1:



(a) Solve for A(1) as function of A_0, A (1). Use mass balance on mixing point upstream of reactor.

$$q \cdot A_0 + Q\, A(1) = (q + Q) \cdot A(0), \text{ or}$$

$$A_0 + \frac{Q}{q} A(1) = \left(1 + \frac{Q}{q}\right) A(0); \text{ let } \underline{R = Q/q} \text{ and}$$

$$\underline{A(0) = \frac{A_0 + R\,A(1)}{1+R}}.$$

(b) solve for A(1) in terms of A(0).

in − out = rate of dissappearing, so

$$(q + Q)\left[A(0) - A(1)\right] = k\,A(1) \cdot V, \text{ or}$$

$$(1+R)\left[A(0) - A(1)\right] = k \cdot \Theta \cdot A(1), \text{ or} \qquad \underline{\underline{A(1) = \frac{A(0)}{1 + \frac{k_1\Theta}{R+1}} = \frac{A_0 + A(0) \cdot R}{1 + R + k_1\Theta}}}.$$

(c) Solve for A(1) in terms of A_0.

$$A(1) = \frac{\frac{A_0 + R\,A(1)}{R+1}}{1 + \frac{k_1\Theta}{R+1}} = \frac{A_0 + R\,A(1)}{1 + R + k_1\Theta}, \text{ or}$$

$$A(1) + \cancel{R\,A(1)} + k_1\Theta\, A(1) = A_0 + \cancel{R\,A(1)}.$$

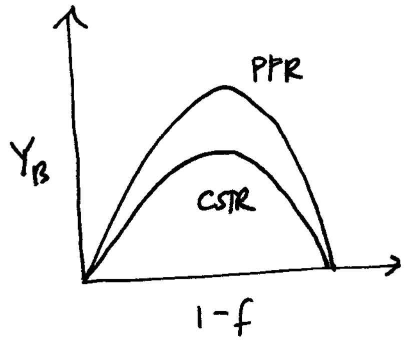
$$A(1)\left[1 + k_1\Theta\right] = A_0, \text{ or} \qquad \boxed{A(1) = \frac{A_0}{1 + k_1\Theta}.}$$

(d) not a f^n of recycle ratio, b/c perfectly mixed $\underline{\underline{\text{already}}}$.

MIXING ≡ DILUTION...

2: (a) $A \to B \to C$.

mixing favors formation of final product. This is shown explicitly by the analysis of Gillespie & Carberry,



$S = \frac{r_B}{r_C} = \frac{kA}{kB}$. mixing dilutes the concentration of A, thus reducing selectivity...

(b) $A \xrightarrow{r_1} B,\ n_1$

$A \xrightarrow{r_2} C,\ n_2$.

$n_2 > n_1$.

mixing favors reaction of lowest order, due to dilution of reagent A.

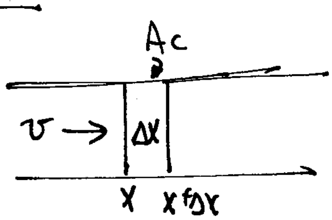
$$S = \frac{r_1}{r_2} = \frac{k_1 A^{n_1}}{k_2 A^{n_2}} = \left(\frac{k_1}{k_2}\right) \cdot A^{(n_1 - n_2)}$$; if $n_2 > n_1$, then.

$$S = \frac{k_1}{k_2} \frac{1}{A^{(n_2 - n_1)}}$$, so as conc. ↓, S ↑. b/c mixing dilutes, mixing favors formation of B.

3: Rxn network: $A \xrightarrow{1} B \xrightarrow{2} C$; $r_1 \quad r_2 \quad r_3$.

$A \xrightarrow{3} D$

(a) Derive relevant ODE's. Shell-balance on species A:



mass balance (@ steady-state) ⇒ in = out, or

conduction in := $-D_A A_c \frac{dA}{dx}\Big|_x$.

conduction out := $-D_A A_c \frac{dA}{dx}\Big|_{x+\Delta x}$.

convection in := $v \cdot A_c \cdot A\Big|_x$.

convection out := $v \cdot A_c \cdot A\Big|_{x+\Delta x}$.

3: Contd... in − out = rate of dissappear of A.

$$-DA_c\frac{dA}{dx}\bigg|_{x} + DA_c\frac{dA}{dx}\bigg|_{x+\Delta x} + v\cdot A_c A\Big|_{x} - v\cdot A_c\cdot A\Big|_{x+\Delta x} = -(r_1+r_3)(A_c\cdot\Delta x), \text{ or}$$

$$+\left\{\frac{D\cdot A_c\frac{dA}{dx}\Big|_{x+\Delta x} - DA_c\frac{dA}{dx}\Big|_{x}}{A_c\cdot\Delta x}\right\} - \left\{\frac{v\cdot A_c\cdot A\big|_{x+\Delta x} - v\cdot A_c\cdot A\big|_{x}}{A_c\cdot\Delta x}\right\} = \frac{(r_1+r_3)(A_c\cdot\Delta x)}{A_c\cdot\Delta x}, \text{ or}$$

$$D\cdot\frac{d^2A}{dx^2} - v\cdot\frac{dA}{dx} = (r_1+r_3) = (k_1+k_3)A, \text{ or}$$

$$-D_A\cdot\frac{d^2A}{dx^2} + v\cdot\frac{dA}{dx} + (k_1+k_3)A = 0 \quad ; \quad \text{likewise}$$

$$-D_B\frac{d^2B}{dx^2} + v\cdot\frac{dB}{dx} + k_2B - k_1A = 0.$$

ⓑ Dankwert's Conditions are always used for Axial Dispersion Models...

$$@\ x=0,\quad D_A\frac{dA}{dx} = v\cdot(A-A_0)$$

$$D_B\frac{dB}{dx} = v\cdot(B-B_0).$$

$$@\ x=L,\quad \frac{dA}{dx} = \frac{dB}{dx} = 0.$$