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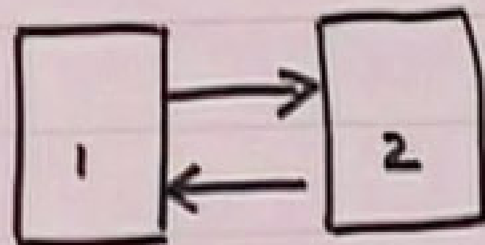
PRACTICE PROBLEMS

Dual Bed Circulating systems



f_1 $\quad$ f_2

$r_1 = -k_1 s \qquad r_2 = k_2(1-s)$

$$f_1 = -Q\alpha S^{\alpha-1}(1-s)^{\beta}$$

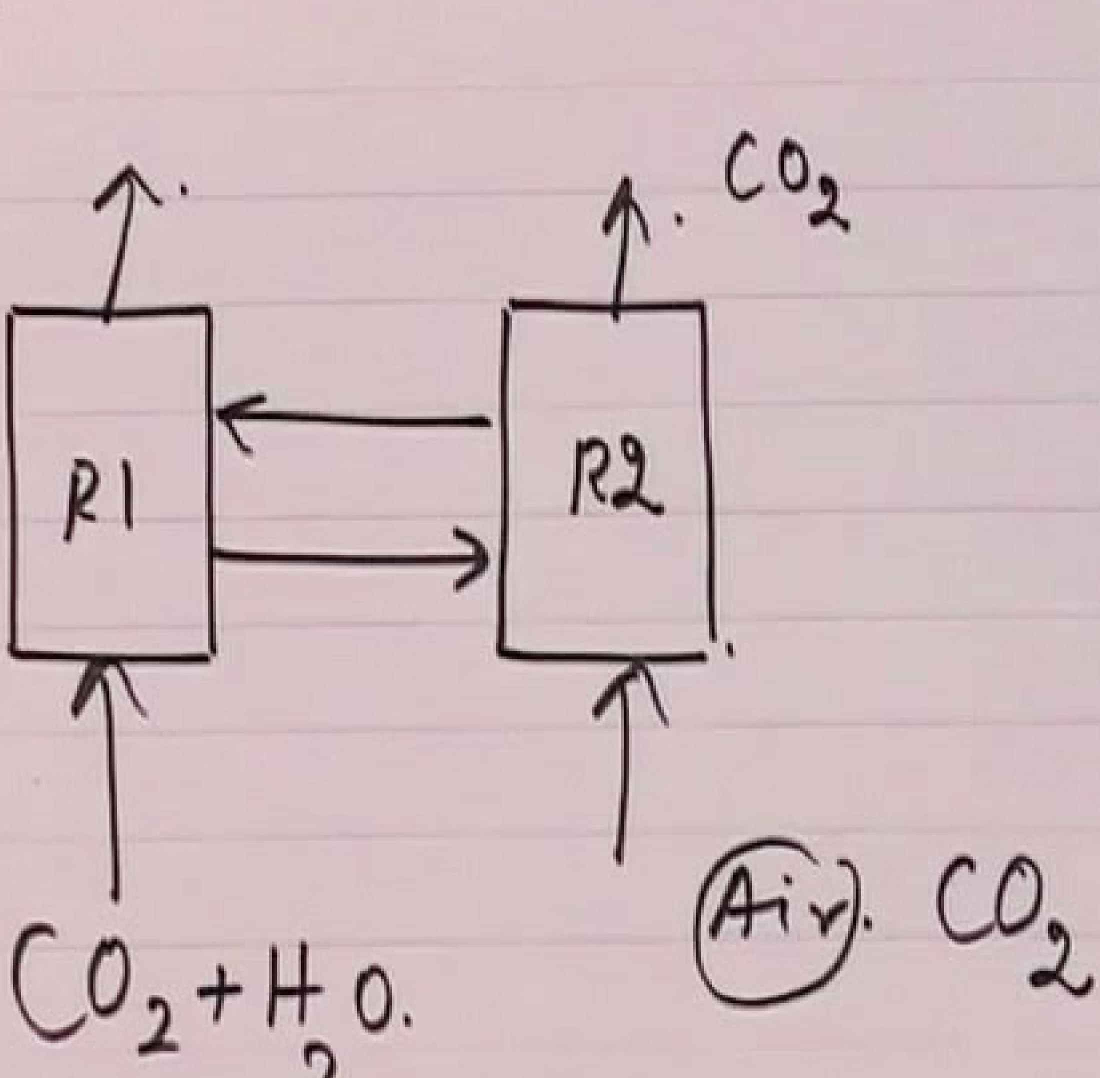
$$f_2 = -Q\beta S^{\alpha}(1-s)^{\beta-1}$$

$$\alpha = 1/k_1\bar{t}_1$$

$$\beta = 1/k_2\bar{t}_2$$

R1 $K_2CO_3 + H_2O + CO_2 = 2KHCO_3$

R2 $2KHCO_3 = K_2CO_3 + H_2O + CO_2$


CO_2
R1
R2
$CO_2 + H_2O$.
Air. CO_2

$$1 = \int_0^1 f_1 \, ds = -Q\,2 \int_0^1 s(1-s)\, ds$$

$$\cancel{Q}= \quad 1 = -2Q\left[\frac{s^2}{2} - \frac{s^3}{3}\right]$$

$$1 = -2Q\left[\frac{1}{6}\right] = -Q/3$$

$$Q = -3$$

$$1 = \int_0^1 -Q\,(1)\,s^2 (1-s)^0\, ds$$

$$1 = \int_0^1 -Q s^2\, ds$$

$$1 = \left(Q \frac{S^3}{3}\right)_0^1 =$$

$$\Rightarrow Q = -3$$

$$f_1 = 3\,(2)\,s^1(1-s)^1$$

$$f_1 = 6\,s\,(1-s)$$

$$f_2 = 3\,s^2$$

$$\bar{s}_1 = \int_0^1 s\, f_1\, ds$$

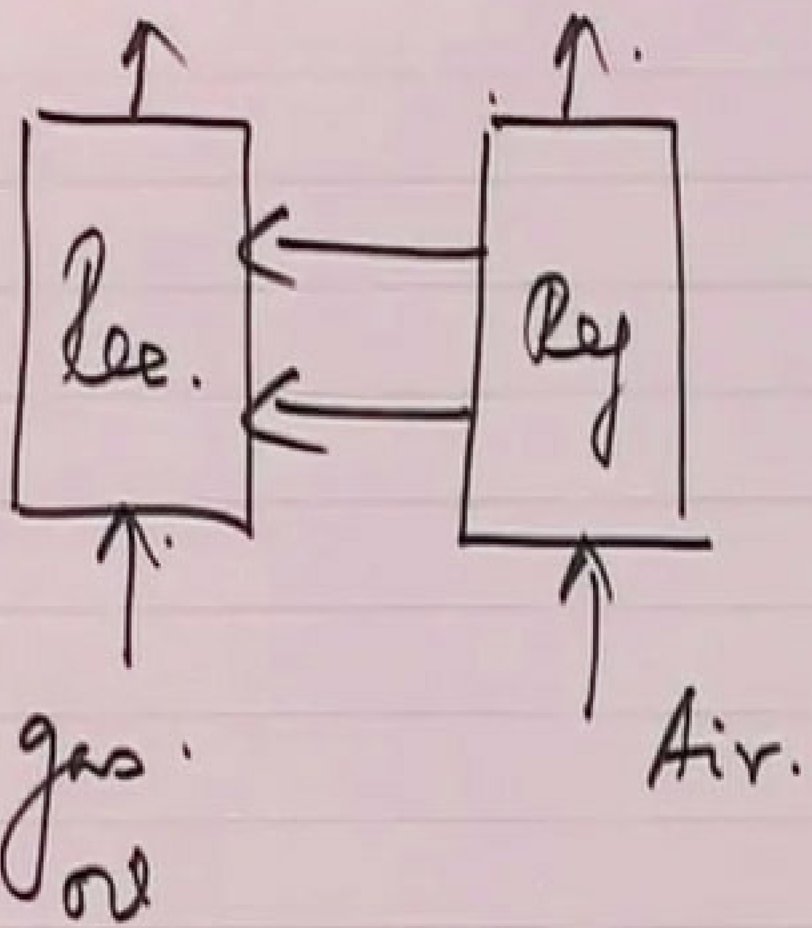
$$\bar{S}_2 = \int_0^1 s\, f_2\, ds$$

$$= \int_0^1 3 s^3\, ds = \left[\frac{3 s^4}{4}\right]_0^1$$

$$= 0.75$$

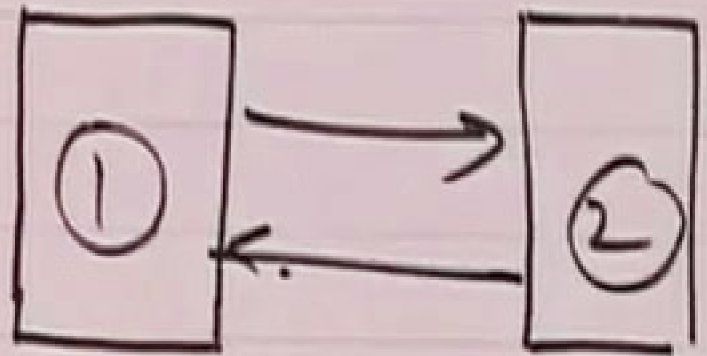
	Exp	Model
$\bar{S}_1$	0.451	0.5
$\bar{S}_2$	0.873	0.75

Q6.



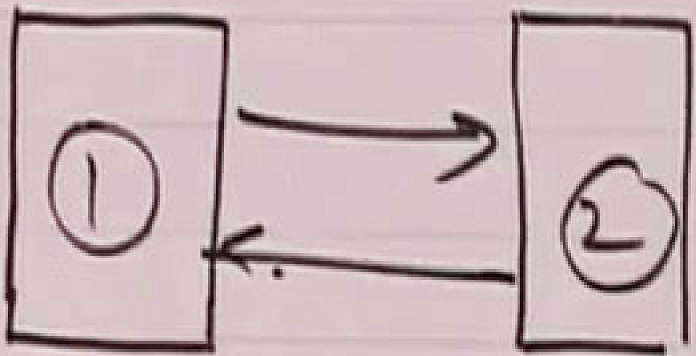
$$r_1 = -(k_1 \bar{s}_1)$$

$$r_2 = k_2 (1 - \bar{s}_2)$$



R1 $v_0 [\bar{a}_2] - v_0 \bar{a}_1 - k_1 W_1 \bar{a}_1 = 0$ —(1)

$$v_0 \bar{a}_1 - v_0 \bar{a}_2 + k_2 W_2 (1-\bar{a}_2) = 0 \quad \text{—(2)}$$



R1 $\quad v_0[\bar{a}_2] - v_0\bar{a}_1 - k_1 W_1 \bar{a}_1 = 0 \quad -(1)$

$$v_0\bar{a}_1 - v_0\bar{a}_2 + k_2 W_2(1-\bar{a}_2) = 0 \quad -(2)$$

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$$\bar{a}_2 - a_1 = \Omega$$

$$\bar{t}_1 + \bar{t}_2 = \Omega\left[\frac{1}{k_1 \bar{a}_1} + \frac{1}{k_2\left[1 - \Omega \bar{a}_1\right]}\right]$$

$$\bar{a}_2 - a_1 = \Omega$$

$$\bar{a}_2 = \Omega + a_1$$

$$0 = -\cancel{P}\left[-\frac{1}{k_1\bar{a}_1^{\,2}} + \frac{1}{k_2(1-\bar{a}_2)^2}\right].$$

$$\left(\frac{k_1}{k_2}\right)^{1/2} = \left(\frac{1-\bar{a}_2}{\bar{a}_1}\right)$$

$$\frac{k_1 \bar{t}_1}{k_2 \bar{t}_2} = \frac{1-\bar{a}_2}{\bar{a}_1}$$

$$\left(\frac{k_1}{k_2}\right)^{1/2} = \left(\frac{1-\bar{a}_2}{\bar{a}_1}\right)$$

NPTEL

$$\bar{a}_2 - \bar{a}_1 = 0.3.$$

$$\frac{k_1 \bar{t}_1}{k_2 \bar{t}_2} = \frac{1-\bar{a}_2}{\bar{a}_1}$$

$$C_A = C_{A0}(1-x) = 5(0.4) = 2\ g/L$$

$$k_1 \,@\, C_A = 2\ g/L = \frac{(0.05)(2)}{1.5}$$

$$= \cancel{0.06}\ \ 0.066/s$$

$$\frac{k_1 \bar{t}_1}{k_2 \bar{t}_2} = \frac{1 - \bar{a}_2}{\bar{a}_1}$$

$$\frac{0.066\, \bar{t}_1}{(0.04)\, \bar{t}_2} = \frac{(0.066)}{(0.04)} \left(\frac{0.04}{.066} \right)^{1/2} = \frac{1 - \bar{a}_2}{\bar{a}_1}$$

$$\bar{a}_2 - \bar{a}_1 = 0.3$$

$$\bar{a}_2 = 0.607.$$

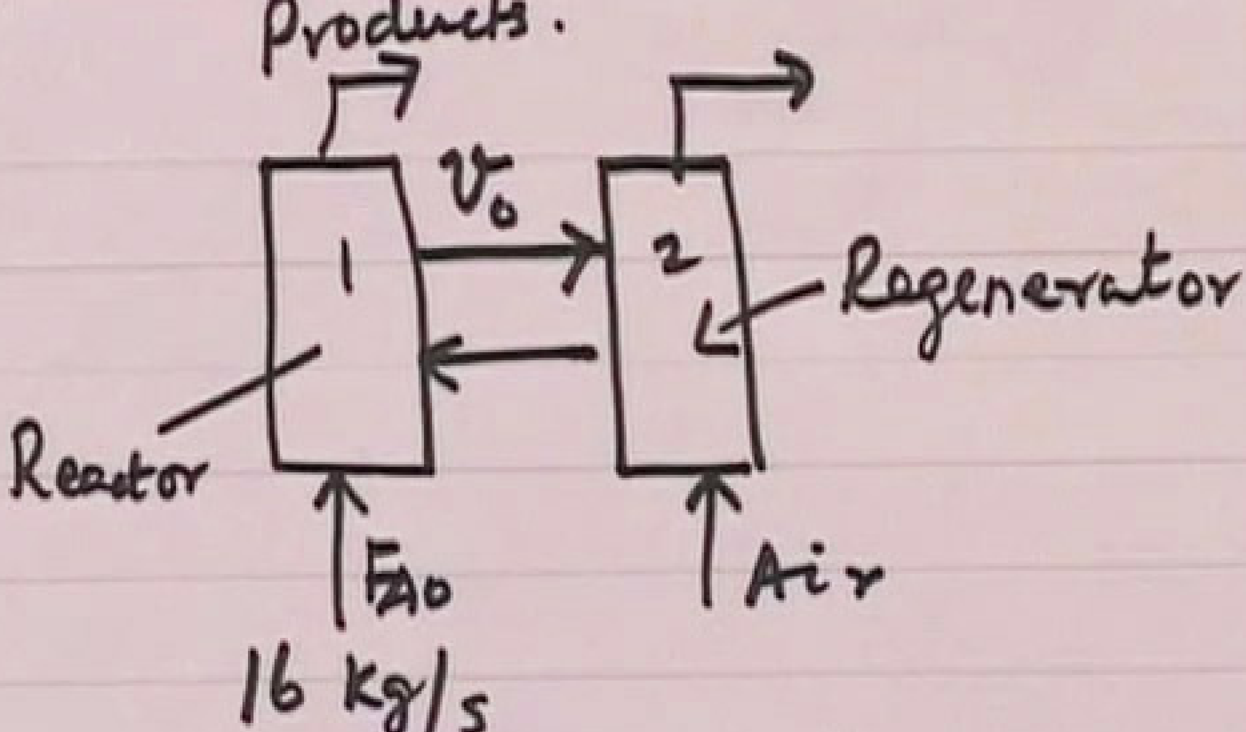
$$\bar{a}_1 = 0.307$$

$$\bar{t}_1 = \frac{\bar{a}_2 - \bar{a}_1}{k_1 \bar{a}_1} \quad \text{—(1).}$$

$$\bar{t}_1 = \frac{0.3}{(0.066)(0.307)} = 14.8$$

$$\bar{t}_2 = \frac{\bar{a}_2 - \bar{a}_1}{k_2(1-\bar{a}_2)}$$

$$= \frac{0.3}{(0.04)(1-0.6071)} = 19$$

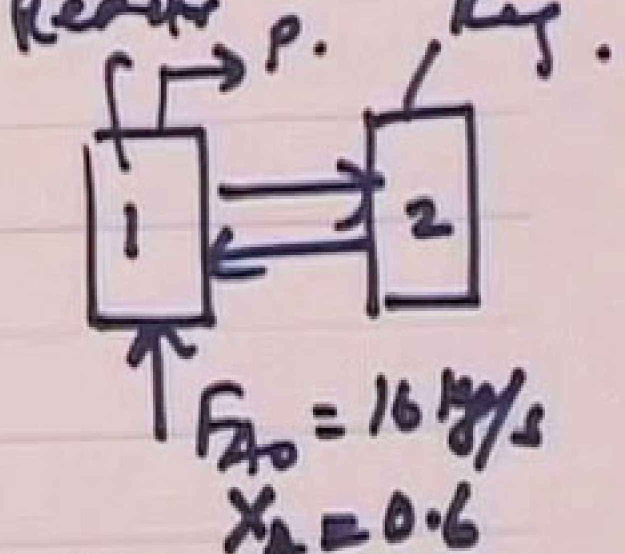


Deactivation/Reg kinetics.

$$r_1 = -k_1 \bar{s}_1 \quad ; \quad r_2 = k_2 (1 - \bar{s}_2)$$

Reaction Rate exp

$$r_A = k_r C_A \bar{s}_1 \; ; \quad k_r C_{A0} = 8.67/\text{min.}$$



Material Balance for A

$$F_{A0} - F_A + r_{A1} W_1 = 0$$

$$W_1 = F_{A0} X_A / (-r_{A1})$$

$$= \frac{(16)(0.6)}{k_r C_A \bar{s}_1} \; ; \quad k_r C_{A0} = 8.67/\text{min}$$

Note not Hr.

$$C_A = C_{A0}(1 - x) = (0.4) C_{A0} \text{ where } C_{A0} = 5 \text{ g/L}$$

So $k_r C_A = (8.67)(0.4)/\text{min.}$; $\bar{s}_1 = 0.307$

Since $(g_1 r_1 \bar{t}_1) = -K_0$

$(g_2 r_2 \bar{t}_2) = +K_0$

Constant $= 0$

$$g_1 r_1 \bar{t}_1 + g_2 r_2 \bar{t}_2 = 0$$

$$g_2 = -g_1 r_1 \bar{t}_1 / r_2 \bar{t}_2$$

$\alpha = 1/k_1 \bar{t}_1$, $\beta = 1/k_2 \bar{t}_2$

$$g_2 = -g_1 \beta/\alpha$$

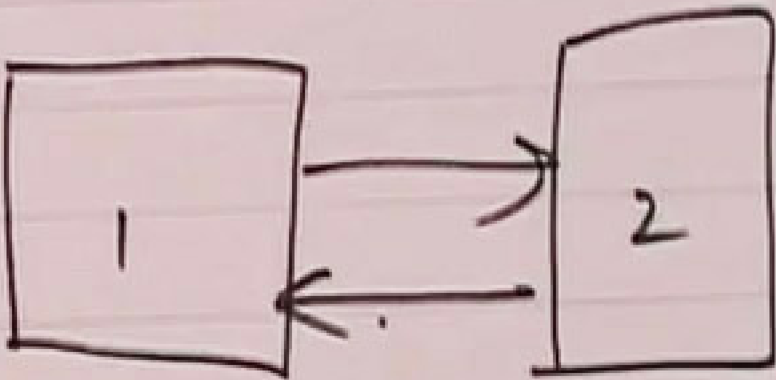
$$g_1 \frac{\beta}{\alpha} - g_1 + \frac{dg_1}{\alpha\, da} = 0$$

$$\frac{dg_1}{da} = g_1 (\alpha - \beta)$$

$$\ln \frac{g_1}{Q} = (\alpha - \beta) a$$

$$g_1 = Q \exp\left[(\alpha - \beta) a\right]$$

$$g_2 = Q \frac{\beta}{\alpha} \exp\left[(\alpha - \beta) a\right]$$



$$r_1 = -k_1$$ $$r_2 = k_2$$

$$f_1 = g_1(s) + K_0\,\delta(s-0)$$

$$f_2 = g_2(s) + 4\,\delta(s-1)$$

$$\int_0^1 g_1 \, dx = 1 - K_1$$

$$\int_0^1 g_2 \, dx = 1 - L_1$$

$$\int_0^1 Q \exp[(\alpha - \beta)x] \, dx = 1 - K_0$$

$$1 - K_0 = \frac{Q}{(\alpha - \beta)} \left[e^{\alpha - \beta} - 1 \right]$$

$$1 - K_0 = \frac{K_0 \alpha}{(\alpha - \beta)} \left[e^{\alpha - \beta} - 1 \right].$$

$$K_0 = \frac{1}{1 + \frac{\alpha}{(\alpha - \beta)} \left[e^{\alpha - \beta} - 1 \right]}.$$

$$L_1 = \frac{\exp\left[\alpha - \beta \right]}{1 + \frac{\alpha}{\alpha - \beta} \cdot \left(e^{\alpha - \beta} - 1 \right)}.$$

$$g_1 = K_0 \alpha e^{(\alpha-\beta)a} \qquad g_2 = L_1 \beta e^{(\alpha-\beta)a}$$

$$1 - K_0 = \frac{K_0 \alpha}{(\alpha-\beta)} \left[e^{\alpha-\beta} - 1 \right].$$

$$K_0 = \frac{1}{1 + \frac{\alpha}{(\alpha-\beta)} \left[e^{\alpha-\beta} - 1 \right]}.$$

$$L_1 = \frac{\exp\left[\alpha-\beta\right]}{1 + \frac{\alpha}{\alpha-\beta} \left(e^{\alpha-\beta} - 1 \right)}.$$