Complete-mix Activated Sludge Design by Monod Kinetics

Effluent soluble COD, aeration time for a target MLVSS, sludge production as VSS and TSS, biomass fraction, observed yield and oxygen demand at a chosen SRT.

Input parameters

Unit system: SI

Parameter	Value	Unit
Flow	2,000.0	m³/d
Influent biodegradable soluble COD	250.00	mg/L
Influent non-biodegradable VSS	40.000	mg/L
Influent inert inorganic solids	15.000	mg/L
Solids retention time	20.000	d
Target MLVSS	3,500.0	mg/L
Maximum substrate utilisation rate (g COD/g VSS·d)	12.500	
Half-velocity constant	10.000	mg/L
Yield (g VSS/g COD)	0.40000	
Endogenous decay (1/d)	0.10000	
Fraction of biomass left as cell debris	15.000	%
Biomass VSS/TSS ratio	85.000	%

Calculated results

Parameter	Value	Unit
Effluent soluble COD	0.30928	mg/L
Aeration time	11.421	h
Aeration volume	951.77	m³
Sludge production as VSS	166.56	kg/d
Sludge production as TSS	211.83	kg/d
Active biomass fraction of the MLVSS	0.39976	
Observed yield, g VSS/g COD	0.33353	
Observed yield, g TSS/g COD	0.42419	
Oxygen required	376.47	kg/d

Notes for this case

- Complete-mix reactor with recycle; the influent biodegradable particulate COD is taken as part of the soluble COD (valid for SRT of 3 d or more). Nitrification is not included in the oxygen demand. Kinetic coefficients are at the design temperature.

Formula and method

$$S = \frac{K_s(1 + b\,SRT)}{SRT(Yk - b) - 1}, \quad X_T\tau = \frac{Y(S_o - S)SRT}{1 + b\,SRT}(1 + f_d b\,SRT) + X_{o,i}SRT$$

$$P_{X,VSS} = \frac{X_T V}{SRT}, \quad R_o = Q(S_o - S) - 1.42P_{X,bio}$$

Variables

Q	Flow	m³/s

S_o	Influent biodegradable soluble COD	kg/m³
$X_{o,i}$	Influent non-biodegradable VSS	kg/m³
$TSS_o - VSS_o$	Influent inert inorganic solids	kg/m³
SRT	Solids retention time	s
X_T	Target MLVSS	kg/m³
k	Maximum substrate utilisation rate (g COD/g VSS·d)	-
K_s	Half-velocity constant	kg/m³
Y	Yield (g VSS/g COD)	-
b	Endogenous decay (1/d)	-
f_d	Fraction of biomass left as cell debris	-
VSS/TSS	Biomass VSS/TSS ratio	-
S	Effluent soluble COD	kg/m³
τ	Aeration time	s
V	Aeration volume	m³
$P_{X,VSS}$	Sludge production as VSS	kg/s
$P_{X,TSS}$	Sludge production as TSS	kg/s
X/X_T	Active biomass fraction of the MLVSS	-
Y_{obs}	Observed yield, g VSS/g COD	-
$Y_{obs,TSS}$	Observed yield, g TSS/g COD	-
R_o	Oxygen required	kg/s

Method and standards

Monod-kinetics design of complete-mix suspended growth.

Assumptions and limits

- Steady state; complete mix; no nitrification.

Report details

Report reference	FCC-W2FP-75HY (the same inputs always give the same reference)
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Calculator	Complete-mix Activated Sludge Design by Monod Kinetics
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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/environmental/wastewater/activated-sludge-complete-mix-design

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Reopens the calculator with the inputs of this report.