

a.

Refer back to homework 2, the yield is

$$Y_0 = 0.07 \text{ g cells/ g } BrO_3^-$$

Then we assume 80 % of the cell are biodegradable.

Thus,

$$Y = Y_0 \times 0.8 = 0.056 \text{ g cells/ g } BrO_3^-$$

The information given from the question

$$\hat{q} = 12 \frac{mg BrO_3^-}{mg cells \cdot d}$$

$$K = 50 \frac{\mu g BrO_3^-}{L}$$

$$S^o = 200 mg/L$$

$$b = 0.01 \text{ d}^{-1}$$

Then

$$S^{min} = K \times \frac{b}{Y\hat{q} - b} = \frac{50 \mu g}{L} \times \frac{0.01 \text{ d}^{-1}}{0.056 \frac{mg \text{ cells}}{mg BrO_3^-} \times 12 \frac{mg BrO_3^-}{mg cells \cdot d} - 0.01 \text{ d}^{-1}} = 0.76 \mu g/L$$

$$[\theta^{min}]_{lim} = \frac{1}{Y\hat{q} - b} = \frac{1}{0.056 \frac{mg \text{ cells}}{mg BrO_3^-} \times 12 \frac{mg BrO_3^-}{mg cells \cdot d} - 0.01 \text{ d}^{-1}} = 1.51 \text{ d}$$

c.

If a chemostat can achieve the target treatment goal

$$S = 10 \mu g/L$$

According the relative equation

$$\frac{1}{\theta_x} = Y \frac{\hat{q}S}{K + S} - b = 0.056 \frac{mg \text{ cells}}{mg \text{ BrO}_3^-} \times \frac{12 \frac{mg \text{ BrO}_3^-}{mg \text{ cells} \cdot d} \times 10 \frac{\mu g}{L}}{50 \frac{\mu g}{L} + 10 \frac{\mu g}{L}} - 0.01 d^{-1} = 0.11 d^{-1}$$

$$\theta_x = 9.0 d$$

If a chemostats cannot achieve the target treatment goal and its safety factor is 10

$$\theta_x^{min} = \frac{K + S^0}{S^0(Y\hat{q} - b) - bK} = 1.51$$

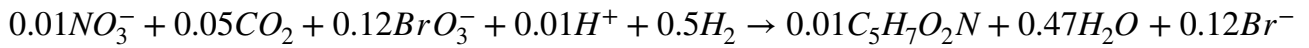
$$SF = \frac{\theta_x}{\theta_x^{min}} = 10 \text{ then } \theta_x = 15.1 d$$

According the relative equation

$$S = K \frac{1 + b\theta_x}{\theta_x(Y\hat{q} - b) - 1} = \frac{50\mu g}{L} \times \frac{1 + 0.01 d^{-1} \times 15.1 d}{15.1 d \times (0.056 \frac{mg \text{ cells}}{mg \text{ BrO}_3^-} \times 12 \frac{mg \text{ BrO}_3^-}{mg \text{ cells} \cdot d} - 0.01 d^{-1}) - 1} = 6.40 \mu g/L$$

d.

According to the reaction



Then

$$Y_{H_2}^0 = 0.12(129)/0.5(2) = 0.052 \text{ g } H_2/\text{g } BrO_3^-$$

Then we assume 80 % of the cell are biodegradable.

Thus,

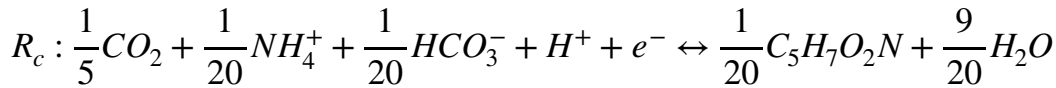
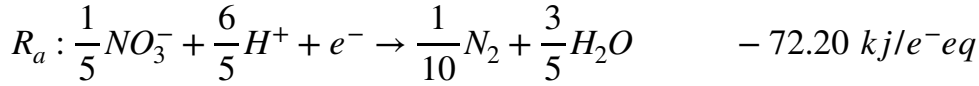
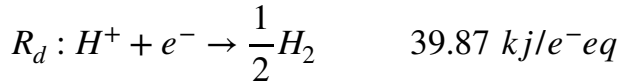
$$Y_{H_2} = Y_{H_2}^0 \times 0.8 = 12.38 \text{ g } H_2/\text{g } BrO_3^-$$

Then if a chemostat can achieve the target treatment goal

$$C_{min}^{H_2} = (S^0 - S) \times Y_{H_2} = 10.34 \text{ mg/L}$$

e.

When Nitrite as electron acceptor



According to the Table 3.1 $f_s^0 = 0.2$

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

$$= 0.80 \times [\frac{1}{5}NO_3^- + \frac{1}{20}NH_4^+ + \frac{1}{20}HCO_3^- + \frac{1}{2}H_2 \rightarrow \frac{1}{20}C_5H_7O_2N + \frac{9}{20}H_2O] +$$

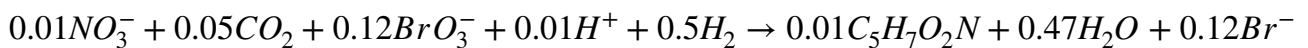
$$0.20 \times [\frac{1}{5}CO_2 + \frac{1}{20}NH_4^+ + \frac{1}{20}HCO_3^- \leftrightarrow \frac{1}{20}C_5H_7O_2N + \frac{9}{20}H_2O]$$

Then

For denitrification process



For Bromide reduction process



$$C_{extra}^{H_2} = C_{min}^{H_2} \times \frac{0.05(113)}{0.4(2)} \times \frac{2(0.5)}{0.01(113)} = 64.63 \text{ mg/L}$$

f.

$$C_{H_2}^0 = [C_{min}^{H_2} + C_{extra}^{H_2}] \times (1 + 10\%) = 82.47 \text{ mg/L}$$