AIR CALCULATIONS

SUB: AIR CALCULATIONS

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$$OU_C = f_{BOD} = 0.56 + \frac{0.2 Y_H F_T \theta_{CT}}{1 + b_H F_T \theta_{CT}} \{ATV 2000$$

$f_{BOD} = OU_C = 0.5 + 0.144\ \theta_{CT}/(1+0.08\ \theta_{CT})$

$= (1 - Y_{obsH}) + 1.42 b_H Y_{obsH} \theta_{CT}\ \{ATV'91$

↓

$OU_c > 1.6$

NO: $OU_c = OU_c$

YES: $OU_c = 1.6$

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OUR_C = Q * BOD_0 corrected * OU_C

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$f_c = 0.1072 \ln \theta_{CT} + 1.441$

$f_N = -0.7887 \ln \theta_{CT} + 3.6306$

AOR,kg/d= $\mathbf{f_C}[OUR_C - 2.9 * N_{DN}] + \mathbf{f_N} * 4.3\ N_N$

2.83 N_{DN}, ATV 2000

4.57 N_N, ATV 2000

$\alpha = 0.3 + 0.0148 * \theta_{CT} * 1.057^{tC-20}$ -------- Emprical α eq'n

Pöpel ------------------ $\alpha = 1 - 0.16(MLSS)^{2/3}$

$\alpha' = \alpha\ (1.024)^{tC-20}$

$\beta = 0.95$

Or choose α (eq α = 0.6)

$$\alpha = \frac{(K_L a)\ wastewater}{(K_L a)\ clean\ water}$$

$$\beta = \frac{Cs\ clean\ water}{Cs\ wastewater}$$

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Relative pressure at Alt, H_{in} meters

$$\frac{P_a}{P_b} = \exp\left[-\frac{gM(z_b - z_a}{RT}\right]$$

$$\frac{P_a}{P_b} = \exp\left[-\frac{(9.81)(28.97)(H)}{8314(273.15+T)}\right]$$

$$\frac{P_a}{P_b} = \exp\left(-\frac{(0.034183H)}{273.15+T}\right)$$

$C_{S,T,sea} = 2x10^{-11}\ T^6 - 2x10^{-8}\ T^5 + 3x10^{-6}\ T^4 - 2x10^{-4}\ T^3 + 9.8x10^3\ T^2 - 0.4147\ T + 14.622$

$C_{S,T,Alt} = C_{S\ T\ sea} * P_a/P_b$

$$P_{atm,Alt} = \frac{P_a}{P_b} * 10.3372$$

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Eqn 5-55 M&E (2000)

Pd = Patm, Alt + Diff Depth

$$C_{S,T,Alt,av} = C_{S,T,Alt}\,\frac{1}{2}\left(\frac{P_d}{P_{atm,Alt}} + \frac{Ot}{21}\right)$$

Ot = (18-19) % O_2 in air leaving tank

$C_{S,20,sea}$=9.07 mg/L

$$CF = \frac{SOR}{AOR} = \frac{9.07}{F\alpha''(\beta C_{S,T,Alt,av} - DO)}$$

DO = 2.0 mg/L

F = Fouling factor

SOR= AOR * CF

$$Air\ Density = P_a = \frac{PM}{RT} = \frac{\left(\frac{P_a}{P_b}\right)(1.01325x10^5\,N/m^2)(28.97\,kg/kgmole}{8314\,\frac{N-m}{kgmole.K}(273.15+T)}$$

$Q_{air,\ m3/d}$ = SOR / (1.201 kg/m^3 * 0.2318 kgO_2/kg air * %SOTE);

0.2786 kgO_2/m^{3}air

SOTE= Oxygen mass absorbed/Oxygen mass app (Flyght %SOTE=30% for Membran diffusers)

AIR - Miscelleneous

$C_{S20\ sea}$ = DO Saturation concentration at sea level at 20°C = 9.07mg/L

$C_{S20\ Depth}$ = DO Saturation concentration at diffuser depth =

$$(8.872 + 0.385728 * \text{Diffuser Depth})\ .\ \frac{C_{S,T,Alt}}{9.07} = \left[\frac{8.872 + Diff\ \ Depth/2.593}{9.07}\right](C_{S,T,Alt})$$

Diffuser Depth = Water Depth – 0.25m

$C_{S\ T\ sea}$ = DO Saturation concentration at sea level at field temperature

Air = 20.95 % O2 by vol
Wt % of O2 in air =0.2095*32/28.97=20.95 * Mol Wt of O2/ Mol Wt of Air = 0.2318

Definitions

% SOTE = Mass of O2 Absorbed/Mass of O2 Applied = 25-40% (for ceramic disks)
& 22-29% (for perforated membran tubes)
spOxygen Absorption (Pöpel) = spOA= gO2/m3 air/m diff submergence

$$spOA = 20\frac{grO_2}{Nm^3 air\ x\ m};\ \ \begin{matrix}\% SOTE\\ @5m\end{matrix} = \frac{20 grO_2/Nm^3 air/mx(5m)}{298\frac{grO_2}{m^3 air}} = 33\% \left\{\begin{matrix}\text{for } S_pOA = 15\frac{grO_2}{m^3 xm}\\ \text{SOTE = 25 \%}\end{matrix}\right.$$

$$SpOTE(\%/m) = \frac{20\frac{grO_2}{Nm^3 air\ x\ m}}{1.201 kg/m^3\ x\ 231.8\frac{gO_2}{kg\,air}} \Rightarrow (7.18)\%/m$$

$$S_pOTE,\%/m = 9.00 - 8.63x10^{-4}(MLSS) + 2.56x10^{-8}(MLSS)^2$$

$$Flyght\ SpOTE/m = 0.8211\ln\left(\frac{m^3 air/h}{dist}\right)\Big\}\ \text{for q'' diffusers} + 5.9256$$

@ X = 3000 mg/L, → %/m = 6.64

$$\frac{6.64}{100}x1.201\frac{kgair}{m^3}x232\frac{gO_2}{kgair} = 18.5\frac{grO_2}{m^3 AirX_m}$$

$$Air = \frac{Nm^3}{h}\left(\frac{760}{P_{atm,Alt}}\right)\underbrace{\left(\frac{273+50^oC}{273+20}\right)}_{1.1}$$

MISCELLENEOUS

Alkalinity

Bicarb. Alk = $C^{''}H = 2.8(SK - \frac{NH_4No}{14}$

SK = Acid capacity

1 mg/L bio P removal $\rightarrow$ 3 mg/L MLSS as Px

Emprical Formula for stable sludge

ATV 2000,

$$\theta_{C_{stable}} = 25.0\,(1.072)^{12-T}$$

Kruger,

$$\theta_{C_{stable}} = 25.39 \cdot e^{-0.042t}$$

Primary Sludge Production

% Removals in Primary Sedimentation				With metal salts
t,h	0.5	1.0	2.0	> 1
BOD_5	20%	25%	30%	40-70
org N	20	25	30	25-40
P	10	15	25	50-90
TSS	40	50	60	60-80