P 12-21

R1 : $A + B \rightarrow 2C$

R2 : $2B + C \rightarrow D$

$\Delta C_{pR_1} = 60 - 30 - 30 = 0$

$\Delta C_{pR_2} = 90 - 60 - 30 = 0$

$\therefore \quad \Delta H_{Rx(T)} = \Delta H^{\circ}_{Rx}$

Energy balance for PFR :

$$\frac{dT}{dV} = \frac{UA(T_a - T) + \sum r_{ij}(\Delta H_{Rx\,ij})}{\sum F_j C_{pj}}$$

$$\frac{dT}{dV} = \frac{UA(T_a - T) + r_{1A}\Delta H_{Rx\,1A} + r_{2B}\Delta H_{Rx\,B}}{\sum F_j C_{pj}} \quad -①$$

$$r_{1A} = \frac{-r_{1C}}{2} = -\frac{1}{2} k_{1C} C_A C_B$$

$$r_{2B} = -2 r_{2D} = \cdot 2\, k_{2D} C_B C_C$$

If we evaluate the differential at maximum temperature (500k) we get

$$\frac{dT}{dV} = 0$$

$$\therefore \quad UA(T_s - T) + r_{1A}\,\Delta H_{Rx1A} + r_{2B}\,\Delta H_{Rx2B} = 0$$

$$r_{1A} = \frac{U_A(T_s - T) + r_2\, 2 k_{2D} C_B C_C (\Delta H_{Rx2B})}{\Delta H_{Rx1A}}$$

$$= \frac{10(500-325) + 2 \cdot 04 \cdot 0 \cdot 2 \cdot 0 \cdot 5 \cdot 5000}{-50000}$$

$$r_{1A} = -0 \cdot 043 \quad = -\frac{1}{2} k_{1C} \cdot 0 \cdot 1 \cdot 0 \cdot 2$$

$$\Rightarrow k_{1C} = 4 \cdot 3$$

$$k_{1C}(500) = k_{1C}(400) \exp\left[\frac{E}{R}\left(\frac{1}{400} - \frac{1}{500}\right)\right]$$

$$\therefore \quad \frac{E}{R} = 9210$$

$$\therefore \quad E = 18300 \ \frac{cal}{mol\ K}$$