Homework 3.

3-1 $C_{Fe^{2+}} = 13\ g/m^3$.

$$4Fe^{2+} + O_2 + 4H^+ \rightarrow 4Fe^{3+} + 2H_2O$$

55.8 g/mol $4e^-$

$$\therefore C_{O_2} = \frac{13}{55.8} \times \frac{1}{4} \times 32 \approx 1.86\ g/m^3.$$

normally loaded urban wastewater BOD_5 ~~250~~ 170 g/m^3.

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typical concentration.

$$\frac{1.86}{250} \approx 0.7\%. \qquad \frac{1.86}{170} \approx 1.09\%$$

3-2 a) $C_{eff-P} = 0.5\ g/m^3$. $Fe/P = \boxed{2.0}$ 1.8

$C_{in-P} = 6\ g/m^3$

$Q = 35000 \times 0.35 = 12250\ m^3/d$

$M_{FeCl_3} = 55.8 + 35.5 \times 3 = 162.3\ g/mol$

$$m_{FeCl_3} = \frac{6}{31} \times \underset{1.8}{2} \times 162.3 = 62.8\ g/m^3$$

$\times 12250\ m^3/d$

$= 0.77\ t/d$ 0.68 t/d.

$\cancel{M}\ V_{40\% FeCl_3} = \frac{0.77}{0.4} = 1.92$ ~~t~~ m^3/d.   1.75 m^3/d

Price $= 0.77 \times 250 = 192.5$ CHF/d.   173 CHF/d

b) $C_{o,P} = 6\ g/m^3$ $C_{o,BOD} = 130\ g\ BOD_5/m^3$ $X_{o,SS} = 100\ g/m^3$

$SP_{c,p} = 6.8 \times \frac{C_{0,P}}{C_{0,BOD}} = 6.8 \times \frac{6}{130} = 0.31$ kgSS/kgBOD.

$SP_p = SP_{c,p} Q_0 C_{0,BOD}$

$= 0.31 \times 12450 \times 130 \approx 500$ kgSS/d

$\theta_x = 5d$! $T = 10°C$, $F_T = 1.072^{(T-15)} = 0.706$

$$SP_{c,BOD} = 0.75 + 0.6 \times \frac{X_{0,SS}}{C_{0,BOD}} - \frac{0.102 \cdot \theta_x \cdot F_T}{1 + 0.17 \cdot \theta_x \cdot F_T}$$

$$= 0.75 + 0.6 \times \frac{100}{130} - \frac{0.102 \times 5 \times 0.706}{1 + 0.17 \times 5 \times 0.706}$$

$$= 0.75 + 0.46 - 0.225$$

≈ 0.9865 kgSS/kgBOD$_5$

$T = 12°C$, $F_T = 1.072^{-3} = 0.81$

$$SP_{c,BOD} = 0.75 + 0.46 - \frac{0.102 \times 5 \times 0.81}{1 + 0.17 \times 5 \times 0.81}$$

$= 0.965$ kgSS/kgBOD$_5$

$\frac{SP_{c,P}}{SP_{c,BOD}} \Rightarrow 31.4\% \sim 32.1\%$

$X_{0,SS} = 0.5 \cdot T_{SS}$???

$C_{0,BOD} = 0.75 \cdot S_{BOD_5}$

after primary treatment

BOD$_5$ => 75%

TSS => 50%

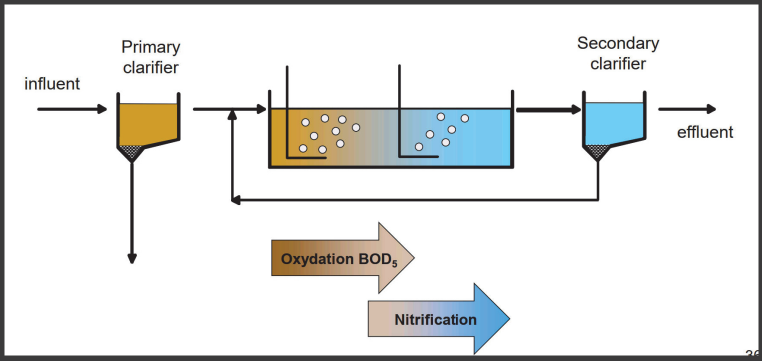
3-3

$NH_4-N_{eff} = 2\ g_N/m^3$ $\times 3.$ $V = 1260 m^3$

$Q_0 = 10000 m^3/d$ $S_{BOD_5} = 190\ g/m^3$ $TSS_{inf} = 170\ g_{TSS}/m^3$

$N_{TKN,inf} = 54\ g_N/m^3$ $NH_4-N_{inf} = 36\ g_N/m^3.$

a). nitrification required. should not be completely mixed.



plug flow.

b) $V = 1260 \times 3 = 3780 m^3.$ $T = 10^\circ C.$ $\theta_x = 10d.$

$C_{0,BOD} = 0.75 \times S_{BOD_5} = 142.5\ g/m^3$

$X_{0,SS} = 0.5 \times TSS_{inf} = 85\ g/m^3.$

$F_T = 0.706$ X_{AT} with nitrification $2.5 - 3.5\ kgSS/m^3$

$$SP_{c,BOD} = 0.75 + 0.6 \times \frac{85}{142.5} - \frac{0.102 \times 10 \times 0.706}{1 + 0.17 \times 10 \times 0.706}$$

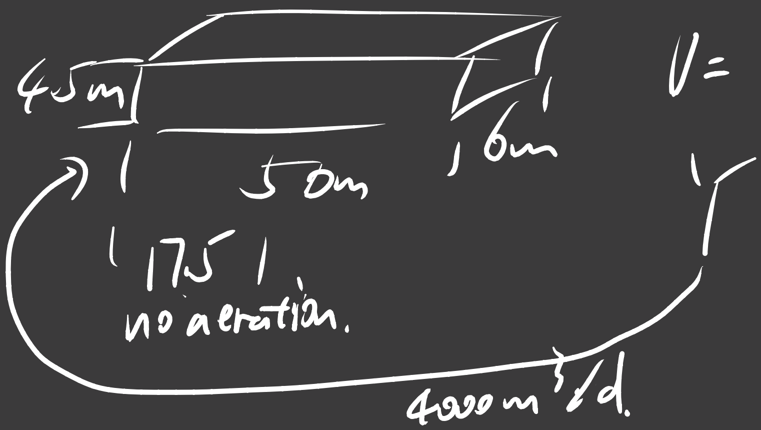
$$= 0.78\ kgSS/kgBOD$$

$$V_{AT} = \frac{Q_0 \cdot C_{0,BOD} \cdot SP_{c,BOD} \cdot \theta_x}{X_{AT}}$$

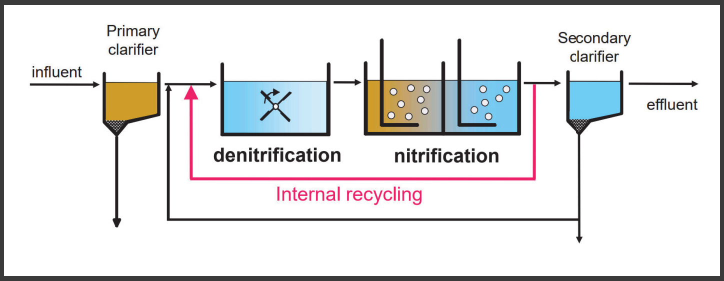
$$= \frac{10000 \times 0.1425 \times 0.78 \times 10}{3} = 3705\ m^3 < 3780\ m^3$$

3-4 $Q_0 = 5000 m^3/d$. $S_{BOD5} = 260 g/m^3$ $TSS_{inf} = 195 g_{TSS}/m^3$

$N_{TKN-inf} = 63 g_N/m^3$ $NO_3-N_{eff} = 25 g_N/m^3$ $NH_4-N_{eff} = 2 g_N/m^3$



$V = 50 \times 6 \times 4.5 \times 3 = 4050 m^3$.



pre-denitrification. N removal less.

$C_{0,BOD} = \underline{0.75} \times BOD_5 = 0.195 kg/m^3$.

$X_{0,SS} = \underline{0.5} \times TSS_{inf} = 0.0975 kg/m^3$.

10% TKN loss after primary treatment.

$\Delta N = 0.9 \times 63 - 25 - 2 - 0.045 \times 195 = 20.925 g/m^3$.

$r_{den} = \frac{\Delta N}{C_{0,BOD}} = \frac{20.925}{195} = 0.107$. kg $N-NO_3$/kg BOD_5

≈ 0.11

$\therefore V_D/V_{AT} = \underline{0.2}$

now $V_D/V_{AT} = 17.5/50 = 0.35 >> 0.2$

$\theta_X = 12.5d$.

$SP_{C,BOD} = 0.75 + 0.6 \times \frac{97.5}{195} - \frac{0.102 \times 12.5 \times 0.706}{1 + 0.17 \times 12.5 \times 0.706}$

$= 0.69$ kg SS/kg BOD_5.

if $X_{AT} = 2.5$ kg TSS/m^3.

$$V_{AT} = \frac{Q_0 \cdot C_{0,BOD} \cdot SP_{C,BOD} \cdot \theta_X}{X_{AT}}$$

$$= \frac{5000 \times 0.195 \times 0.69 \times 12.5}{2.5} = 3363.75\ m^3.$$

$$V_{AT}/3 = 1121.25\ m^3 < V_{AT}' = 4050/3 = 1350\ m^3$$

$$V_D = 0.2\ V_{AT} = 224.25\ m^3 < V_D' = 1350 \times 0.35 = 4725\ m^3$$

η_N.

$$\Delta N_D = 20.925\ g/m^3$$

$$\Delta N_N = 0.9 \times 63 - 2 - 0.045 \times 195 = 45.925\ g/m^3$$

$$\eta_N = \frac{\Delta N_D}{\Delta N_N} = \frac{20.925}{45.925} = 0.456$$

$$r = \frac{1}{(1-\eta_n)} - 1 = \boxed{0.837}$$

$$\boxed{+0.5} = 1.337.$$

recirculation rate ↓.   pH. / alkalinity.