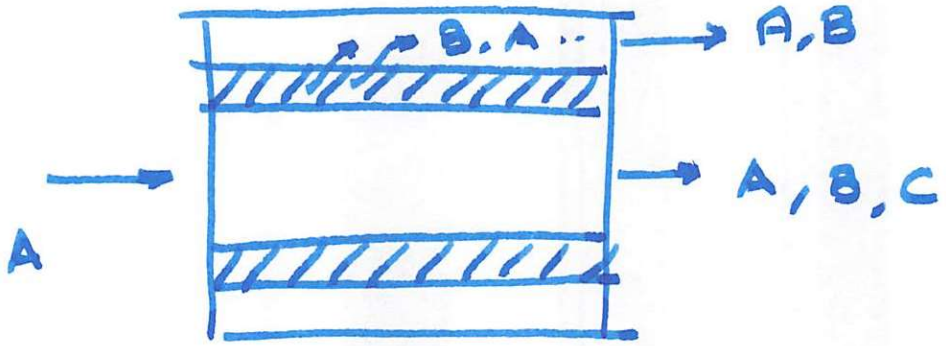
P-6-6

Membrane reactor

$A \rightleftharpoons B + 2C$



$k = 10$ 1/min $\quad F_{A_0} = 100$ mol/min

$K_C = 0.01$ mol/dm^3 $\quad \nu_0 = 100$ dm^3/min

$k_{CA} = 1$ 1/min $\quad V = 20$ dm^3

$k_{CB} = 40$ 1/min

A) Mole balance equations for A, B, and C need to be solved simultaneously.

$$\frac{dF_A}{dV} = r_A - R_A \quad \text{—①}$$

$$\frac{dF_B}{dV} = r_B - R_B \quad \text{—②}$$

} both A and B diffuse through membrane

$$\frac{dF_C}{dV} = r_C \qquad \text{— (3)}$$

$$-r_A = k\left[C_A - \frac{C_B C_C^2}{K_C}\right]$$

$$= k\left[\frac{C_{TO} F_T}{F_T}\right]$$

$$-r_A = k\left[\frac{C_{TO} F_A}{F_T} - \left(\frac{C_{TO}}{F_T}\right)^3 \left(\frac{F_B F_C^2}{K_C}\right)\right] \qquad \text{— (4)}$$

$$R_A = k_{CA} C_A = \frac{k_{CA} C_{TO} F_A}{F_T} \qquad \text{— (5)}$$

$$R_B = k_{CB} C_B = \frac{k_{CB} C_{TO} F_B}{F_T} \qquad \text{— (6)}$$

Stoichiometry

$$-r_A = r_B = \frac{r_C}{2} \qquad \text{— (7)}$$

Solve eqn (1) - (7) numerically.

b) We need to solve eq^{n} ~~(7)~~ ~~(8)~~ (8) – (10) simultaneously

$$\frac{dF_A}{dV} = r_A \quad \text{— (8)}$$

$$\frac{dF_B}{dV} = r_B \quad \text{— (9)}$$

$$\frac{dF_C}{dV} = r_C \quad \text{— (10)}$$

c) Conversion would be greater if C were diffusing out

→ rate of reverse reaction

$$-r_{rev} = k_r C_B C_C^2$$

↑ 2nd order w.r.t. C

P6-7

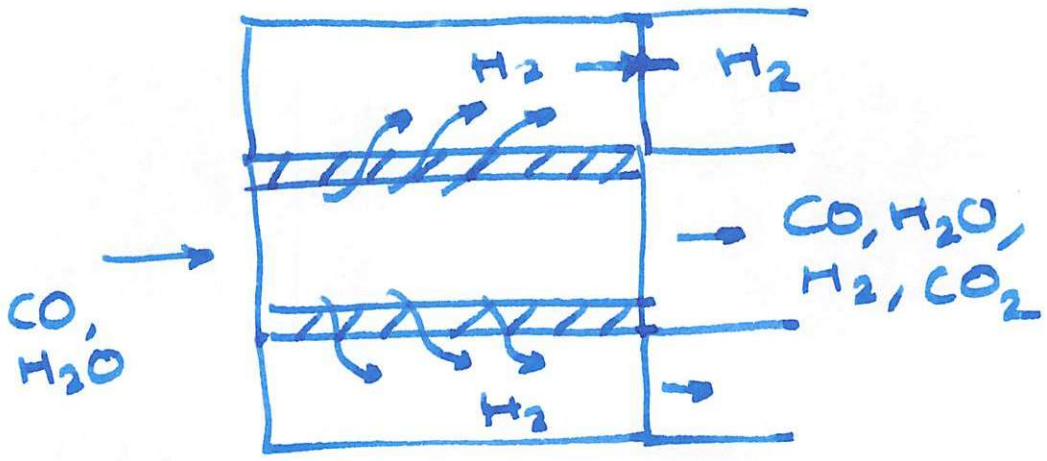
Fuel cell

$$CO + H_2O \rightleftharpoons CO_2 + H_2$$

$$A + B \rightleftharpoons C + D$$

Assumption

- catalyst distributed evenly over whole volume



Mole balance

$$\frac{dF_A}{dW} = r'_A \quad \text{—— (1)}$$

$$\frac{dF_B}{dW} = r'_B \quad \text{—— (2)}$$