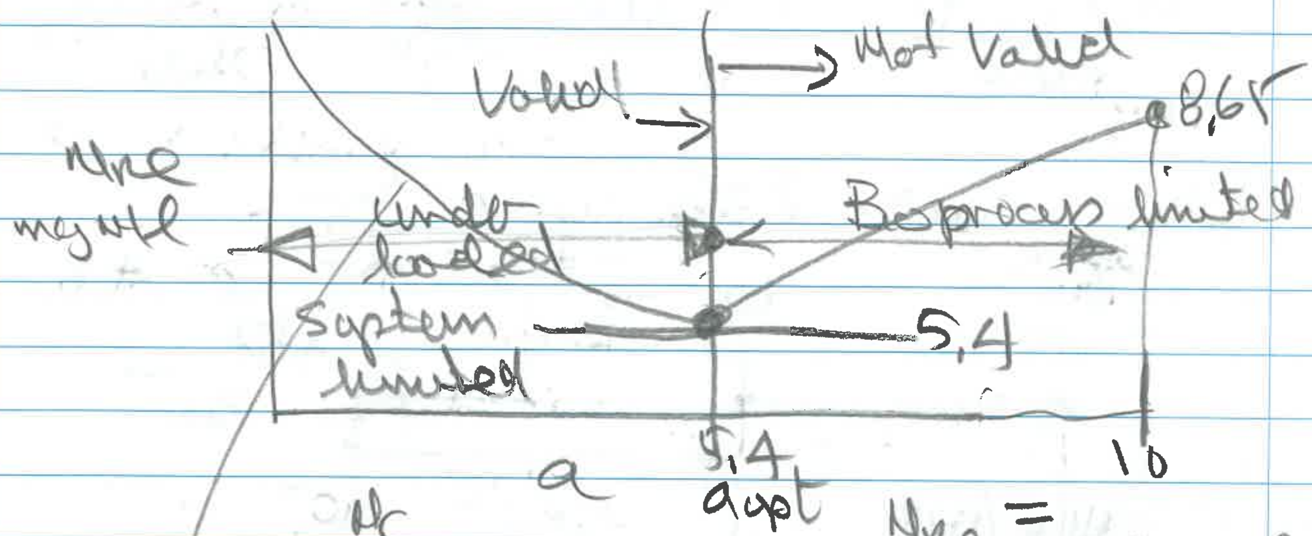
$A = \frac{2}{2.86} = 0.7 \quad B = +3.03 \; ; \; C = 36.71$

$$a_{opt} = \frac{-3.03 + \sqrt{3.03^2 + 4 \times 0.7 \times 36.71}}{2 \times 0.7}$$

$$= +5.4$$

$$N_{ne} = \frac{N_c}{a+s+1} = \frac{40}{5.4+1+1} = 5.4 \text{ mg } NO_3\text{-N}/l$$



$N_{ne} = \frac{N_c}{a+s+1}$

$$N_{ne} = N_c - D_{p1} + \frac{aO_a + sO_s}{2.86}$$

$a = 10$

$$N_{ne} = 40.0 - 30.7 + \frac{10 \times 2 + 1 \times 1}{2.86}$$

$$= 8.65 \text{ mg } NO_3\text{-N}/l$$

$TN = TKN + NO_3$
$= 2.0 + 5.4$
$= 7.4$ mgN/l

$$\%\text{ Removal} = \frac{50 - 7.4}{50} = 85.2\%$$

2/10h45 NL

3.6 Oxygen recovered by denitrification

$$FO_d = 2.86\, Q_i (N_c - N_{ne}) \quad NO_3 \text{ denit.}$$

$$= 2.86 \times 24.875 (40 - 5.4)$$

$$= 2460 \text{ kgO/d}$$

$$FO_t = FO_c + FO_n - FO_d$$

$$= 7732 + 4545 - 2460 = 9817 \text{ kgO/d}$$

organics removal   nitrification   denit.

3.5 Volume of anoxic $= 0.39 \times V_R$ (total volume from 4.2

$= 0.39 \times 8473$

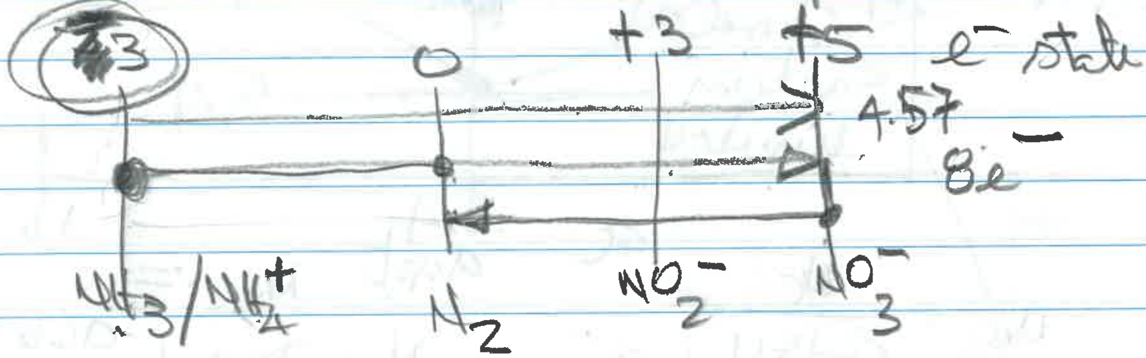
$= 3304\ m^3$

Aerobic volume $= 8473 - 3304 = 5169\ m^3$

$$OUR_{aerobic} = \frac{FOt^{*}}{V_{aer}\ 24} = \frac{9817\ kg/d}{5{,}169\ ML\ 24\ h/d}$$

Not peak OUR $= 79.14\ \frac{mg\ O}{L.h}$ at steady state

Where does 2.86 come from



$$NH_4^+ + 3H_2O \rightarrow NO_3^- + 10H^+ + 8e^-$$

$$8(H^+ + e^-) + 2O_2 \rightarrow 4H_2O$$

$$64\ g\ O / 14\ g\ N = 4.57\ g\ O/g\ N$$

If 8/8 is 4.57, what is $\frac{5}{8}$ of $4.57 = 2.86$

$$NO_3^- + 5e^- + 6H^+ \rightarrow \frac{1}{2}N_2 + 3H_2O \quad \div 5$$

$$O_2 + 4e^- + 4H^+ \rightarrow 2H_2O \quad \div 4$$

$$\frac{1}{5}NO_3^- + 1e^- + \frac{6}{5}H^+ \rightarrow \frac{1}{10}N_2 + \frac{3}{5}H_2O$$

$$\frac{1}{4}O_2 + 1e^- + H^+ \rightarrow \frac{2}{4}H_2O$$

$\frac{1}{5}$ mole $NO_3^- \equiv \frac{1}{4}O_2$

$\frac{14}{5} \equiv \frac{32}{4}$ 1 mole $NO_3^- \equiv \frac{32}{4} \times \frac{5}{14} \equiv 2.86$

~~EDC~~ γ_s e^-/mole

$= +4x + y - 2z - 3a + 5b + 6c - ch$

$\boxed{C_x H_y O_z N_a P_b S_c^{ch}}$

C H O N P S charge

+5

Acetate CH_3COO^- or CH_3COOH

COD $\gamma_s = 4\times2 + 3 - 2\times2 - (-1) = +8\ e^-$/mol

$\gamma_s = 4\times2 + 4 - 2\times2 - (0) = +8\ e^-$/mol

COD $\gamma_{NH_4^+} = 0 + 4 - 2(0) - 3(1) + 0 + 0 - (+1)$

$= 0$

TOD $\gamma_{NH_4^+} = 0 + 4 - 2(0) + 5 + 0 + 0 - (+1)$

$= +8\ e^-$/mole

COD has reference NH_3 (NH_4^+); CO_2; H_2O

$\gamma_{s\,CO_2} = 4\times1 + 0 - 2\times2 = 0$ (CO_2 no COD)

$\gamma_{s\,H_2O} = 0 + 2 - (2\times1) = 0$

CH_4 — C — CO_2

-4 — 0 — $+4$

CH_4 COD is relative to CO_2 and H_2O

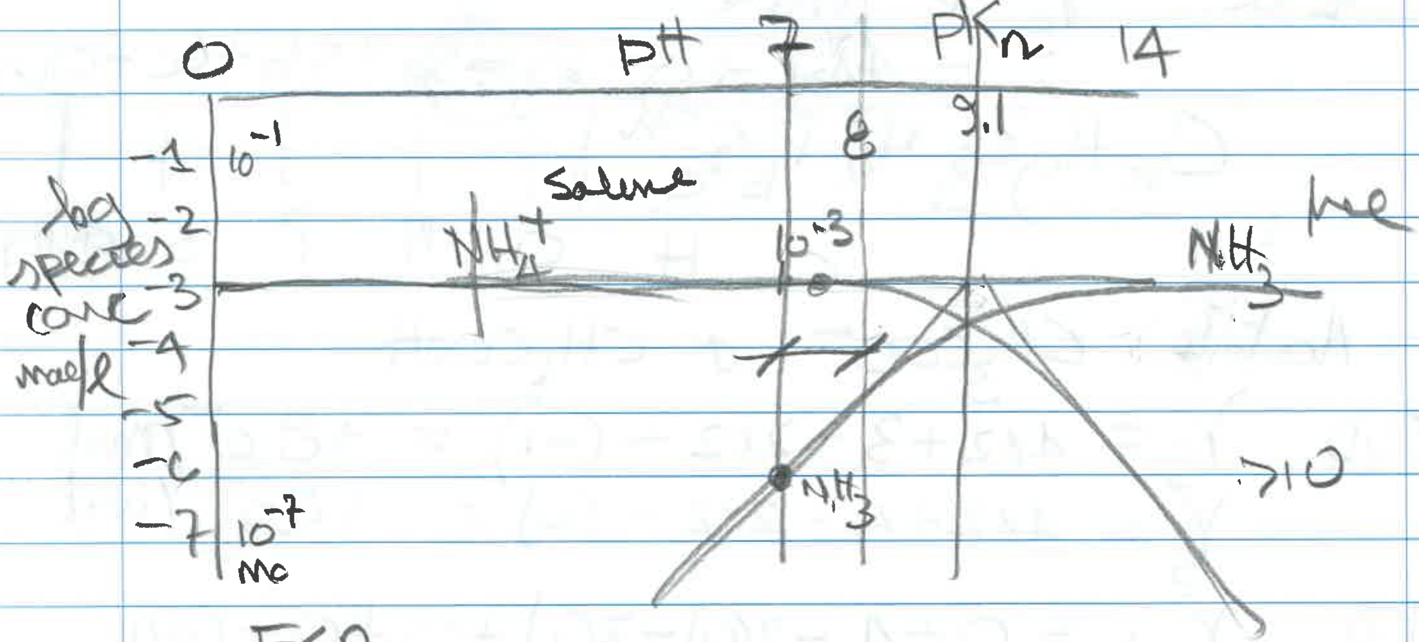
$\gamma_{s\,CH_4} = 4\times1 + 4 - 0 + 0 = 8\ e^-$/mol.

1 mole methane has COD (EDC) $= 8 \times \frac{32}{4}$

$8\ e^-/\text{mol} \times 8\ g\ O_2/e^- = \longrightarrow = 64\ g\ COD/\text{mol}$.

2/11h35 NL

2| 11h45 NL NH_4^+/NH_3 same EDC



FSA

$$K = \frac{\prod \text{Products}}{\prod \text{Reactant}}$$

$$NH_4^+ \rightleftharpoons H^+ + NH_3$$

$$K_n = \frac{[H^+][NH_3]}{[NH_4^+]} = 10^{-9.1}$$ mol/l

$$pH = -\log[H^+] \text{ mol/l}$$

$$pK_n = -\log(10^{-9.1}) = 9.1$$

pH 7-8 most ammonia is NH_4^+

Alk is expressed as mg/l as $CaCO_3$

$\{eq/l\} = [mol/l] \times n_x$ — number of H^+ or OH^- a compound can react with.

CO_3^{2-}	H_2CO_3	2
OH^-		1
H^+		1
SO_4^{2-}		2
Cl^-		1
PO_4^{3-}		3

PAC or PDC
Proton accepting or donating capacity

$$mg/l \text{ as } CaCO_3 = \{m.eq/l\} \times EW_{CaCO_3}$$

$$EW_{CaCO_3} = \frac{MM_{CaCO_3}}{n_{x\,CaCO_3}} = \frac{40+12+48}{2} = \frac{100}{2}$$

$$= \{m.eq/l\} \times \frac{100}{2}.$$

Pure water added 106 g $NaHCO_3$ water/$1m^3$
What is the alk in mg/l as $CaCO_3$

$$MM \text{ of } NaHCO_3 = 23+1+12+48 = 84\,g/mol$$

$$[mmol/l] = \frac{106\,g \times 1000\,mg}{1000\,l \;\; 84\,g} = 1.26\,mmol/l$$

$$\{meq/l\} = [mmol/l]\,n_x = 1.26 \times 1$$
$$= 1.26$$

$$mg/l \text{ as } CaCO_3 = \{meq/l\} \times EW_{CaCO_3}$$
$$= 1.26 \times \frac{100}{2} = 63\,mg/l \text{ as } CaCO_3$$

$$NH_4^+ + 2O_2 \rightarrow NO_3^- + 2H^+ + H_2O$$

14 g N decreased alk by 2 mol H^+/l

14 g N decrease alk by $2 \times 50 = 100\,mg/l$ as $CaCO_3$
nitrification $\quad EW_{CaCO_3} \; n_x = 1$

1 g N decrease alk by $\frac{100}{14} = 7.14\,mg/l$ as $CaCO_3$

Denitrification

$$NO_3^- + 5(e^- + H^+) + H^+ \rightarrow \tfrac{1}{2}N_2 + 3H_2O.$$

In denit we pick up $1H^+$ 1 mol/l H^+

14 g NO_3-N denit increases alk by 1×50

1 g NO_3-N denit " " by $\frac{50}{14} = 3.57$ mg/l as $CaCO_3$

Influent = 250 mg/l as $CaCO_3$.

Alk loss on nitrification $= 7.14 \times N_c$

$= 7.14 \times 40 = -286$ mg/l as $CaCO_3$

Alk gained by denit $= +3.57(N_c - N_{ne})$

$= 3.57(40.0 - 5A)$

$= +127$ mg/l as $CaCO_3$

Settled ww

TKN $\boxed{50.0}$

$\boxed{\text{org N}}$

FSA $\boxed{35.1}$ NH_4^+

FBSO $\boxed{3.8}$ USO $\boxed{}$

BPO $\boxed{5.33}$ BPO

UPO $\boxed{}$

$C_aH_9O_3N_aP_b \longrightarrow CO_2 + NH_3 + \cancel{H_3PO_4} + H_2O + e^- + H^+$

e^-

FBSO + BPO N is released as NH_3

$3.8 + 5.3 = 8.6$ mg NH_3-N/l

pick up $NH_3 + H^+ \longrightarrow NH_4^+$

Removing 9.1 mg N/l from the bulk as

$9.1 \times 3.57 =$ mg/l as $CaCO_3$

gain in alk → H^+ removed.

$39.1 + 9.1 - 7.33 = 40.9$ called N_c

FSA org N picked by biomass from FSA & make product

when all FSA $\rightarrow NO_3^-$

$CO_2 + H_2O + NH_4^+ \longrightarrow C_5H_7O_2N_{0.9}P_{0.1} + H^+$.

Net change $= 9.1 - 7.3 = 1.8$ mg/l N gain

net gain on alk from algal and growth
$= +1.8 \times 3.57 \frac{\text{mg/l as } CaCO_3 \text{ alk}}{\text{mg/l } NH_4}$

$= +6.3$ mg/l as $CaCO_3$.

Effluent Alk = influent − loss nitrif
+ gain denit ± gain algal & loss biomass growth

$= 250 - 286 + 124 + 6$
$= 94$ mg/l as $CaCO_3$

E) Effl alk < 50 pH ↓ 7
Slows ANO! Dose lime pH ↑ 7.0.

Lets say Effl Alk = 10 mg/l as $CaCO_3$

Dose lime to get Effl Alk = 60 mg/l as $CaCO_3$
Dose 50 mg/l as $CaCO_3$

↓ 80 mg/l as $CaCO_3$

24.875 Ml/d →

Dose = x kg lime/h

$\frac{x \cancel{1000} \times 1000 \text{ mg/h}}{\text{Ml/d } 24.875 \times 10^6 \text{ l}/24\text{h/d}} = 0.965x \quad \frac{\text{mg/h}}{\text{l/h}} = \frac{\text{mg}}{\text{l}}$

mg lime
$Ca(OH)_2 = 40 + 2 \times 17 = 74$ g/mol

$\left[\frac{\text{mmol}}{\text{l}}\right] = \frac{.965x}{74}$

$\left\{\text{meq/l}\right\} = \frac{.965x}{74} n_x$

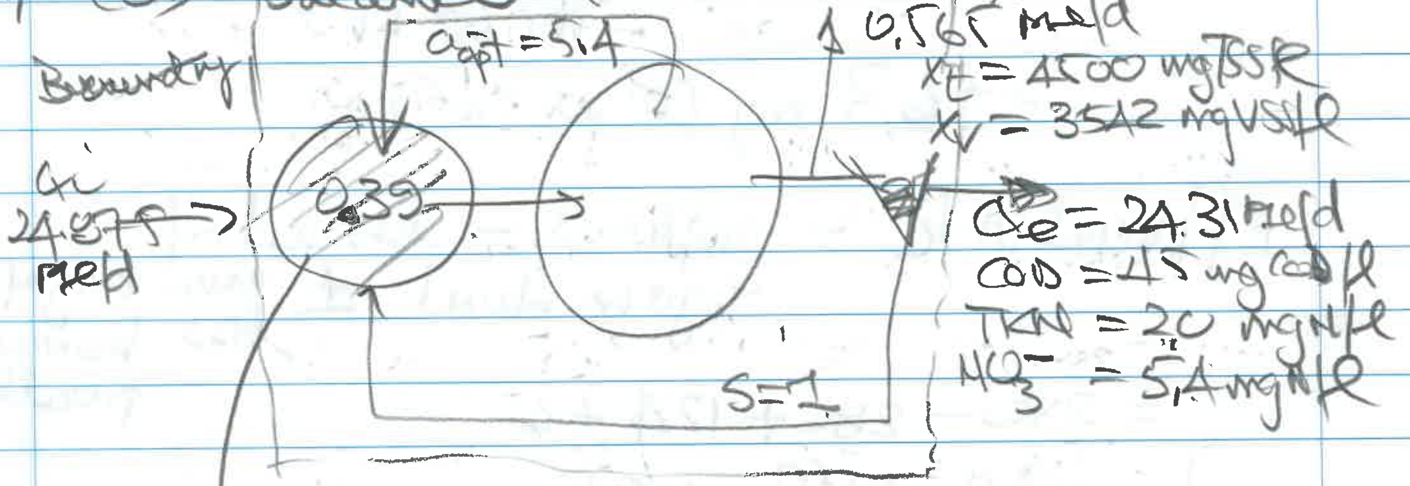
$\text{mg/l as } CaCO_3 = \{\text{meq/l}\} EW = \frac{0.965x}{74} \times 2 \frac{100}{2} = 50$

$x = 38.54$ kg/h

$\frac{1}{2}$ 1/2h 3/2

3/8h45 NL

3.7 COD Balance ~~(same as Q2,9)~~



$\rightarrow N_2 = N_c - N_{ne} = 40.0 - 5.4 = \underline{\underline{34.6}}$ mgN/l

COD balance (same as Q2,9)
Flux of COD in = 11816 kgCOD/d
Effluent COD $= Q_e S_{te} = 24.31 \times 45 = 1094$ kg COD/d

COD in waste flow $= Q_w(S_{te} + f_{cv}X_v)$
Ml/d * mg/l = kg/d $= 0.565(45 + 1.481 \times 3542)$
$= 2989$ kg COD/d

e^- (COD) passed to $O_2 = FO_c$ organics only!
$= 7732$ kg O/d

$COD_{out} = 1094 + 2989 + 7732 = 11815$ kg COD/d

Balanced.

N Balance $N_{in} = Q_i N_{ti} = 1244.8$ kg N/d
(as Q2).

N in effluent $= Q_e(\underset{TKN}{N_{te}} + \underset{NO_3}{N_{ne}})$
$= 24.31(20 + 5.4) = 179.9$ kgN/d

N in waste flow $= Q_w(N_{te} + N_{ne} + f_n X_v)$
$= 0.565(20 + 5.4 + 0.10 \times 3542)$
$= 204.3$ kg N/d

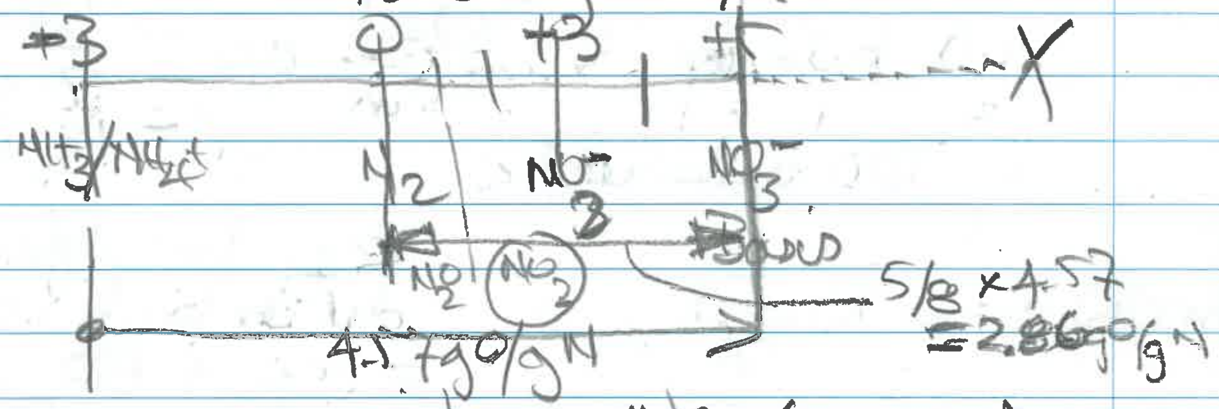
$$\text{N}_2 \text{ exits as gas} = (Q_o + Q_w)(N_c - N_{ne})^{\text{Denitrified}}$$
$$= 24.875\,(40.0 - 5.4)$$
$$= 860.7 \text{ kgN/d}$$

$$\text{Total N out} = 179.9 + 204.3 + 860.7 = 1244.8 \text{ kgN/d}$$

$N_{in} = N_{out}$ Balanced ✓

TOD Balance = Total Oxygen demand balance (EDC)

$$\text{Flux TOD} = (COD + 4.57\,TKN)\,Q_i$$
$$= (475 + 4.57 \times 50)\,24.875$$
$$= 17500 \text{ kg TOD/d}$$



COD basis: CO_2 & H_2O (zero COD) Basement datum.

So TOD = COD + 4.57 × TKN (all e^- donor ≥ 0: Fe^{2+}, H_2S, NO_2^-)

$$\text{TOD in effluent} = Q_e(COD + 4.57\,TKN)$$
$$= 24.31(45 + 4.57 \times 2) = 1318 \text{ kgTOD/d}$$

3 g/h 30 NL

$$\text{TOD in waste flow} = Q_w(\text{TOD}_{dissolved} + \text{TOD}_{particulate})$$
$$= Q_w\{(S_{te} + 4.57\,N_{te}) + (COD \text{ of } VSS + 4.57\,TKN \text{ of } VSS)\}$$
$$= 0.565\{(45 + 4.57 \times 2) + X_v(f_{cv} + 4.57 f_n)\}$$
$$= 0.565\{(45 + 4.57 \times 2) + 3542(1.481 + 4.57 \times 0.1)\}$$

TOD in waste flow = 3909.0 kg TOD/d

Remember N_2 has TOD! because it can donate e^- to become NO_3^- (basis)

$$TOD \text{ of } N_2 = (Q_e + Q_w)\,2.86\,(N_c - N_{ne})$$
$$= 24.875 \times 2.86\,(40.0 - 5.4)$$
$$= 2460 \text{ kg TOD/d}$$

Total TOD out = 1318 + 3909 + 9817 + 2460
Eff $\quad Q_w \quad FO_t$ Me $\quad N_2$

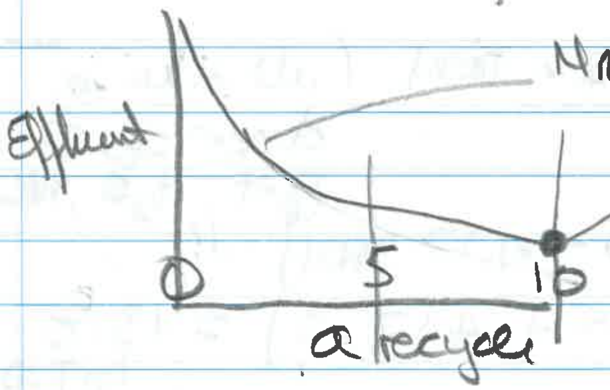
= 17500 kg TOD/d

TOD balance = $\frac{TOD\,out}{TOD\,in} \times 100 = \frac{17500}{17500} \times 100$
= 100%

TOD Balanced.

FO_t for system without denitrification =
$= FO_c + FO_n$

Balance BRT of MLE system;

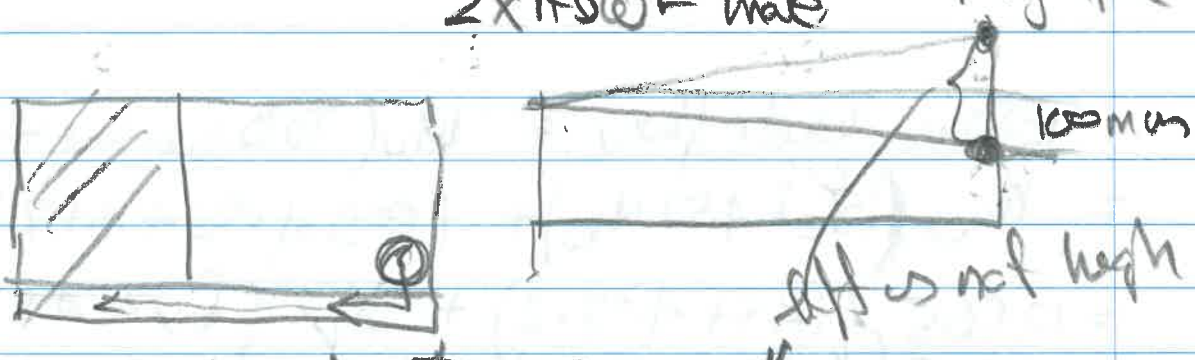


$N_{ne} = \frac{N_c}{a+S+1}$

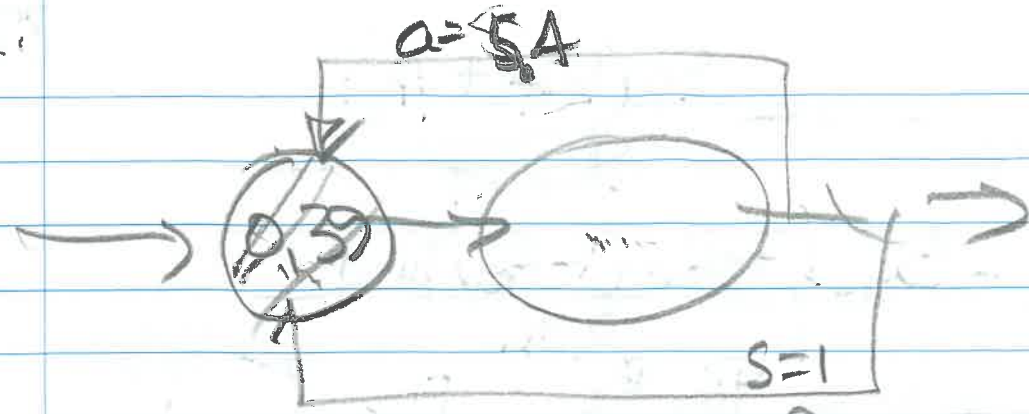
say a = 6 $\quad N_{ne} = \frac{40}{8}$
$= 5$ mgN/l.

a = 8 $\quad N_{ne} = \frac{40}{10} = 4$ mgN/l
1 mgN/l

2 x ADWF max

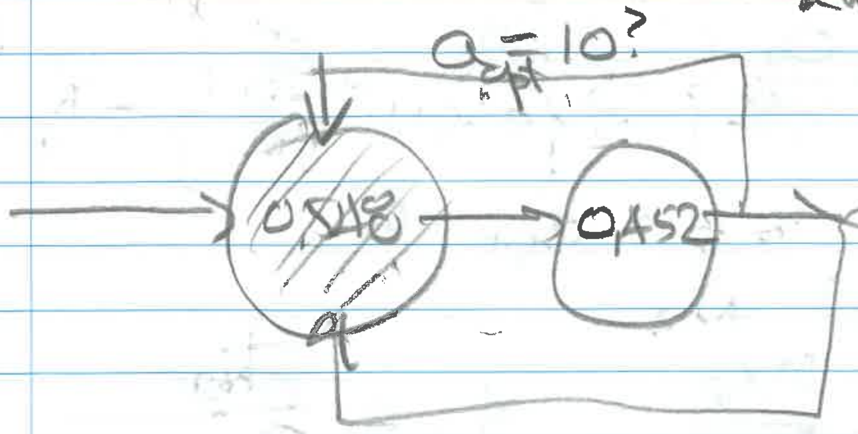


Set upper limit To a ≤ 6 approx.



$5.4 \, mg \, NO_3\text{-}N/l$

SRT = 15d $\quad f_{xm} = 0.548$



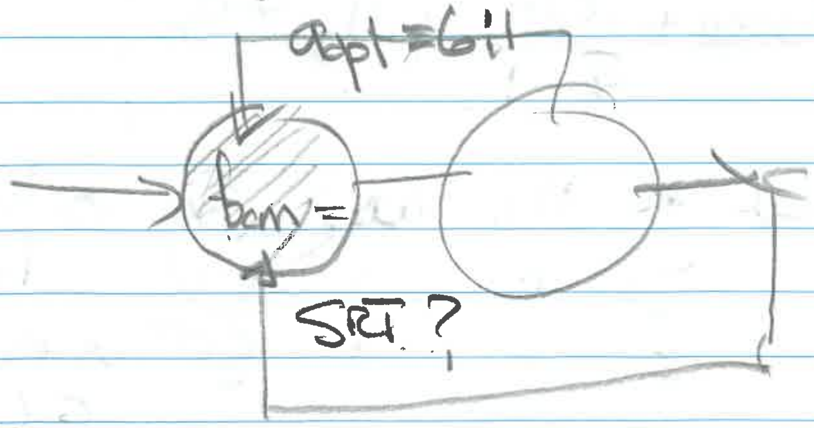
$N_{te} = \frac{40}{10+1+1} = 3.3$

SRT = 15d

$f_{xt} = f_{xm} = 0.548$

N_c same $= 40 \, mg \, NO_3\text{-}N/l$

If we want $a_{ept} = a_{prec} = 6{:}1$ then the SRT of the MLE will < 15d



R_s	$f_{xt} = f_{xm}$	D_{p1}	N_s	N_c	N_{ti}	N_{te}
5	0.10	22	12	35	47	
8	0.23	30	10	37	49	
10	0.399	37.04	9.26	37.14	50.0	
	Eq 1	Eq 2	Eq 3	Eq 4	Eq 5	

Eq 1 $f_{bm} = 1 - \frac{S_f (b_{AT} + 1/R_S)}{\mu_{AMT}}$

Eq 2 $D_{p,I} = S_{bi} \left\{ \frac{f_{sb's} (1 - f_{av} Y_{HV})}{2.86} + K_{2T} \frac{Y_{HV} R_S}{1 + b_{HT} R_S} f_{xem} \right\}$ Eq 1

Eq 3 $a \left\{ \frac{N_c}{a+s+1} + \frac{O_a}{2.86} \right\} + S \left\{ \frac{N_c}{a+s+1} + \frac{O_s}{2.86} \right\} = D_{p,I}$ Eq 2

$a = 6$ to give $a_{opt} = 6$

So I get N_c

Eq 4 $N_s = f_n \frac{19 X_v}{R_S Q_i}$ $N_{te} = \frac{K_{nT}}{S_f - 1}$

because $f_{xt} = f_{xm}$

see C 3.1

Eq 5 $N_{ti} = N_{te} + N_s + N_c$

$N_{ne} = \frac{N_c}{a+s+1}$ Eq 6 $= \left(N_{ouse} + \frac{K_{nT}}{S_f - 1} + N_s + N_c \right)$

If N_{ti} calculate $<$ N_{ti} www SRT is too low

N_{ti} " $>$ " " " " too high

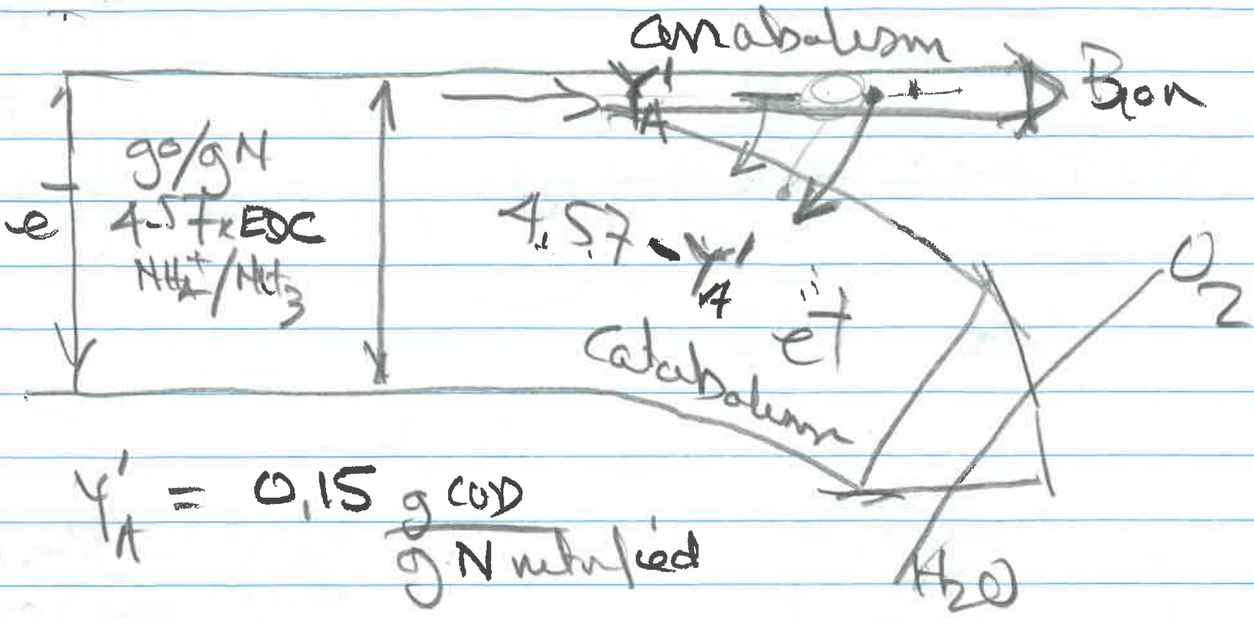
N_{ti} " $=$ " " SRT is correct.

R_S	$f_{xt} = f_{xm}$	$D_{p,I}$	N_c	N_{ti}	N_{ne} Eq 6
9.26	0.399	37.04	37.15	50.0	4.64

3/10h30 NL

3/10h45 NL

AAO



$Y'_A = 0.15 \frac{g\ COD}{g\ N\ nitrified}$

So growth only $Y'_A e^-$ to biomass $= 0.15$ g0/gN
$4.57 - Y'_A$ to O_2 $= 4.42$ "

When we calculate FO_n we assumed
$Y'_A = 0.0$ i.e. use $4.57\ FN_C\ (FNO_3\text{-}N)$ kgN/d

$$MX_{BA}(ANO_3) = \frac{Y_A R_S}{1 + b_{AT} R_S} \frac{FN_C\ (kg\ NO_3\text{-}N/d)}{C_i N_C} \quad kg\ VSS/d$$

$$= \frac{0.15 \cancel{/ TCV}\ 15}{1 + 0.036 \times 15} (24.875 \times 40.0)$$

1.481

$= 969$ kg VSS nitrifiers

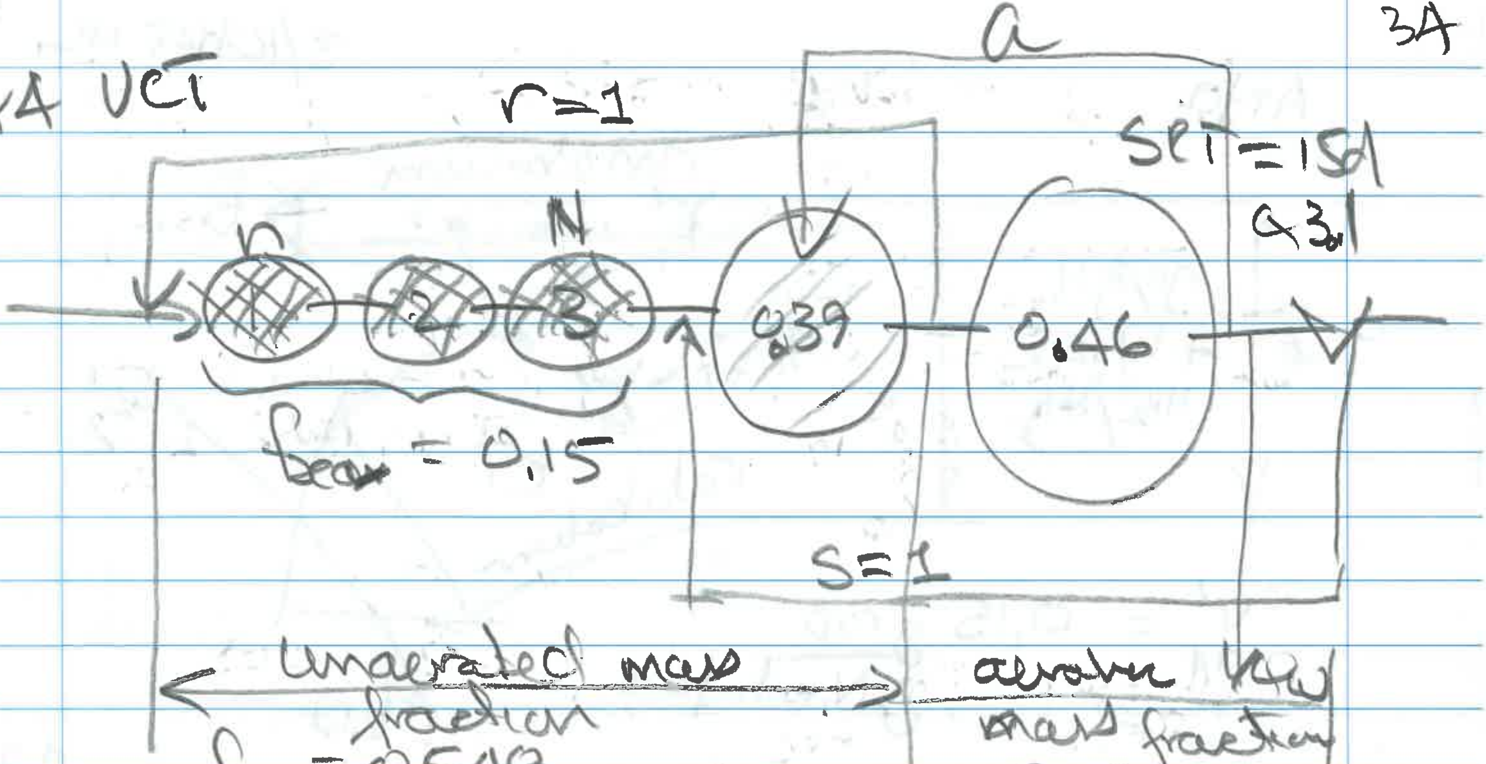
$\frac{MX_{BA}}{MX_V} \times \frac{100}{1} = \frac{969}{30021} \times 100 = 3.1\%$
too small to include in the VSS.

Net yield of ANO Brown
observed yield $Y_A = \frac{Y'_A R_S}{(1 + b_{AT} R_S) R_S}$ $\frac{g\ VSS\ ANO}{gN \cdot d}$

SRT	Y_A	$4.57 - Y_A$	SRT	Y_A	$4.57 - Y_A$
0	0.15	4.42	25	0.075	4.495
5	0.125	4.445	40	0.057	4.512
8	0.114	4.446			

11h00 NL

Q4 UCT



f_{xm} = 0.548
f_{xt} = 0.54(0.15+0.39)

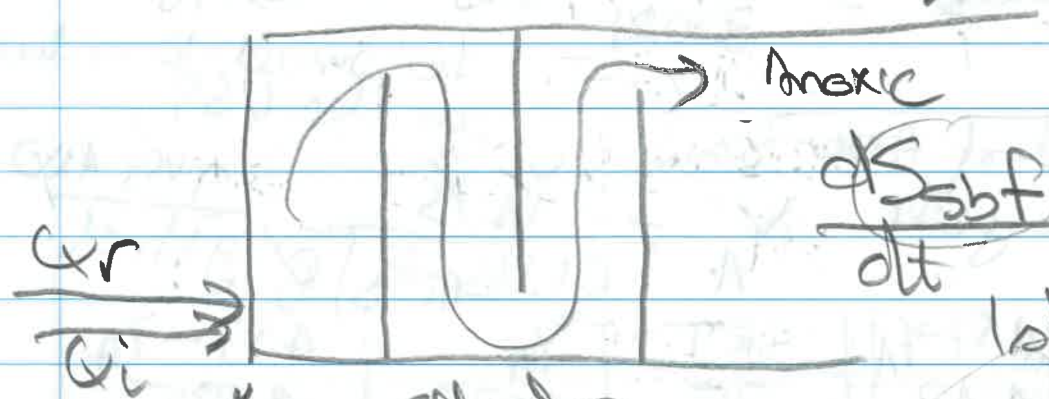
How much of the COD goes to OHO ?
" " " " " " to PAO .

VFA	FBSO	BPO
50	115	255

OHO

S_{bsfN}

ie FBSO not converted to VFA and exits last anaerobic cmpt. (N) N=3



same

$$\frac{dS_{sbf}}{dt} = -k_f X_{BH} S_{bs}$$ OHO

1st order

$$S'_{bsi} = S_{bsi} - 3.0 O_i - 8.6 N_{nr}$$

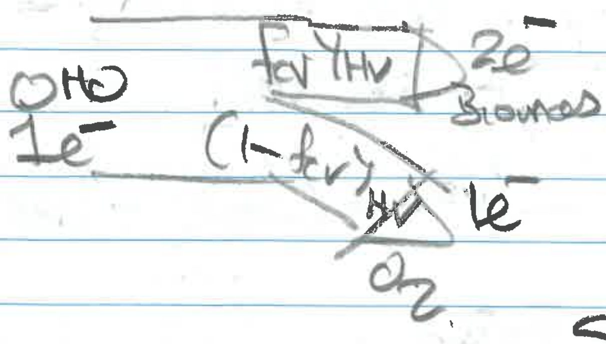
S'_{bsi} effective Influent FBSO conc

Influent DO

NO_3 in anoxic r

$$S'_{bsfi} = \underset{115}{S_{bsfi}} - 3.0\,O_i - 2.86\,N_{nr}\,r$$

$\frac{2.86}{(1-f_{cv}Y_{HV})}$ $\frac{1}{(1-f_{cv}Y_{HV})}$ NO_3 in r recycle



So say $O_i = 0$
$N_{nr} = 0$

$$S'_{bsfi} = S_{bsfi} = 115 \text{ mgCOD/l}$$

$$S_{bsfn} = \frac{S'_{bsfi}/(1+r)}{\left\{1 + K_{ferm}\frac{f_{xa}}{N}\frac{MX_{BH}}{Q_i}\frac{1}{1+r}\right\}^n}$$

want $n = N = 3$ so then S_{bsfN} is the FBSO conc exiting 3rd (last) cmpt.

$$S_{bsfN3} = \frac{115/(1+1)}{\left\{1 + K_{ferm}\frac{0.15}{3}\frac{MX_{BH}}{Q_i}\frac{1}{1+1}\right\}^3} \quad (1)$$

$$K_{fermT} = K_{ferm20}(1.029)^{T-20}$$
$$= 0.06(1.029)^{16-20}$$
$$= 0.0535 \text{ l/(mgOHOVSS.d)}$$

$$MX_{BH} = FS_{bOHO}\frac{Y_{HV}R_s}{1+b_{OHT}R_s} \text{ — } 1.603$$

$$\frac{MX_{BH}}{Q_i} = S_{bOHO}\frac{Y_{HV}R_s}{1+b_{OHT}R_s}$$

$$S_{bsHO} = S_{bi} - \underbrace{\{VFA + \underbrace{(S'_{bsfi} - S_{bsfN})(1+r)}_{\text{COD to PAO}}\}}_{\text{COD to OHO}}$$

$$\frac{MX_{BH}}{Q_i} = \underbrace{1.603}_{\frac{Y_{HV}R_S}{1+b_{HT}R_S}} \left\{S_{bi} - (VFA + S'_{bsfi} - (1+r)S_{bsfN})\right\} \quad ②$$

Trial	S_{bsfN}	Eq 2 MX_{BH}/Q_i	Eq 1 S_{bsfN}
1	0	409	15.53
2	15.53	459	13.69
3	13.69	453	13.89
4	13.89	453	13.87

Flux COD to OHO FS_{bsHO} =
$$Q_i\left[420 - \{50 + 115 - 2 \times 13.87\}\right]$$
$$= 7034 \text{ kg COD/d}$$

Flux COD to PAO $= Q_i\{50 + 115 - 2 \times 13.87\}$
$$= 3413 \text{ kg COD/d}$$

FS_{bi} = Bio COD flux $= 7034 + 3413 = 10447$ kg COD/d

3/17h45 NL

4.2 $MX_{BH} = FS_{bsHO} \underbrace{1.603}_{\frac{Y_{HV}R_S}{1+b_{HT}R_S}}$
$$= 7034 \times 1.603 = 11276 \text{ kg VSS}$$

$$MX_{E,OHO} = f_H b_{HT} R_S MX_{BH}$$
$$= 0.20 \times 0.214 \times 15 \times 11276$$
$$= 7241 \text{ kg VSS}$$

$$MX_{PAO} = MX_{BG} = \frac{Y_{PAO} R_S}{1 + b_{PAO} R_S} FS_{bPAO}$$

$$= \frac{0.45 \times 15}{1 + b_{PAO} 15}$$

$$b_{GT} = b_{G20} (1.029)^{T-20}$$

$$= 0.04 (1.029)^{16-20}$$

$$= 0.036 /d$$

$$= 3413 \times \underbrace{\frac{0.45 \times 15}{1+0.036 \times 15}}_{4.397} = 15008 \text{ kg VSS.}$$

$$MX_{E,PAO} = f_G \, b_{GT} \, R_S \, MX_{PAO}$$

$$= 0.25 \times 0.036 \times 15 \times 15008$$

$$= 2008 \text{ kgVSS.}$$

MX_I (UPO) same as MLE $= FX_{Ti} R_S$
$= 2519$ kg VSS.

$$MX_V (VSS) = MX_{BH} + MX_{E,OHO} + MX_{PAO} + MX_{E,PAO} + MX_I$$

$$= 11276 + 7221 + 15008 + 2008 + 2519$$

$$= 38052 \text{ kg VSS} \quad (\text{MLE } 30021 \text{ kg VSS})$$

So PAO produce more sludge but less O_2 due to slow End Resp Rate b_G!

4.3 P removal = P removed by PAO + P removed by the rest of the VSS wasted.

$$= f_P \frac{MX_V}{R_S Q_i}$$

no large 0.025!

$$P_{removal} = \frac{\underbrace{(0.355}_{\text{maximum polyP content of PAO}}+\underbrace{0.025)}_{\text{normal P content of PAO.}} MX_{PAO} + 0.025(MX_V - MX_{PAO})}{R_S Q_i}$$

$$= \frac{\underbrace{0.355\, MX_{PAO}}_{\text{PolyP}} + \underbrace{0.025\, MX_V}_{\text{"normal P"}}}{R_S Q_i}$$

$$= \frac{0.355 \times 15008 + 0.025 \times 38052}{15 \times 24.875}$$

$= 16.8$ mgP/l But influent $P = 9.6$ mgP/l

TP $\boxed{9.6}$

OP	FBSO	USO
$\boxed{7.28}$	$\boxed{0.96}$	$\boxed{0}$
	$\boxed{1.19}$ BPO	$\boxed{0.17}$ UPO ← included in X_I USS.

become OP in utilizing

P available for uptake by PAO of OHO

$= P_{ti} - P_{ouse} = 9.6 - 0$

$$\underset{9.6}{P_{ti} - P_{ocesi}} = \frac{\overbrace{(\text{PolyP in PAO})}^{?\ \to\ f_{PP,PAO}} MX_{PAO} + 0.025\, MX_V}{R_S Q_i}$$

$$f_{PP,PAO} = \frac{Q_i R_S (P_{ti} - P_{ocesi}) - 0.025\, MX_V}{MX_{PAO}}$$

$$f_{PP,PAO} \ \frac{g\,PolyP-P}{g\,PAO\,VSS} = \frac{15 \times 24.875 \times (9.6-0) - 0.025 \times 33052}{15008}$$

$$= 0.175$$

So total P content of PAO = PolyP + biomass P
$= 0.175 + 0.025$
$= 0.200$ gP/g PAO VSS.

Q4.4 @ Effluent TP = 0 $P_{OUSi} = 0$
$P_{Si}(OP) = 0$.

$$FO_{cOHO} = FS_{bOHO}\left\{(1-f_{cv}Y_{HV}) + f_{cv}(1-f_H)\,b_{HT} \times \frac{Y_{HV}R_s}{1+b_{HT}R_s}\right\}$$

$$= 17034\{0.334 + 1.481 \times 0.8 \times 0.214 \times 1.603\}$$

$$= 5206 \text{ kgO/d}$$

$$FO_{cPAO} = FS_{bPAO}\left\{(1-f_{cv}Y_{GV}) + f_{cv}(1-f_{G})\,b_{GT} \times \frac{Y_{GV}R_s}{1+b_{GT}R_s}\right\}$$

0.25

$$= 3413\{0.334 + 1.481 \times 0.75 \times 0.036 \times 4.397\}$$

$$= 1733 \text{ kgO/d}$$

$$FO_c = FO_{cOHO} + FO_{cPAO} = 5206 + 1733$$

$$= 6939 \text{ kgO/d}$$

(NDLE FO_c was 7732 kgO/d!)

$$b_{PAO} = \frac{1}{6} b_{OHO} = \frac{0.04}{0.24} \text{ at } 20°C$$

4.5 COD Balance

$FX_v = \frac{MX_v}{R_s}$ kg VSS/d

$FS_{ti} = Q_i S_{ti} = 24.875 \times 475$
$= 11816$ kg COD/d

Flux dissolved COD in $Q_w + Q_e$ $(= Q_i)$
$= Q_i S_{te} = 24.875 \times 45$
$= 1119$ kg COD/d

Flux in waste flow particulates
$= f_{cv} MX_v / R_s = 1.48 \; \frac{38052}{15}$
$= 3757$ kg COD/d

$FO_c = 6939$ kgO/d

Total COD out $= 1119 + 3757 + 6939$
$= 11816$ kg COD/d

So COD out = COD in $\therefore$ COD balanced

Calculations correct up to here!

3/12h30 AL