OXYGEN REQUIREMENTS

$$R_0 = \underbrace{Q \cdot \{[(bCOD)_{in} - (bCOD)_{out}]}_{\text{substrate (Heterotrophs)}} + \overset{\text{O.D. Ammonia}}{4.33}[(NH_4^{\oplus})_{in} - \underbrace{(NH_4^{\oplus})_{out}}_{\text{substrate (Autotrophs)}}]\} - 1.42 \cdot P_{x,bio}$$

Q: FLOW RATE

1.42: O.D. $C_5H_7NO_2$

$P_{x,bio}$: SLUDGE PRODUCTION

[7-61]

$$R_0 = \boxed{Q(S_0 - S)} - \boxed{1.42 \cdot P_{x,bio}}$$

$$P_{x,bio} = \left(\text{DAILY SLUDGE PRODUCTION}\right) = \left[\frac{mass_{C_5H_7NO_2}}{time}\right] = \overset{(A)}{\boxed{\text{SLUDGE PRODUCTION HETEROTROPHS}}} + \overset{(C)}{\boxed{\text{S.P. AUTOTROPHS}}}$$

(10% total → DEBRIS)

$$\underline{\text{LOAD}} \quad Q \cdot \Delta bCOD \xrightarrow[\text{RESPIRATION}]{(1-Y)} CO_2 \xleftarrow{} O_2$$

$$Q \cdot \Delta bCOD \xrightarrow[\text{SYNTHESIS}]{(Y)} C_5H_7NO_2 \text{ (BIOMASS)}$$

$$\text{YIELD} = \frac{\text{SLUDGE PRODUCTION}}{\text{LOAD APPLIED}} = \frac{mass_{VSS}}{mass_{bCOD}}$$

VSS ← $C_5H_7NO_2$

$$P_{x,H} = (A) = \frac{Y_H \quad Q \cdot \Delta bCOD}{1 + k_{D_H} \cdot MCRT}$$

Y_{OBS_H}

k_{D_H}: DECAY CONSTANT $\left[\frac{1}{t}\right]$ — b_H] Book

$MCRT$: mean cell retention time (sludge age) [d] — SRT] Book

$$P_{x,A} = \underbrace{\frac{Y_A \quad Q \cdot \Delta NH_4^{+}}{1 + kd_A \cdot MCRT}}_{Y_{obs_A}}$$

kd_A: $kd_{,N}$ or b_A or b_N

$$\boxed{P_{x,bio} = \underbrace{\frac{Y_H \quad Q \cdot \Delta bCOD}{1 + kd_H \cdot MCRT}}_{(A)} + \underbrace{\frac{Y_A \quad Q \cdot \cancel{bCOD}\ \Delta NH_4^{+}}{1 + kd_A \cdot MCRT}}_{(C)} + \underbrace{\overbrace{\left[(A) + (C)\right] \cdot 10\%}^{\text{Debris}}}_{(B)} = \left[\frac{kg_{VSS}}{d}\right]}$$

DATA

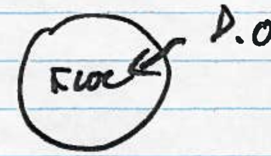
✓ R_0 = calculated

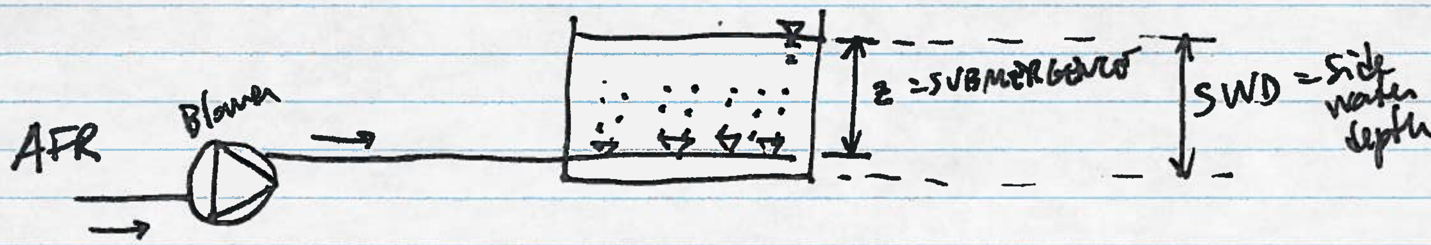
safety Factor

↓

✓ $OTR_{DESIRED} := 1.5 \cdot R_0$

$\left[\frac{mass_{O_2}}{time}\right] \Rightarrow \left[\frac{kg_{O_2}}{h}\right]$ or $\left[\frac{kg_{O_2}}{d}\right]$

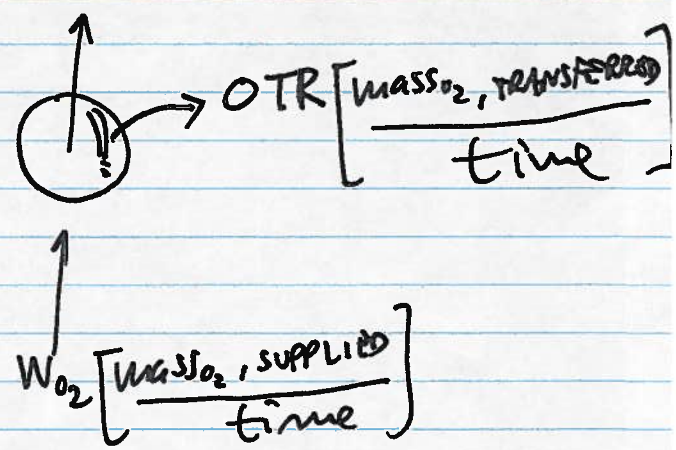




$$AFR \cdot \rho_{AIR} \cdot \overset{0.23}{\hat{y}_{O_2}} = W_{O_2}$$

$$\left[\frac{\cancel{vol_{AIR}}}{t}\right] \left[\frac{\cancel{mass_{AIR}}}{\cancel{vol_{AIR}}}\right] \left[\frac{mass_{O_2}}{\cancel{mass_{AIR}}}\right] \quad \left[\frac{mass_{O_2,\ SUPPLIED}}{time}\right]$$

$W_{O_2} >> OTR_{desired}$



$$\frac{OTR}{W_{O_2}} = [\%] = \boxed{OTE}$$

O_2 TRANSFER EFFICIENCY

@ STD CONDITIONS

1 atm

20°C

Ø salinity

Ø D.O.

OTE → SOTE

↳ FINE-PORE DIFFUSERS

~ 2%/ft SUBMERGENCE

CLEAN WATER — PROCESS WATER (WW)

SOTE — α SOTE

$$\frac{\alpha\,SOTE}{SOTE} = \alpha = \frac{SOTE(WW)}{SOTE(CW)}$$

SOTE(WW) ← measured in WW

SOTE(CW) ← measured in CW

$$\frac{OTR}{W_{O_2}} = OTE \quad \longleftrightarrow \quad \boxed{W_{O_2} = \frac{OTR}{OTE}} = \frac{\alpha SOTR}{\alpha SOTE} = \frac{\alpha F SOTR}{\alpha F SOTE}$$

W_{O_2} ← Blower

αF ← Fouling Factor

$$1.5R_0 \sim \alpha S OTR = \alpha S OTE \cdot W_{O_2}$$

$\alpha SOTR$ ← Product; $\alpha SOTE$ ← η; W_{O_2} ← feed

Given by R_0 calculation

unknown

SOTE → 2%/ft CW

α → 0.2–0.7

0.2–0.5 bCOD removal only

0.4–0.7 NDN

αSOTE ~1%/ft WW

Q, bCOD, NH4, $P_{X,bio}$ → $1.5R_0$

Blower size → AFR

$$AFR = \frac{W_{O_2}}{\rho_{AIR} \cdot \hat{y}_{O_2}} = \boxed{\frac{\alpha SOTR}{\alpha SOTE} \cdot \frac{1}{\rho_{AIR} \cdot \hat{y}_{O_2}}}$$

BLOWER POWER

[4th, 5-56a]

[5th, 5-77a]

$$\left[\frac{\text{MASS}_{AIR,SUPPLIED}}{t}\right] = AFR \cdot \rho_{AIR}$$

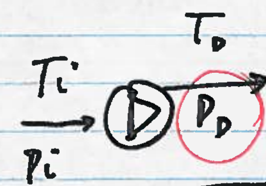
$8.314\ J/mol \cdot K$

$$BHP = \frac{W_{AIR} \cdot R \cdot T_i}{28.97 \cdot \eta \cdot \gamma}\left[\left(\frac{P_D}{P_i}\right)^{\gamma} - 1\right]$$

η: (0.7–0.9)

$\gamma = 0.283$ AIR

BREAK HORSE POWER [kW]



$$\boxed{P_D > Z + h_L + DWP \cdot \Psi}$$

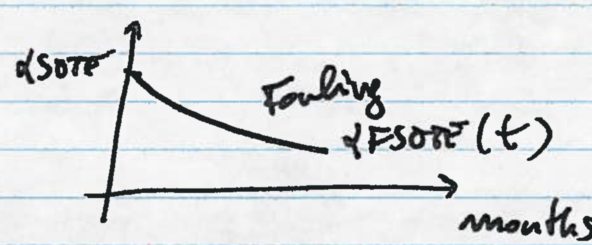
subergence

line h_L

$$BHP \sim \left(\frac{OTR}{OTE}, \frac{1}{\alpha}, \frac{1}{SOTE}, \frac{1}{F}\Psi\right)$$

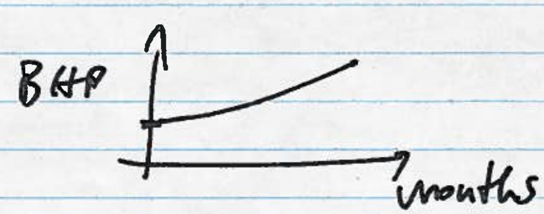
] → DESIRED O_2 TRANSFER

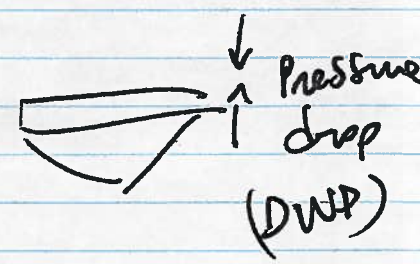
] → COMBINED EFFICIENCY

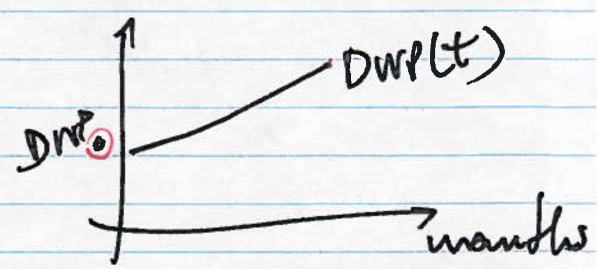


$$\frac{\alpha FSOTE(t)}{\alpha SOTE(t=0)} = \text{Fouling factor} = F$$

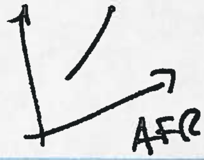
@ CONST OTR



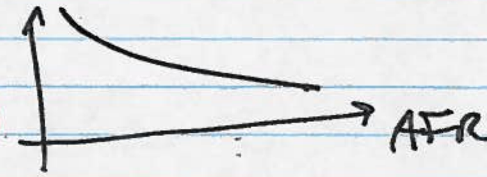




Pressure Factor = $\Psi = \frac{DWP(t)}{DWP_0}$



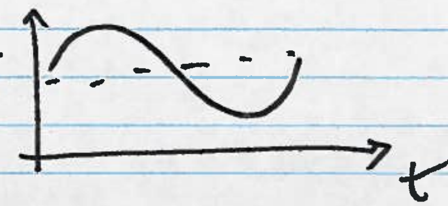
BHP DYNAMICS

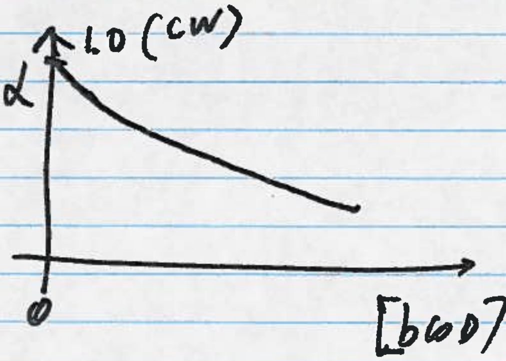


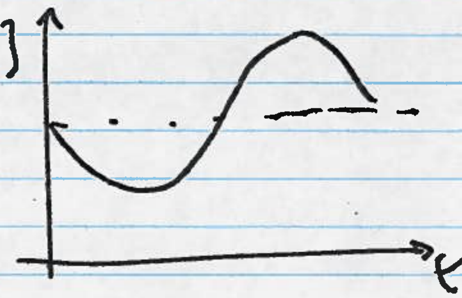
$$BHP \sim \left(\frac{1}{\alpha F SOTE} , \Psi \right)$$

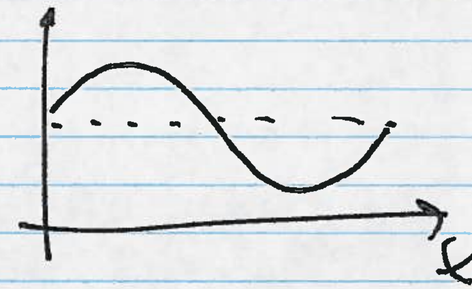
MONTHLY TO YEARLY

DIURNAL

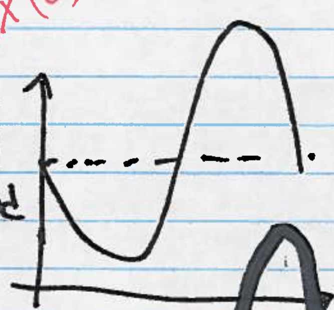


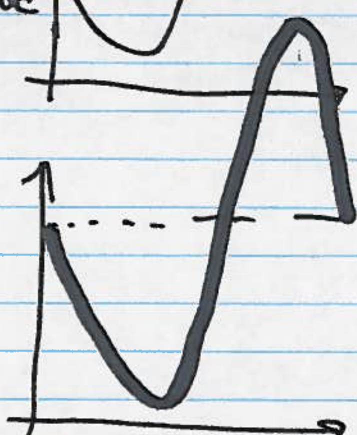


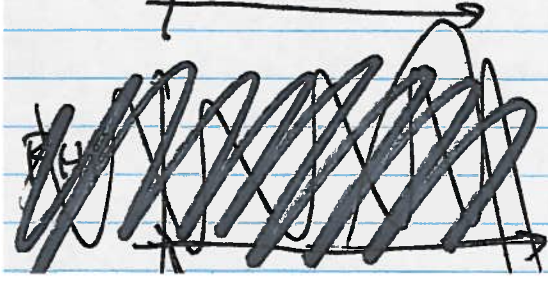


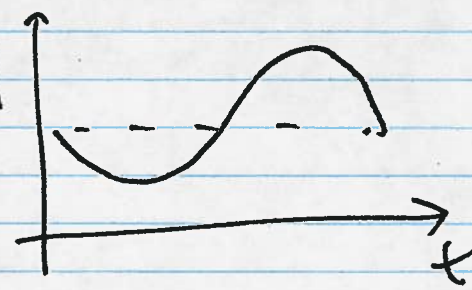


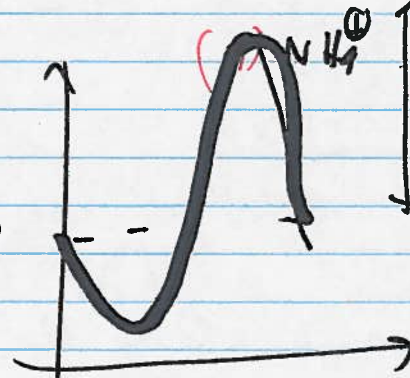
$$AFR \sim \frac{OTR^{(4)}}{\alpha SOTE^{(5)} \times (6)}$$

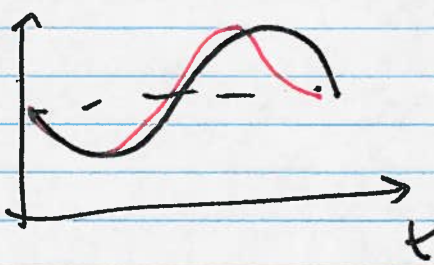


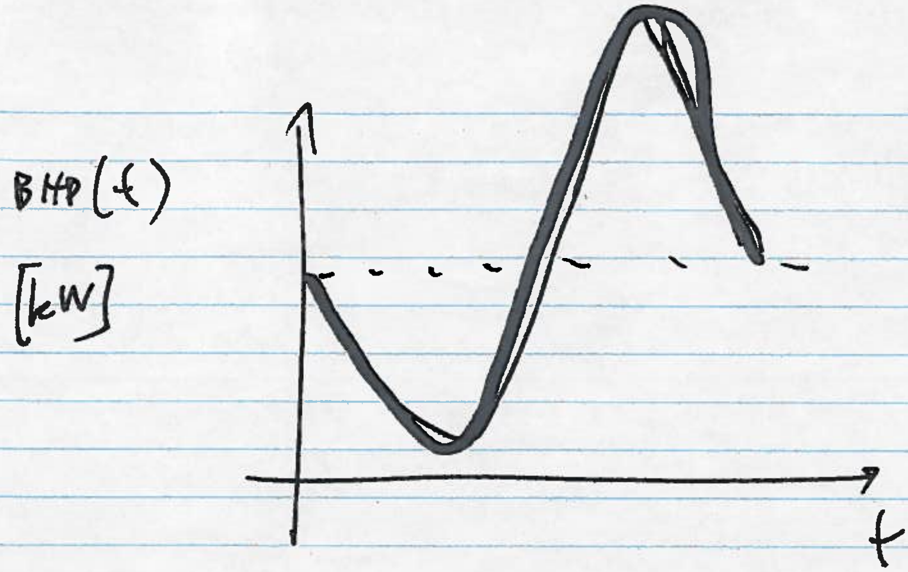


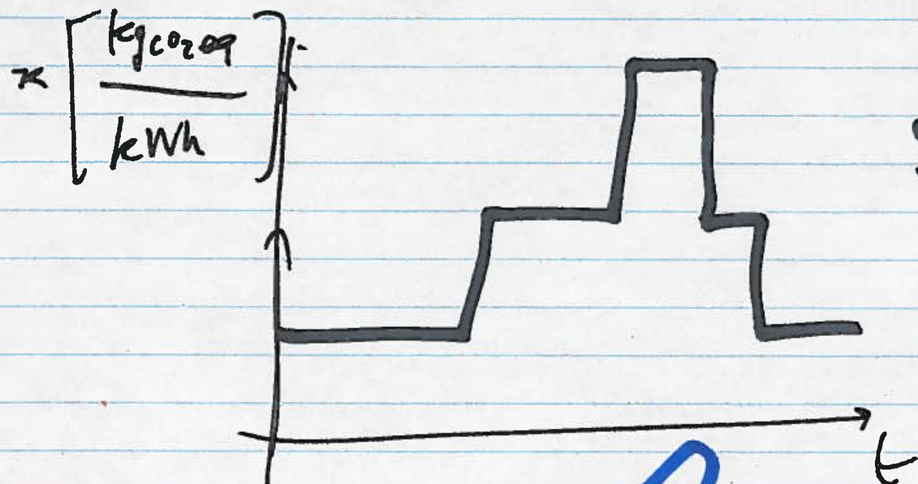












Socal