Important Design of a Plastic Media Trickling Filter Formulas PDF

Formulas
Examples
with Units

List of 24
Important Design of a Plastic Media Trickling Filter Formulas

1) Area of Filter Formulas

1.1) Area of Filter with known volumetric flow rate and flow velocity Formula

Evaluate Formula

Formula

$$A = \left(\frac{V}{V_f}\right)$$

Example with Units

$$3.0038\,\text{m}^2 = \left(\frac{24\,\text{m}^3/\text{s}}{7.99\,\text{m/s}}\right)$$

2) Dosing Rate Formulas

2.1) Dosing Rate given Rotational Speed Formula

Evaluate Formula

Formula

$$DR = \frac{1.6 \cdot Q_T}{N \cdot n}$$

Example with Units

$$32 = \frac{1.6 \cdot 12\,\text{m/s}}{4 \cdot 9\,\text{rev/min}}$$

2.2) Number of Arms in Rotary Distributor Assembly given Rotational Speed Formula

Evaluate Formula

Formula

$$N = \frac{1.6 \cdot Q_T}{n \cdot DR}$$

Example with Units

$$4 = \frac{1.6 \cdot 12\,\text{m/s}}{9\,\text{rev/min} \cdot 32}$$

2.3) Rotational Speed of Distribution Formula

Evaluate Formula

Formula

$$n = \frac{1.6 \cdot Q_T}{N \cdot DR}$$

Example with Units

$$9\,\text{rev/min} = \frac{1.6 \cdot 12\,\text{m/s}}{4 \cdot 32}$$

2.4) Total applied Hydraulic Loading Rate given Rotational Speed Formula

Evaluate Formula

Formula

$$Q_T = \frac{n \cdot N \cdot DR}{1.6}$$

Example with Units

$$12\,\text{m/s} = \frac{9\,\text{rev/min} \cdot 4 \cdot 32}{1.6}$$

3) Hydraulic Loading Rate Formulas

3.1) Hydraulic Loading of Filter Formula

Evaluate Formula

Formula

$$H = \frac{V}{A}$$

Example with Units

$$8\,\text{m/s} = \frac{24\,\text{m}^3/\text{s}}{3\,\text{m}^2}$$

3.2) Influent Wastewater Hydraulic Loading Rate given Total Hydraulic Loading Rate Formula

Evaluate Formula

Formula

$$Q = \left(Q_T - Q_R \right)$$

Example with Units

$$6.5\,\text{m/s} = \left(12\,\text{m/s} - 5.5\,\text{m/s} \right)$$

3.3) Recycle Flow Hydraulic Loading Rate given Total Hydraulic Loading Rate Formula

Evaluate Formula

Formula

$$Q_R = \left(Q_T - Q \right)$$

Example with Units

$$5.5\,\text{m/s} = \left(12\,\text{m/s} - 6.5\,\text{m/s} \right)$$

3.4) Total Applied Hydraulic Loading Rate Formula

Evaluate Formula

Formula

$$Q_T = \left(Q + Q_R \right)$$

Example with Units

$$12\,\text{m/s} = \left(6.5\,\text{m/s} + 5.5\,\text{m/s} \right)$$

4) Organic Loading Formulas

4.1) Area of Filter given Organic Loading Formula

Evaluate Formula

Formula

$$A = \frac{BOD_5}{O_L \cdot L_f}$$

Example with Units

$$3\,\text{m}^2 = \frac{225\,\text{kg/d}}{30\,\text{kg/d*m}^2 \cdot 2.5\,\text{m}}$$

4.2) BOD Load given Organic Loading Formula

Evaluate Formula

Formula

$$BOD_5 = O_L \cdot A \cdot L_f$$

Example with Units

$$225\,\text{kg/d} = 30\,\text{kg/d*m}^2 \cdot 3\,\text{m}^2 \cdot 2.5\,\text{m}$$

4.3) Filter Length given Organic Loading Formula

Evaluate Formula

Formula

$$L_f = \frac{BOD_5}{O_L \cdot A}$$

Example with Units

$$2.5\,\text{m} = \frac{225\,\text{kg/d}}{30\,\text{kg/d*m}^2 \cdot 3\,\text{m}^2}$$

4.4) Organic Loading to Trickling Filter Formula

Evaluate Formula

Formula

$$O_L = \left(\frac{BOD_5}{A \cdot L_f} \right)$$

Example with Units

$$30\,\text{kg/d*m}^2 = \left(\frac{225\,\text{kg/d}}{3\,\text{m}^2 \cdot 2.5\,\text{m}} \right)$$

5) Treatability Constant Formulas

5.1) Depth of Actual Filter using Treatability Constant Formula

Evaluate Formula

Formula

$$D_2 = D_1 \cdot \left(\frac{K_{30/20}}{K_{30/25}} \right)^{\frac{1}{a}}$$

Example with Units

$$7.5936\,\text{m} = 6.1\,\text{m} \cdot \left(\frac{28.62}{26.80} \right)^{\frac{1}{0.3}}$$

5.2) Depth of Reference Filter using Treatability Constant Formula

Evaluate Formula

Formula

$$D_1 = D_2 \cdot \left(\frac{K_{30/25}}{K_{30/20}} \right)^{\frac{1}{a}}$$

Example with Units

$$6.1052\,\text{m} = 7.6\,\text{m} \cdot \left(\frac{26.80}{28.62} \right)^{\frac{1}{0.3}}$$

5.3) Empirical Constant given Treatability Constant Formula

Evaluate Formula

Formula

$$a = \left(\frac{\ln\left(\frac{K_{30/25}}{K_{30/20}} \right)}{\ln\left(\frac{D_1}{D_2} \right)} \right)$$

Example with Units

$$0.2988 = \left(\frac{\ln\left(\frac{26.80}{28.62} \right)}{\ln\left(\frac{6.1\,\text{m}}{7.6\,\text{m}} \right)} \right)$$

5.4) Temperature Activity Coefficient given Treatability Constant Formula

Evaluate Formula

Formula

$$\theta = \left(\frac{K_{30/20}}{K_{20/20}} \right)^{\frac{1}{T - 20}}$$

Example with Units

$$1.035 = \left(\frac{28.62}{0.002} \right)^{\frac{1}{25\,^\circ\text{C} - 20}}$$

5.5) Treatability Constant at 20 Degrees Celsius and 20 ft Filter Depth Formula

Evaluate Formula

Formula

$$K_{20/20} = \frac{K_{30/20}}{(\theta)^{T - 20}}$$

Example with Units

$$0.002 = \frac{28.62}{(1.035)^{25\,^\circ\text{C} - 20}}$$

5.6) Treatability Constant at 30 degree Celsius and 20 ft Filter Depth Formula

Evaluate Formula

Formula

$$K_{30/20} = K_{30/25} \cdot \left(\frac{D_2}{D_1} \right)^{a}$$

Example with Units

$$28.6273 = 26.80 \cdot \left(\frac{7.6\,\text{m}}{6.1\,\text{m}} \right)^{0.3}$$

5.7) Treatability Constant at 30 degree Celsius and 25 ft Filter Depth Formula

Evaluate Formula

Formula

$$K_{30/25} = K_{30/20} \cdot \left(\frac{D_1}{D_2} \right)^{a}$$

Example with Units

$$26.7932 = 28.62 \cdot \left(\frac{6.1\,\text{m}}{7.6\,\text{m}} \right)^{0.3}$$

5.8) Treatability Constant at 30 degrees Celsius and 20 ft Filter Depth Formula

Evaluate Formula

Formula

$$K_{30/20} = K_{20/20} \cdot (\theta)^{T - 20}$$

Example with Units

$$28.6212 = 0.002 \cdot (1.035)^{25\,^{\circ}\text{C} - 20}$$

5.9) Wastewater Temperature using Treatability Constant Formula

Evaluate Formula

Formula

$$T = 20 + \left(\ln\left(\frac{K_{30/20}}{K_{20/20}} \right) \cdot \left(\frac{1}{\ln(\theta)} \right) \right)$$

Example with Units

$$24.9988\,^{\circ}\text{C} = 20 + \left(\ln\left(\frac{28.62}{0.002} \right) \cdot \left(\frac{1}{\ln(1.035)} \right) \right)$$

6) Volumetric Flow Rate Formulas

6.1) Flowrate applied to Filter without Recirculation Formula

Evaluate Formula

Formula

$$V = Q_v \cdot A$$

Example with Units

$$24\,\text{m}^3/\text{s} = 8\,\text{m/s} \cdot 3\,\text{m}^2$$

6.2) Volumetric Flowrate applied Per Unit of Filter Area given Discharge and Area Formula

Evaluate Formula

Formula

$$Q_v = \left(\frac{V}{A} \right)$$

Example with Units

$$8\,\text{m/s} = \left(\frac{24\,\text{m}^3/\text{s}}{3\,\text{m}^2} \right)$$

Variables used in list of Design of a Plastic Media Trickling Filter Formulas above

- **a** Empirical Constant
- **A** Area of Filter *(Square Meter)*
- **BOD_5** BOD Loading to Filter *(Kilogram per Day)*
- **D_1** Depth of Reference Filter *(Meter)*
- **D_2** Depth of Actual Filter *(Meter)*
- **DR** Dosing Rate
- **H** Hydraulic Loading *(Meter per Second)*
- **$K_{20/20}$** Treatability Constant at 20°C and 20ft Depth
- **$K_{30/20}$** Treatability Constant at 30°C and 20ft Depth
- **$K_{30/25}$** Treatability Constant at 30°C and 25ft Depth
- **L_f** Filter Length *(Meter)*
- **n** Rotational Speed of Distribution *(Revolution per Minute)*
- **N** Number of Arms
- **O_L** Organic Loading *(kilogram per Day Square Meter)*
- **Q** Influent Wastewater Hydraulic Loading Rate *(Meter per Second)*
- **Q_R** Recycle Flow Hydraulic Loading Rate *(Meter per Second)*
- **Q_T** Total Applied Hydraulic Loading Rate *(Meter per Second)*
- **Q_v** Volumetric Flow per Unit Area *(Meter per Second)*
- **T** Wastewater Temperature *(Celsius)*
- **V** Volumetric Flow Rate *(Cubic Meter per Second)*
- **V_f** Flow Velocity *(Meter per Second)*
- **θ** Temperature Activity Coefficient

Constants, Functions, Measurements used in list of Design of a Plastic Media Trickling Filter Formulas above

- Functions: **ln**, ln(Number)
  The natural logarithm, also known as the logarithm to the base e, is the inverse function of the natural exponential function.
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Temperature** in Celsius (°C)
  Temperature Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Frequency** in Revolution per Minute (rev/min)
  Frequency Unit Conversion
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Second (m³/s)
  Volumetric Flow Rate Unit Conversion
- Measurement: **Mass Flow Rate** in Kilogram per Day (kg/d)
  Mass Flow Rate Unit Conversion
- Measurement: **Solid Loading Rate** in kilogram per Day Square Meter (kg/d*m²)
  Solid Loading Rate Unit Conversion

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