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Design of a Plastic Media Trickling Filter Formulas

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List of 24 Design of a Plastic Media Trickling Filter Formulas

Design of a Plastic Media Trickling Filter

Area of Filter

1) Area of Filter with known volumetric flow rate and flow velocity

Open Calculator

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

ex $$3.003755\text{m}^2 = \left(\frac{24\text{m}^3/\text{s}}{7.99\text{m/s}}\right)$$

Dosing Rate

2) Dosing Rate given Rotational Speed

Open Calculator

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

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

3) Number of Arms in Rotary Distributor Assembly given Rotational Speed

Open Calculator

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

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

4) Rotational Speed of Distribution

Open Calculator

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

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

5) Total applied Hydraulic Loading Rate given Rotational Speed

Open Calculator

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

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

Hydraulic Loading Rate

6) Hydraulic Loading of Filter

Open Calculator

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

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

7) Influent Wastewater Hydraulic Loading Rate given Total Hydraulic Loading Rate

Open Calculator

fx $$Q = (Q_T - Q_R)$$

ex $$6.5\text{m/s} = (12\text{m/s} - 5.5\text{m/s})$$

8) Recycle Flow Hydraulic Loading Rate given Total Hydraulic Loading Rate

Open Calculator

fx $$Q_R = (Q_T - Q)$$

ex $$5.5\text{m/s} = (12\text{m/s} - 6.5\text{m/s})$$

9) Total Applied Hydraulic Loading Rate

Open Calculator

fx $$Q_T = (Q + Q_R)$$

ex $$12\text{m/s} = (6.5\text{m/s} + 5.5\text{m/s})$$

Organic Loading

10) Area of Filter given Organic Loading

Open Calculator

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

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

11) BOD Load given Organic Loading

Open Calculator

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

$$225kg/d = 30kg/d*m^2 \cdot 3m^2 \cdot 2.5m$$

12) Filter Length given Organic Loading

Open Calculator

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

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

13) Organic Loading to Trickling Filter

Open Calculator

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

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

Treatability Constant

14) Depth of Actual Filter using Treatability Constant

Open Calculator

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

ex $$7.593569\text{m} = 6.1\text{m} \cdot \left(\frac{28.62}{26.80} \right)^{\frac{1}{0.3}}$$

15) Depth of Reference Filter using Treatability Constant

Open Calculator

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

ex $$6.105166\text{m} = 7.6\text{m} \cdot \left(\frac{26.80}{28.62} \right)^{\frac{1}{0.3}}$$

16) Empirical Constant given Treatability Constant

Open Calculator

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

ex $$0.298845 = \left(\frac{\ln\left(\frac{26.80}{28.62} \right)}{\ln\left(\frac{6.1\text{m}}{7.6\text{m}} \right)} \right)$$

17) Temperature Activity Coefficient given Treatability Constant

Open Calculator

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

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

18) Treatability Constant at 20 Degrees Celsius and 20 ft Filter Depth

Open Calculator

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

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

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

Open Calculator

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

ex $$28.62727 = 26.80 \cdot \left(\frac{7.6\text{m}}{6.1\text{m}}\right)^{0.3}$$

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

Open Calculator

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

ex $$26.79319 = 28.62 \cdot \left(\frac{6.1\text{m}}{7.6\text{m}}\right)^{0.3}$$

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

Open Calculator

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

ex $$28.62123 = 0.002 \cdot (1.035)^{25^\circ\text{C}-20}$$

22) Wastewater Temperature using Treatability Constant

Open Calculator

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

ex $$24.99875^\circ\text{C} = 20 + \left(\ln\left(\frac{28.62}{0.002}\right) \cdot \left(\frac{1}{\ln(1.035)}\right)\right)$$

Volumetric Flow Rate

23) Flowrate applied to Filter without Recirculation

Open Calculator

fx $$V = Q_v \cdot A$$

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

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

Open Calculator

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

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

Variables Used

- **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

- Function: **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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