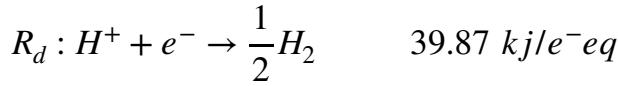


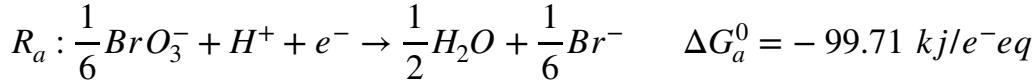
1.

(a)

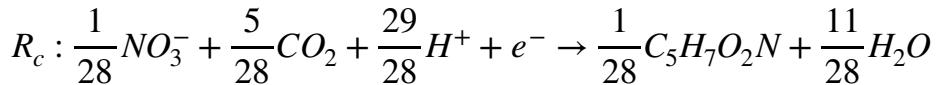
Electron donar: H_2



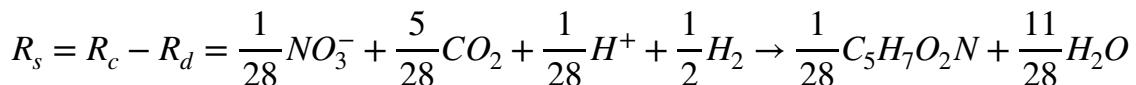
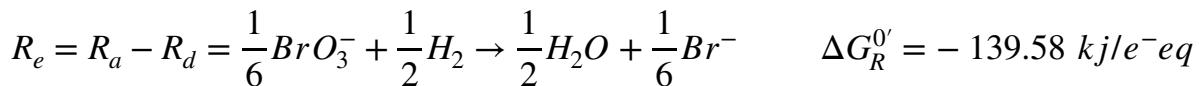
Electron acceptor: BrO_3^-



Synthesis half reaction (nitrate as nitrogen source):



(b)



When $\varepsilon = 0.6$, $\Delta G_p = \Delta G_{pyr}^{0'} - \Delta G_c^{0'} = 35.9 + 78.82 > 0$, since $\Delta G_p > 0$ then $n = +1$ due to

Autotrophic.

other side, $\Delta G_{PC} = 13.5 \text{ } kj/e^- eq$ when nitrite as nitrogen source.

And $\Delta G_r = \Delta G_a - \Delta G_c = -99.71 - 39.87 = -139.59 \text{ } kj/e^- eq$

$$A = -\left[\frac{\frac{\Delta G_p}{\varepsilon^n} + \frac{\Delta G_{PC}}{\varepsilon}}{\varepsilon \Delta G_r}\right] = 2.53 \quad f_s^0 = \frac{1}{1+A} = 0.28 \quad \text{so} \quad f_e^0 = 0.72$$

$$\Delta G_R^0 = f_e^0 \times (\Delta G_a^0 - \Delta G_d^0) = -100.50 \text{ } kj/e^- eq$$

$$\Delta G_{Syn}^0 = f_s^0 \times (\Delta G_c^0 - \Delta G_d^0) = -20.63 \text{ } kj/e^- eq$$

(c)

$$\text{For overall reaction, } R = f_e^0 \times (R_a - R_d) + f_s^0 \times (R_c - R_d)$$

the molar number of $C_5H_7O_2N$ and H_2 is 0.01 and 0.5, respectively.

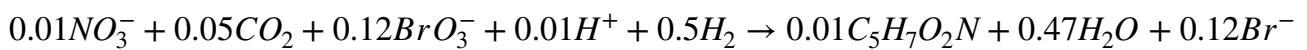
$$\text{Then } Y = 0.01(113)/0.5 = 2.26 \text{ g cells/mol } H_2$$

$$= 0.01(113)/0.5(2) = 1.13 \text{ g cells/g } H_2$$

$$= 0.01(113)/8 = 0.14 \text{ g cells/COD}$$

(d)

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



2.

The information given from textbook

$$\hat{q} = 16mg \text{ } BOD_L/mg \text{ } VSS_a \quad f_d = 0.8$$

$$K = 20 \text{ mg/L} \quad X_i^0 = 50mg \text{ } VSS_i/L$$

$$b = 0.15/d \quad S^0 = 400mg \text{ } COD/L$$

$$Y = 0.5mg \text{ } Vss_a/mg$$

Using the related equations from the textbook

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

$$X_a = Y(S^0 - S) \frac{1}{1 + b\theta_x}$$

$$X_v = X_i^0 + Y(S^0 - S)\theta_x + (1 - f_d)b\theta_x \quad \text{and} \quad X_a = X_i + X_v$$

$$r_{ut} = - \frac{S^0 - S}{\theta_x}$$

$$UAP = \frac{-(\hat{q}_{UAP}X_a\theta + K_{UAP} + k_1r_{ut}\theta) + \sqrt{(\hat{q}_{UAP}X_a\theta + K_{UAP} + k_1r_{ut}\theta)^2 - 4K_{UAP}k_1r_{ut}\theta}}{2}$$

$$BAP = \frac{-(K_{BAP} + (\hat{q}_{BAP} - k_2)X_a\theta) + \sqrt{(K_{BAP} + (\hat{q}_{BAP} - k_2)X_a\theta)^2 + 4K_{BAP}k_2X_a\theta}}{2}$$

Where

$$k_1 = 0.12g \text{ } COD_p/g \text{ } COD_s \quad \hat{q}_{UAP} = 1.8g \text{ } COD_p/g \text{ } VSS_a$$

$$k_2 = 0.09g \text{ } COD_p/g \text{ } COD_s \quad K_{UAP} = 100mg \text{ } COD_p/g \text{ } VSS_a$$

$$\hat{q}_{BAP} = 0.1g \text{ COD}_p/g \text{ VSS}_a$$

$$K_{BAP} = 85mg \text{ COD}_p/g \text{ VSS}_a$$

Noguera 1991 analyzed aerobic data and obtained the these values above.

Then $SMP = UAP + BAP$ and $Soluble COD = S + SMP$

θ_x (d)	S. (mg VSS _i /L)	X _a (mg VSS _i /L)	X _i (mg VSS _i /L)	UAP(mgCO D _p /L)	BAP(mgCO D _p /L)	SMP(mg COD _p /L)	S+SMP(mg COD _p /L)
1	3.36	172.45	55.17	12.68	13.20	25.88	29.23
5	0.91	114.02	67.10	4.42	34.76	39.18	40.10
10	0.65	79.87	73.96	3.21	44.46	47.67	48.31
30	0.47	36.32	82.69	2.38	55.18	57.55	58.02

* Detailed calculate process by Python programming

My opinion:

With an increases in the θ_x , the UAP value decreases and the BAP value increases. But as for SMP value, it will increase with θ_x increasing. Thus the SMP and S + SMP value should be mainly controlled by the range of θ_x

As is often the case, the soluble COD is dominated by SMP, not original substrate. The soluble BOD_L will equal the soluble COD is all of the SMP is biodegradable.