Important Pumping Rate Formulas PDF

Formulas
Examples
with Units

List of 11
Important Pumping Rate Formulas

1) Average Daily Influent Flow Rate Formulas

1.1) Average Daily Influent Flow Rate given Net Waste Activated Sludge Formula

Evaluate Formula

Formula

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

Example with Units

$$0.0003\,\text{m}^3\text{/d} = \frac{20\,\text{mg/d}}{8.34 \cdot 0.8 \cdot \left(25\,\text{mg/L} - 15\,\text{mg/L} \right)}$$

1.2) Average Daily Influent Flow Rate given Theoretical Oxygen Requirement Formula

Evaluate Formula

Formula

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

Example with Units

$$0.0003\,\text{m}^3\text{/d} = \left(2.5\,\text{mg/d} + \left(1.42 \cdot 20\,\text{mg/d} \right) \right) \cdot \left(\frac{0.68}{8.34 \cdot \left(25\,\text{mg/L} - 15\,\text{mg/L} \right)} \right)$$

1.3) Average Daily Influent Flow Rate using Recirculation Ratio Formula

Evaluate Formula

Formula

$$Q_a = \frac{RAS}{\alpha}$$

Example with Units

$$1.2048\,\text{m}^3\text{/d} = \frac{10\,\text{m}^3\text{/d}}{8.3}$$

2) RAS Pumping Rate Formulas

2.1) RAS Pumping Rate from Aeration Tank Formula

Evaluate Formula

Formula

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

Example with Units

$$78.56\,\text{m}^3\text{/d} = \frac{1200\,\text{mg/L} \cdot 1.2\,\text{m}^3\text{/d} - 200\,\text{mg/L} \cdot 400\,\text{m}^3\text{/d}}{200\,\text{mg/L} - 1200\,\text{mg/L}}$$

2.2) RAS Pumping Rate using Recirculation Ratio Formula

Evaluate Formula

Formula

$$RAS = \alpha \cdot Q_a$$

Example with Units

$$9.96\,\text{m}^3\text{/d} = 8.3 \cdot 1.2\,\text{m}^3\text{/d}$$

3) WAS Pumping Rate Formulas

3.1) WAS Pumping Rate from Aeration Tank Formula

Evaluate Formula

Formula

$$Q_w = \frac{V}{\theta_c}$$

Example with Units

$$142.8571\,\text{m}^3/\text{d} = \frac{1000\,\text{m}^3}{7\,\text{d}}$$

3.2) WAS Pumping Rate from Return Line given RAS Pumping Rate from Aeration Tank Formula

Evaluate Formula

Formula

$$Q_w = \left(\left(\frac{X}{X_r}\right) \cdot \left(Q_a + RAS\right)\right) - RAS$$

Example with Units

$$57.2\,\text{m}^3/\text{d} = \left(\left(\frac{1200\,\text{mg/L}}{200\,\text{mg/L}}\right) \cdot \left(1.2\,\text{m}^3/\text{d} + 10\,\text{m}^3/\text{d}\right)\right) - 10\,\text{m}^3/\text{d}$$

3.3) WAS Pumping Rate from Return Line given Wasting Rate from Return Line Formula

Evaluate Formula

Formula

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

Example with Units

$$399.9999\,\text{m}^3/\text{d} = \left(1000\,\text{m}^3 \cdot \frac{1200\,\text{mg/L}}{7\,\text{d} \cdot 200\,\text{mg/L}}\right) - \left(1523.81\,\text{m}^3/\text{d} \cdot \frac{60\,\text{mg/L}}{200\,\text{mg/L}}\right)$$

3.4) WAS Pumping Rate using Wasting Rate from Return Line when Concentration of Solid in Effluent is Low Formula

Evaluate Formula

Formula

$$Q_w = V \cdot \frac{X}{\theta_c \cdot X_r}$$

Example with Units

$$857.1429\,\text{m}^3/\text{d} = 1000\,\text{m}^3 \cdot \frac{1200\,\text{mg/L}}{7\,\text{d} \cdot 200\,\text{mg/L}}$$

4) Wasting Rate Formulas

4.1) Wasting Rate from Return Line Formula

Evaluate Formula

Formula

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

Example with Units

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

4.2) Wasting Rate from Return Line when Concentration of Solid in Effluent is Low Formula

Evaluate Formula

Formula

$$\theta_c = \frac{V \cdot X}{Q_w' \cdot X_r}$$

Example with Units

$$15\,\text{d} = \frac{1000\,\text{m}^3 \cdot 1200\,\text{mg/L}}{400\,\text{m}^3/\text{d} \cdot 200\,\text{mg/L}}$$

Variables used in list of Pumping Rate Formulas above

- **f** BOD Conversion Factor
- 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_w WAS Pumping Rate from Reactor *(Cubic Meter per Day)*
- 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)*
- **X** MLSS *(Milligram per Liter)*
- X_e Solid Concentration in Effluent *(Milligram per Liter)*
- X_r Sludge Concentration in Return Line *(Milligram per Liter)*
- Y_{obs} Observed Cell Yield
- α Recirculation Ratio
- θ_c Mean Cell Residence Time *(Day)*

Constants, Functions, Measurements used in list of Pumping Rate Formulas above

- Measurement: **Time** in Day (d)
  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)
  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

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