1.

$$R_d : \frac{7}{36}CO_2 + H^+ + e^- \rightarrow \frac{14}{36}H_2O + \frac{1}{36}C_7H_8$$

$$R_a : \frac{1}{4}O_2 + H^+ + e^- \leftrightarrow \frac{1}{2}H_2O \qquad -78.72\ kj/e^-eq$$

$$R_c : \frac{1}{28}NO_3^- + \frac{5}{28}CO_2 + \frac{29}{28}H^+ + e^- \rightarrow \frac{1}{28}C_5H_7O_2N + \frac{11}{28}H_2O$$

$f_s = 0.3 \qquad f_e = 0.7$

$R = f_e^0 \times (R_a - R_d) + f_s^0 \times (R_c - R_d)$

2.

The information given from Question 4.24, the removal is 96%

Where

$$S = S^0 \times remvoal\ efficiency = (1 - 0.96) \times 50 = 2mg/L$$

When bulk liquid concentration of benzoate is $2\ mg/L$

$$J_{ss} = 0.15\frac{mg}{cm^2 \cdot d} \text{ and } a = 3\ cm^{-1}$$

the numerical values are substituted into Equation 4.42

$$S = S^0 - \frac{J_{ss}aV}{Q}$$

Solving the Volume equation to

$$V = \frac{Q(S^0 - S)}{J_{ss}a} = \frac{100\frac{m^3}{d} \times \frac{1000L}{m^3} \times 48\frac{mg}{L}}{0.15\frac{mg}{cm^2 \cdot d} \times 3cm^{-1}} = 10.67\ m^3$$

3.

In the first CSTR

$$\theta_x = \frac{1}{Y\hat{q} - b}$$

$$S = K\frac{1 + b\theta_x}{\theta_x(Y\hat{q} - b) - 1}$$

4.

$$[\theta_x]_{lim} = \frac{1}{Y\hat{q} - b}$$

$$\theta_x = SF[\theta_x]_{lim}$$

$$\theta = \theta_x[\frac{X_i^0}{X_v} + \frac{Y(S^0 - S)(1 + (1 - f_d)b\theta_x)}{X_v(1 + b\theta_x)})]$$

$$V = Q \times \theta =$$