$$\overset{A}{C_2H_4} + \overset{B}{\tfrac{1}{2}O_2} \longrightarrow \overset{C}{\text{(ethylene oxide)}} \qquad Ag \qquad 260°C$$

$$r' = k' P_A^{1/3} P_B^{1/3} \quad \frac{\text{lbmol}}{\text{lb}_{cat} \cdot \text{hr}} \qquad k = 0.0141 \frac{\text{lbmol}}{\text{atm} \cdot \text{lb}_m \cdot \text{hr}}$$

10 atm → [60 lb of cat] → F_A, F_B, F_C, F_I

$$F_{Ao} = 1.08 \frac{\text{lb-mol}}{\text{hr}} \qquad F_{Co} = 0 \frac{\text{lbmol}}{\text{hr}}$$

$$F_{Bo} = 0.54 \frac{\text{lbmol}}{\text{hr}} \qquad F_{Io} = F_{Bo} \cdot \frac{0.79}{0.21}$$

$$\frac{dF_A}{dW} = -r' \qquad \frac{dF_C}{dW} = r' \qquad P_i = \frac{F_i}{F_T} P_T = \frac{F_i}{F_T} P_o$$

$$\frac{dF_B}{dW} = -\frac{1}{2} r' \qquad F_T = F_A + F_B + F_C + F_{Io}$$

Pressure drop → $\frac{dP}{dz} \neq 0$ or $\frac{dP}{dW} \neq 0$

Ergun equation

pressure

ρu - superficial velocity

gas viscosity

$$\frac{dP}{dz} = -\frac{G}{\rho g_c D_p} \left(\frac{1-\phi}{\phi^3}\right) \left[\underbrace{\frac{150(1-\phi)\mu}{D_p}}_{\text{laminar}} + \underbrace{1.75G}_{\text{turbulent}} \right]$$

length

porosity

$\boxed{\text{gas density}}$

pressure dependent

particle diameter

→ 32.174 $\text{lb}_m \cdot \text{ft}/\text{s}^2 \cdot \text{lb}_f$

At steady state

$$\dot{m}_0 = \dot{m}$$

$$\downarrow$$

$$\boxed{G = \rho u = \rho \frac{v}{A_c} \Rightarrow \rho_0 \frac{v_0}{v} \cdot \frac{v}{A_c} = \frac{\rho_0 v_0}{A_c}}$$

$$v = v_0 \frac{P_0}{P} \frac{T}{T_0} \frac{F_T}{F_{T0}}$$

$$\rho_0 v_0 = \rho v \Rightarrow \rho = \rho_0 \frac{v_0}{v}$$

$$\hookrightarrow \boxed{\rho = \rho_0 \frac{P}{P_0} \frac{T_0}{T} \frac{F_{T0}}{F_T}}$$

$$\frac{dP}{dz} = -\frac{G(1-\phi)}{\rho_0 g_c D_p \phi^3}\left[\frac{150(1-\phi)\mu}{D_p} + 1.75G\right]\frac{P_0}{P}\frac{T}{T_0}\frac{F_T}{F_{T0}}$$

catalyst density

let $W = (1-\phi)A_c \cdot Z \cdot \rho_c$

$$\beta_0 = \frac{G(1-\phi)}{\rho_0 g_c D_p \phi^3}\left[\frac{150(1-\phi)\mu}{D_p} + 1.75G\right]$$

$$\frac{dP}{dW} = -\frac{\beta_0}{A_c(1-\phi)\rho_c} \frac{P_0}{P} \frac{T}{T_0} \frac{F_T}{F_{T0}}$$

let $\alpha = \dfrac{2\beta_0}{A_c \rho_c (1-\phi) P_0}$

$$\boxed{\frac{dP}{dW} = -\frac{\alpha}{2} \frac{P_0}{P/P_0} \frac{F_T}{F_{T0}}}$$