Homework 2.

2-1. a). $\overset{-3}{NH_4^+} + 2O_2 \rightarrow \overset{+5}{NO_3^-} + H_2O + 2H^+$ ($8e^-$)

$C_n = 50 - 12.5 = 37.5$ mg/L.

$C_c = 80 - 17.5 = 62.5$ mg/L.

$C_d = 30 - 7.5 = 22.5$ mg/L.

$NOD_n = \frac{37.5}{14} \times 2 \times 32 = 171.4$ mg/L. 68.6% BOD

$NOD_c = \frac{62.5}{14} \times 2 \times 32 = 285.7$ mg/L. 81.63% BOD

$NOD_d = \frac{22.5}{14} \times 2 \times 32 = 102.9$ mg/L. 68.57% BOD

b). NOD 小很多.

$NH_4^+ + 1.86O_2 + 1.98HCO_3^- \rightarrow 0.02C_5H_7NO_2 + 0.98NO_3^- + 1.88H_2CO_3 + 1.04H_2O$

$NOD_n = \frac{37.5}{14} \times 1.86 \times 32 = 159.43$ mg/L.

$NOD_c = \frac{62.5}{14} \times 1.86 \times 32 = 265.71$ mg/L.

$NOD_d = \frac{22.5}{14} \times 1.86 \times 32 = 95.66$ mg/L.

$\left(1 - \frac{1.86}{2}\right) \times 100\% = 7\%$. 小.

2-2. $T = 15^\circ C$. $C_{O_2} = 2 g/m^3$ $\theta x = 5$ d. pH = 7.0-7.5

$\mu_{max}(T_{20}) = 0.2 - 5\ d^{-1}$ $k_{O_2} = 0.5 - 1.0$ mg O_2/L.

$\theta_T = 0.106$. pHopt = 7.2. $[NH_4^+] = 2 mg/L$.

$$\mu_{max}(T) = \mu_{max}(T_{20})\, e^{\theta_T (T-20)}$$

$$= 0.8 \cdot e^{0.106 \times (-5)}\ d^{-1}$$

$$= 0.8 \times 0.5 \ d^{-1} = 0.5\ d^{-1}$$

$$\mu = \mu_{max} \frac{[NH_4^+]}{10^{0.05T - 1.158} + [NH_4^+]} \cdot e^{0.098(T-15)} \frac{[DO]}{K_{O_2} + [DO]} \cdot$$

if. $K_{O_2} = 1$, pH = 7.5 $\quad [1 - 0.833 \cdot |pHopt - pH|]$

$$= 0.5 \times \frac{2}{10^{0.05 \times 15 - 1.158} + 2} \cdot e^{0} \cdot \frac{2}{1+2} \cdot (1 - 0.833 \times 0.3)$$

$$= 0.5 \times \frac{2}{0.4 + 2} \cdot 1 \cdot \frac{2}{3} \cdot 0.7$$

$$= 0.208\ d^{-1}$$

if $K_{O_2} = 0.5$, pH = 7.0

$$= 0.5 \times \frac{2}{0.4 + 2} \times 1 \times \frac{2}{0.5 + 2} \times (1 - 0.833 \times 0.2)$$

$$= 0.278\ d^{-1}$$

$\therefore SF = \mu \cdot \theta_x = 1.0 \text{ or } 1.38 > 1.$

So WWTP does nitrify.

2-3. COD = 340 g/m^3. BOD = 170 g/m^3.

TKN = 30 g/m^3 $\quad Y = 0.5\ g/g_{OM}$

for aerobic.

$M_{COD} = 1.425\ g/g_{OM}$.

$\therefore OM = \frac{340}{1.425} = 238.6\ g_{OM}/m^3$.

$\therefore Y = 0.5 \times 238.6 = \underline{119.3\ g/m^3}$.

for denitrifying.

depend on what to include NH_4^+ or not ???

$0.65\ C_{18}H_{19}O_9N + 4.8\rho\ NO_3^- + 4.8\rho\ H^+ \rightarrow$

$C_5H_7NO_2 + 2.2\rho\ N_2 + 6.7\ CO_2 + 11.2\ H_2O$.

$M_{OM} = 18\times12 + 19\times1 + 9\times16 + 14 = 329\ g/mol$

$C_{OM} = \frac{238.6}{329}\ mol/m^3 = 0.607\ mol$

$M_{biomass} = 5\times12 + 7\times1 + 14 + 2\times16 = 113\ g/mol$

$m_{biomass} = \frac{0.607}{0.65} \times 113\ g/m^3 = \underline{105.5\ g/m^3}$.

for nitrifier.

$NH_4^+ + 1.86\ O_2 + 1.98\ HCO_3^- \rightarrow$

$0.02\ C_5H_7NO_2 + 0.98\ NO_3^- + 1.88\ H_2CO_3 + 1.0\times\ H_2O$.

$\Delta C_{NH_4^+} = 30 - 0.045\ g\,N/g\,BOD_5 \times 170\ g/m^3$.

$= 30 - 7.65\ g/m^3$.

$= 22.35\ g/m^3$.

$\therefore m_{biomass} = \frac{22.35}{14} \times 0.02 \times 113 = \underline{3.6\ g/m^3}$.

2-4 $TAL_0 = 4.1$ eqv/m³. $\Delta C_{N-NO_3} = 25$ g/m³.

$0.61\ C_{8}H_{10}O_2N + 4.54\ NO_3^- + 0.3\ NH_4^+ + 4.54\ H^+ \rightarrow$

$C_5H_7NO_2 + 2.27\ N_2 + 5.1\ CO_2 + 5.45\ H_2O$

$\therefore \Delta C_{H^+} = \frac{25}{14} \times \frac{4.54}{454} = 1.63$ mol/m³.

$\therefore TAL = TAL_0 + \Delta C_{H^+} = 4.1 + 1.63 = 5.73$ eqv/m³. >5

>5 $\Delta C_{N-NO_3} = 20$ g/m³.

$M_{biomass} = 113$ g/mol. $Y = 0.5$ g/g om.

$0.61\ C_{8}H_{10}O_2N + 4.54\ NO_3^- + 0.3\ NH_4^+ + 4.54\ H^+ \rightarrow$

$C_5H_7NO_2 + 2.27\ N_2 + 5.1\ CO_2 + 5.45\ H_2O$

$\Delta C_{biomass} = \frac{20}{14} \times \frac{0.61}{454}$ mol/m³

$= 0.19$ mol/m³ $= \underline{75.43}$ g/m³.

aerobic heterotrophic.

$C_8H_{10}O_2N + 8.8\ O_2 + 0.74\ NH_3 \rightarrow$

$1.74\ C_5H_7NO_2 + 5.3\ CO_2 + 4.52\ H_2O$

$\frac{M_{biomass}}{m_{OM}} = 0.5 = \frac{113x}{319} \therefore x = 1.74$

$\Delta BOD_5 = \frac{75.43}{319} \times 8.8 \times 32 = \underline{54.05}$ g/m³.

+2 +9 -18 -3

$a\ C_{18}H_{19}O_9N + b\ NO_3^- + c\ NH_4^+ + d\ H^+ \longrightarrow$

0 +7 -3 -4 $\searrow$ 28 e⁻ +4

$e\ C_5H_7NO_4 + f\ N_2 + g\ CO_2 + h.\ H_2O$

C: $18a = 5e + g.$ $\quad 18a = 5 + g.$

H: $19a + 4c + d = 7e + 2h$ $\quad 19a + 4c + d = 7 + 2h.$

O: $9a + 3b = 2e + 2g + h.$ $\quad 9a + 3b = 2 + 2g + h$

N: $a + b + c = e + 2f$ $\quad a + b + c = 1 + 2f.$

e: $5b = 4g - 2a$ $\quad 2a + 5b = 4g$

g: $b = c + d.$

if $e = 1.$ $\quad g = 18a - 5$

$5b = 4g - 2a = 72a - 20 - 2a = 70a - 20$

$b = 14a - 4$

$9a + 42a - 12 = 2 + 36a - 10 + h$

$h = 15a - 4 = b + a.$

$= g - 3a + 1$

$19a + b + 3c = 7 + 30a - 8.$

$c = 1 - a$

$a + 14a - 4 + 1 - a = 1 + 2f$.

$f = 7a - 2$ $\quad b = 2f$

$10a + 4 - 4a + d = 7 + 30a - 8$.

$d = 15a - 5 = 5(3a - 1) = h - 1$

$\therefore b = 14a - 4 \quad e = 1 \quad g = 18a - 5$

$c = 1 - a. \quad f = 7a - 2 \quad h = 15a - 4.$

$d = 15a - 5 \quad b = 2f. \quad 5(g - h) = d.$

$\because f = 2.7$ depend on how much H_2 => biomass.

$\therefore a = 0.61 \quad b = 4.54 \quad c = 0.39. \quad d = 4.5$

$e = 1 \quad f = 2.7 \quad g = 5.25 \quad h = 5.5.$