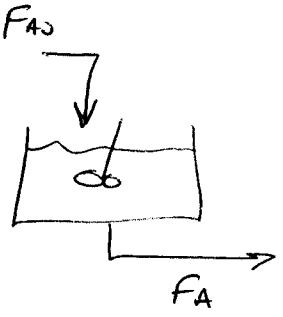
## CSTR




$$r_A = -k C_A$$

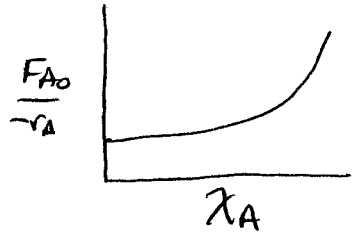
$$\frac{d C_A V}{dt} = F_{A0} - F_A + r_A V$$

$\frac{d}{dt} \to 0$ s.s.

$$0 = \chi_A F_{A0} + r_A V$$

$$\chi_A = \frac{F_{A0} - F_A}{F_{A0}}$$

$$V = -\frac{\chi_A F_{A0}}{r_A} \text{ or } \left(-\frac{F_{A0}}{r_A}\right)(\chi_A)$$




Goal $\chi_A = 0.8$

$\frac{F_{A0}}{-r_A} = 100\ L$

$V = (100L)(0.8) = 80L$

---

## PFR

$$\frac{\partial C_A}{\partial t} = -\frac{\partial F_A}{\partial V} + r_A \Rightarrow \frac{\partial F_A}{\partial V} = r_A$$

$$F_{A0} \chi_A = F_{A0} - F_A$$

$$F_{A0} d\chi_A = 0 - dF_A$$

$$-F_{A0} \frac{d\chi_A}{dV} = r_A$$

$$\int_0^V dV = \int_0^{0.8} \left(-\frac{F_{A0}}{r_A}\right) d\chi_A$$

$V$ = area under curve

by hand

$$\frac{dF_A}{dV} = r_A$$

$$\frac{dF_A}{r_A} = dV$$

$F_A = C_A \nu$ ($\frac{mol}{L}\ \frac{L}{s}$)

$\nu = \nu_0 =$ constant

$$\int_0^V \frac{\nu_0 dC_A}{-k C_A} = \int_0 dV$$

$$-\frac{\nu_0}{k} \int \frac{dC_A}{C_A} = V$$

$$-\nu_0/k \ln C_A \Big|_{C_{A0}}^{C_A}$$

Integration continued

$$\frac{dF_A}{dV} = r_A$$

$$dV = \frac{dF_A}{r_A}$$

liquid

$F_A = C_A \upsilon \rightarrow dF_A = dC_A \upsilon$

$\upsilon = \upsilon_0$

$$\int_0^V dV = \int \frac{\upsilon_0 \, dC_A}{-k C_A}$$

$$V = -\frac{\upsilon_0}{k} \int_0^{X=0.8} \frac{dC_A}{C_A}$$

$C_A = ?$

$$X_A = \frac{F_{A0} - F_A}{F_{A0}}$$

$$X_A = \frac{C_{A0}\upsilon_0 - C_A \upsilon}{C_{A0}\upsilon_0}$$

for liquids $\upsilon = \upsilon_0$

Solving for $C_A = C_{A0}(1 - X_A)$

$dC_A = 0 - C_{A0} dX_A$

$$V = -\frac{\upsilon_0}{k} \int_0^{X_A} -\frac{C_{A0} \, dX_A}{C_{A0}(1 - X_A)}$$

$$V = +\frac{\upsilon_0}{k} \left[ -\ln(1 - X_A) \right]_0^{X_A}$$

$$= -\frac{\upsilon_0}{k} \left[ \ln[1 - X_A] - \ln[1 - 0] \right]$$

$$V = \frac{-2 L/s}{0.1 s^{-1}} \ln(1 - 0.8)$$

$$V = 32.2 L$$

Count blocks

8 (20)(0.1)
3 (20)(0.1)
1 (20)(0.1)
1 (20)(0.1)
20 (0.1
20 (0.1)
20 (0.1)

16 (20)0.1) = 32 L

# Board Set-up

Red step 1 M.B.
Black step 2 $X_A$

## Batch

C.V. fluid
assumption: well-mixed

$$\frac{\partial(C_A V)}{\partial t} = r_A V$$

$$X_A = \frac{n_{A_0} - n_A}{n_{A_0}}$$

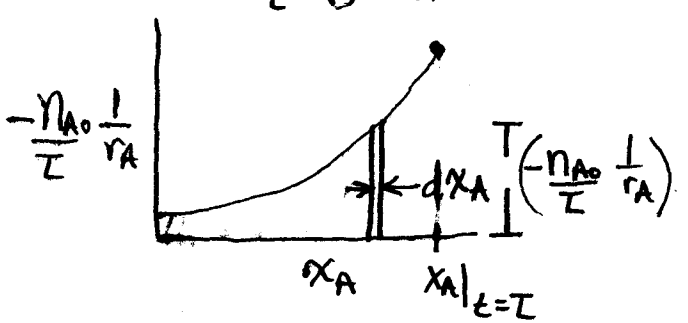
$$n_A = n_{A_0}(1 - X_A)$$

$$\frac{\partial n_A}{\partial t} = \frac{\partial}{\partial t}\left(n_{A_0}(1-X_A)\right) = -n_{A_0}\frac{\partial X_A}{\partial t} = r_A V$$

$$\int_0^\tau V\,dt = -n_{A_0}\int_{X_A=0}^{X_A}\frac{dX_A}{r_A}$$

for $V$ = constant

$$V = -\frac{n_{A_0}}{\tau}\int\frac{dX_A}{r_A} \simeq -\frac{n_{A_0}}{\tau}\leq\left(\frac{\Delta X_A}{r_A}\right)$$




## CSTR

C.V. fluid
well-mixed

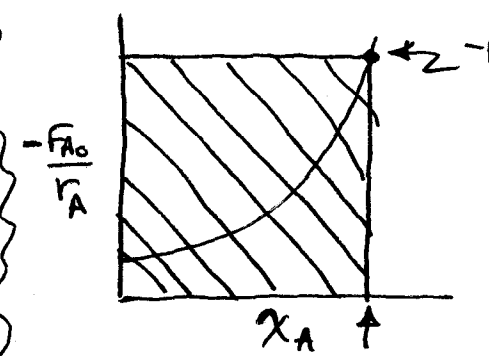
$$\frac{d(C_A V)}{dt} = F_{A_0} - F_A + r_A V$$

SS 0

$$X_A = \frac{F_{A_0} - F_A}{F_{A_0}}$$

$$0 = F_{A_0}X_A + r_A V$$

$$V = \left(-\frac{F_{A_0}X_A}{r_A}\right)$$




No mixing (di
No diffusion
& fluid flow >> diffusion

## PFR (Front Board)

C.V. ~~plug of fluid $\Delta V$~~
& section of reactn $\Delta V$

Plug Flow $-\frac{\partial C_A}{\partial r}\frac{\partial r_A}{\partial \theta}\frac{\partial T}{\partial r}\frac{\partial T}{\partial \theta} = 0$

$$\Delta V\frac{\partial r_A}{\partial t} = F_A|_V + F_A|_{V+\Delta V} + r_A\Delta V$$

$$\lim_{\Delta V\to 0}\left[\frac{\partial C_A}{\partial t} = -\frac{(F_A|_{V+\Delta V} - F_A|_V)}{V+\Delta V - V} + r_A\right]$$

$$\frac{\partial C_A}{\partial t} = -\frac{\partial F_A}{\partial V} + r_A$$

0 at ss.

$$F_{A_0}\,dX_A = -dF_A$$

$$-F_{A_0}\frac{dX_A}{dV} = r_A$$

$$\int_0^V dV = -F_{A_0}\int\left(\frac{dX_A}{r_A}\right)$$