Important Substrate Concentration Formulas PDF

Formulas
Examples
with Units

List of 11
Important Substrate Concentration Formulas

1) Concentration of Solids Formulas

1.1) Concentration of Sludge in Return Line given RAS Pumping Rate from Aeration Tank Formula

Evaluate Formula

Formula

$$X_r = X \cdot \frac{Q_a + RAS}{RAS + Q_w'}$$

Example with Units

$$32.7805\,\text{mg/L} = 1200\,\text{mg/L} \cdot \frac{1.2\,\text{m}^3\text{/d} + 10\,\text{m}^3\text{/d}}{10\,\text{m}^3\text{/d} + 400\,\text{m}^3\text{/d}}$$

1.2) Concentration of Sludge in Return Line given Wasting Rate from Return Line Formula

Evaluate Formula

Formula

$$X_r = \left(V \cdot \frac{X}{\theta_c \cdot Q_w'}\right) - \left(Q_e \cdot \frac{X_e}{Q_w'}\right)$$

Example with Units

$$199.9999\,\text{mg/L} = \left(1000\,\text{m}^3 \cdot \frac{1200\,\text{mg/L}}{7\,\text{d} \cdot 400\,\text{m}^3\text{/d}}\right) - \left(1523.81\,\text{m}^3\text{/d} \cdot \frac{60\,\text{mg/L}}{400\,\text{m}^3\text{/d}}\right)$$

1.3) Concentration of Solids in Effluent given Wasting Rate from Return Line Formula

Evaluate Formula

Formula

$$X_e = \left(V \cdot \frac{X}{\theta_c \cdot Q_e}\right) - \left(Q_w' \cdot \frac{X_r}{Q_e}\right)$$

Example with Units

$$60\,\text{mg/L} = \left(1000\,\text{m}^3 \cdot \frac{1200\,\text{mg/L}}{7\,\text{d} \cdot 1523.81\,\text{m}^3\text{/d}}\right) - \left(400\,\text{m}^3\text{/d} \cdot \frac{200\,\text{mg/L}}{1523.81\,\text{m}^3\text{/d}}\right)$$

2) Effluent Substrate Concentration Formulas

2.1) Effluent Flow Rate given Wasting Rate from Return Line Formula

Evaluate Formula

Formula

$$Q_e = \left(V \cdot \frac{X}{\theta_c \cdot X_e} \right) - \left(Q_w' \cdot \frac{X_r}{X_e} \right)$$

Example with Units

$$1523.8095\,\text{m}^3/\text{d} = \left(1000\,\text{m}^3 \cdot \frac{1200\,\text{mg/L}}{7\,\text{d} \cdot 60\,\text{mg/L}} \right) - \left(400\,\text{m}^3/\text{d} \cdot \frac{200\,\text{mg/L}}{60\,\text{mg/L}} \right)$$

2.2) Effluent Substrate Concentration given Net Waste Activated Sludge Formula

Evaluate Formula

Formula

$$S = S_o - \left(\frac{P_x}{Y_{obs} \cdot Q_a \cdot 8.34} \right)$$

Example with Units

$$24.9975\,\text{mg/L} = 25\,\text{mg/L} - \left(\frac{20\,\text{mg/d}}{0.8 \cdot 1.2\,\text{m}^3/\text{d} \cdot 8.34} \right)$$

2.3) Effluent Substrate Concentration given Theoretical Oxygen Requirement Formula

Evaluate Formula

Formula

$$S = S_o - \left(\left(O_2 + \left(1.42 \cdot P_x \right) \right) \cdot \left(\frac{f}{8.34 \cdot Q_a} \right) \right)$$

Example with Units

$$24.9979\,\text{mg/L} = 25\,\text{mg/L} - \left(\left(2.5\,\text{mg/d} + \left(1.42 \cdot 20\,\text{mg/d} \right) \right) \cdot \left(\frac{0.68}{8.34 \cdot 1.2\,\text{m}^3/\text{d}} \right) \right)$$

2.4) Effluent Substrate Concentration given Volume of Reactor Formula

Evaluate Formula

Formula

$$S = S_o - \left(\frac{V \cdot X_a \cdot \left(1 + \left(k_d \cdot \theta_c \right) \right)}{\theta_c \cdot Q_a \cdot Y} \right)$$

Example with Units

$$15.6994\,\text{mg/L} = 25\,\text{mg/L} - \left(\frac{1000\,\text{m}^3 \cdot 2500\,\text{mg/L} \cdot \left(1 + \left(0.050\,\text{d}^{-1} \cdot 7\,\text{d} \right) \right)}{7\,\text{d} \cdot 1.2\,\text{m}^3/\text{d} \cdot 0.5} \right)$$

3) Influent Substrate Concentration Formulas

3.1) Influent Substrate Concentration for Organic Loading using Hydraulic Retention Time Formula

Evaluate Formula

Formula

$$S_o = V_L \cdot \theta_s$$

Example with Units

$$9.84\,\text{mg/L} = 1.23\,\text{mg/L} \cdot 8\,\text{s}$$

3.2) Influent Substrate Concentration given Net Waste Activated Sludge Formula

Evaluate Formula

Formula

$$S_o = \left(\frac{P_x}{8.34 \cdot Y_{obs} \cdot Q_a}\right) + S$$

Example with Units

$$15.0025\,\text{mg/L} = \left(\frac{20\,\text{mg/d}}{8.34 \cdot 0.8 \cdot 1.2\,\text{m}^3\text{/d}}\right) + 15\,\text{mg/L}$$

3.3) Influent Substrate Concentration given Organic Loading Formula

Evaluate Formula

Formula

$$S_o = V_L \cdot \frac{V}{Q_i}$$

Example with Units

$$25.102\,\text{mg/L} = 1.23\,\text{mg/L} \cdot \frac{1000\,\text{m}^3}{49\,\text{m}^3\text{/s}}$$

3.4) Influent Substrate Concentration given Theoretical Oxygen Requirement Formula

Evaluate Formula

Formula

$$S_o = \left(O_2 + \left(1.42 \cdot P_x\right)\right) \cdot \left(\frac{f}{8.34 \cdot Q_a}\right) + S$$

Example with Units

$$15.0021\,\text{mg/L} = \left(2.5\,\text{mg/d} + \left(1.42 \cdot 20\,\text{mg/d}\right)\right) \cdot \left(\frac{0.68}{8.34 \cdot 1.2\,\text{m}^3\text{/d}}\right) + 15\,\text{mg/L}$$

Variables used in list of Substrate Concentration Formulas above

- **f** BOD Conversion Factor
- k_d Endogenous Decay Coefficient *(1 Per Day)*
- O_2 Theoretical Oxygen Requirement *(Milligram per Day)*
- P_x Net Waste Activated Sludge *(Milligram per Day)*
- Q_a Average Daily Influent Flow Rate *(Cubic Meter per Day)*
- Q_e Effluent Flow Rate *(Cubic Meter per Day)*
- Q_i Influent Average Flow Rate *(Cubic Meter per Second)*
- Q_w' WAS Pumping Rate from Return Line *(Cubic Meter per Day)*
- **RAS** Return Activated Sludge *(Cubic Meter per Day)*
- **S** Effluent Substrate Concentration *(Milligram per Liter)*
- S_o Influent Substrate Concentration *(Milligram per Liter)*
- **V** Reactor Volume *(Cubic Meter)*
- V_L Organic Loading *(Milligram per Liter)*
- **X** MLSS *(Milligram per Liter)*
- X_a MLVSS *(Milligram per Liter)*
- X_e Solid Concentration in Effluent *(Milligram per Liter)*
- X_r Sludge Concentration in Return Line *(Milligram per Liter)*
- **Y** Maximum Yield Coefficient
- Y_{obs} Observed Cell Yield
- θ_c Mean Cell Residence Time *(Day)*
- θ_s Hydraulic Retention Time in Seconds *(Second)*

Constants, Functions, Measurements used in list of Substrate Concentration Formulas above

- Measurement: **Time** in Day (d), Second (s)
  Time Unit Conversion
- Measurement: **Volume** in Cubic Meter (m^3)
  Volume Unit Conversion
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Day (m^3/d), Cubic Meter per Second (m^3/s)
  Volumetric Flow Rate Unit Conversion
- Measurement: **Mass Flow Rate** in Milligram per Day (mg/d)
  Mass Flow Rate Unit Conversion
- Measurement: **Density** in Milligram per Liter (mg/L)
  Density Unit Conversion
- Measurement: **First Order Reaction Rate Constant** in 1 Per Day (d^{-1})
  First Order Reaction Rate Constant Unit Conversion

Download other Important Design of a Complete Mix Activated Sludge Reactor PDFs

- Important Pumping Rate Formulas
- Important Substrate Concentration Formulas

Try our Unique Visual Calculators

- Percentage increase
- HCF calculator
- Mixed fraction

Please SHARE this PDF with someone who needs it!

This PDF can be downloaded in these languages

English Spanish French German Russian Italian Portuguese Polish Dutch

9/18/2024 | 12:16:29 PM UTC