



# Design of Trickling Filter using NRC Equations Formulas

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#### List of 21 Design of Trickling Filter using NRC **Equations Formulas**

#### Design of Trickling Filter using NRC Equations

#### 1) Area given Hydraulic Loading 🛂

$$\mathbf{K} = (1+lpha) \cdot rac{\mathrm{W_w}}{\mathrm{H} \cdot 1440}$$

 $\mathbf{ex} = 52.5 \mathrm{m}^2 = (1+1.5) \cdot \frac{1.4 \mathrm{m}^3/\mathrm{s}}{4 \mathrm{m}^3/\mathrm{d} \cdot 1440}$ 

2) Hydraulic Loading to each Filter 🖸

 $\mathbf{K} \left| \mathbf{H} = (1+lpha) \cdot rac{\mathbf{W}_{\mathrm{w}}}{\mathbf{A} \cdot 1440} \right|$ 

 $\mathbf{ex} \ 4.2 \mathrm{m}^3/\mathrm{d} = (1+1.5) \cdot rac{1.4 \mathrm{m}^3/\mathrm{s}}{50 \mathrm{m}^2 \cdot 1440}$ 

#### **BOD Loading**

### 3) BOD Loading for First Stage Filter 🗹

fx 
$$W^{'}=Q_{
m i}\cdot W_{
m w}\cdot 8.34$$











## 4) BOD Loading for First Stage Filter using BOD Loading for Second Filter Stage

 $W = rac{W^{'}}{1-E_{
m f}}$ 

Open Calculator 🗗

ex  $3.428571 \text{kg/d} = \frac{2.4 \text{kg/d}}{1 - 0.3}$ 

#### 5) BOD Loading for Second Stage Filter

fx  $W^{'}=(1-E_{\mathrm{f}})\cdot W$ 

Open Calculator

 $\mathbf{ex} \ 2.45 \mathrm{kg/d} = (1 - 0.3) \cdot 3.5 \mathrm{kg/d}$ 

# 6) BOD Loading to Second Filter Stage given Efficiency of Second Filter Stage

fx

Open Calculator

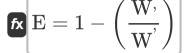
$$ext{W'} = ext{V}_{ ext{T}} \cdot ext{F} \cdot \left( \left( rac{1 - ext{E}_{ ext{f}}}{0.0561} 
ight) \cdot \left( \left( rac{100}{ ext{E}_{2}} 
ight) - 1 
ight) 
ight)^{2}$$

$$= 1.921506 \mathrm{kg/d} = 0.0035 \mathrm{m}^{_{3}} \cdot 0.4 \cdot \left( \left( \frac{1 - 0.3}{0.0561} \right) \cdot \left( \left( \frac{100}{99} \right) - 1 \right) \right)^{2}$$



#### Efficiency of Filter 2

7) Efficiency of First Filter given BOD Loading for Second Filter



Open Calculator 🗗

$$oxed{ex} 0.825 = 1 - \left(rac{0.42 \mathrm{kg/d}}{2.4 \mathrm{kg/d}}
ight)$$

8) Efficiency of First Filter Stage

$$ext{E}_1 = rac{100}{1 + \left(0.0561 \cdot \sqrt{rac{ ext{W}^{'}}{ ext{V}_{ ext{T}} \cdot ext{F}}}
ight)}$$

Open Calculator 🗗

9) Efficiency of First Filter Stage using Efficiency of Second Filter Stage

$$\mathbf{E} = 1 + \left( \left( rac{0.0561}{rac{100}{\mathrm{E}_2}} - 1 
ight) \cdot \sqrt{rac{\mathrm{W}^{'}}{\mathrm{V_T \cdot F}}} 
ight)$$

Open Calculator

ex 
$$0.866964 = 1 + \left( \left( \frac{0.0561}{\frac{100}{99}} - 1 \right) \cdot \sqrt{\frac{2.4 \mathrm{kg/d}}{0.0035 \mathrm{m}^3 \cdot 0.4}} \right)$$





#### 10) Efficiency of Second Filter Stage 🖸

$$\mathbf{E}_2 = rac{100}{1 + \left(\left(rac{0.0561}{1 - \mathbf{E}_1}
ight) \cdot \sqrt{rac{ ext{W}^{'}}{ ext{V}_{ ext{T}} \cdot ext{F}}}
ight)}$$

Open Calculator 🗗

ex  $100.008 = \frac{100}{1 + \left(\left(\frac{0.0561}{1-100}\right) \cdot \sqrt{\frac{2.4 \text{kg/d}}{0.0035 \text{m}^3 \cdot 0.4}}\right)}$ 

#### 11) Overall Efficiency of Two Stage Trickling Filter

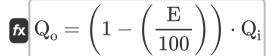


Open Calculator

 $oxed{ex} 2.390158 = \left( 24 {
m mg/L} - rac{0.002362 {
m mg/L}}{24 {
m mg/L}} 
ight) \cdot 100$ 

#### Influent and Effluent BOD

#### 12) Effluent BOD given Overall Efficiency of Two-Stage Trickling Filter



Open Calculator 🗗

$$ext{ex} \ 0.002322 ext{mg/L} = \left(1 - \left(rac{2.39}{100}
ight)
ight) \cdot 0.002379 ext{mg/L}$$



13) Influent BOD given BOD Loading for First Stage Filter 🗗

Open Calculator 2

 $\left|\mathbf{R}
ight|\mathbf{Q}_{\mathrm{i}}=rac{\mathrm{W}^{'}}{\mathrm{W}_{\scriptscriptstyle\mathrm{W}}\cdot 8.34}$ 

 $0.002379 \text{mg/L} = \frac{2.4 \text{kg/d}}{1.4 \text{m}^3/\text{s} \cdot 8.34}$ 

#### 14) Influent BOD given Overall Efficiency of Two-Stage Trickling Filter 🖸

Open Calculator  $\left| \mathbf{Q}_{\mathrm{i}} = rac{100 \cdot \mathbf{Q}_{\mathrm{o}}}{100 - \mathbf{E}} 
ight|$ 

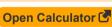
 $oxed{ex} 0.00242 {
m mg/L} = rac{100 \cdot 0.002362 {
m mg/L}}{100 - 2.39}$ 

#### Recirculation Factor

#### 15) Recirculation Factor

 $\mathrm{F}=rac{1+lpha}{\left(1+rac{lpha}{10}
ight)^2}$ 

ex 
$$1.890359 = \frac{1+1.5}{\left(1+\frac{1.5}{10}\right)^2}$$







#### Recirculation Ratio

#### 16) Recirculation Ratio given Hydraulic Loading

 $lpha = \left(rac{\mathrm{H}\cdot\mathrm{A}\cdot1440}{\mathrm{W_w}}
ight) - 1$ 

Open Calculator

ex  $1.380952 = \left(rac{4 ext{m}^3/ ext{d} \cdot 50 ext{m}^2 \cdot 1440}{1.4 ext{m}^3/ ext{s}}
ight) - 1$ 

#### 17) Recirculation Ratio of Wastewater

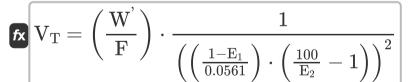
 $oldsymbol{lpha} = rac{Q_{
m r}}{W_{
m w}}$ 

Open Calculator

ex  $1.785714 = \frac{2.5 \mathrm{m}^3/\mathrm{s}}{1.4 \mathrm{m}^3/\mathrm{s}}$ 

#### Volume of Filter

18) Volume of Filter Media given Efficiency of Second Filter Stage



Open Calculator

 $\boxed{ 2.2 \text{E}^{\text{--}7} \text{m}^{\text{3}} = \left( \frac{2.4 \text{kg/d}}{0.4} \right) \cdot \frac{1}{\left( \left( \frac{1-100}{0.0561} \right) \cdot \left( \frac{100}{0.0} - 1 \right) \right)^{2} } }$ 





#### Wastewater Flow G

#### 19) Wastewater Flow given BOD Loading for First Stage

 $\left| \mathbf{W}_{\mathrm{w}} = rac{\mathrm{W}^{'}}{8.34 \cdot \mathrm{Q_{i}}} 
ight|$ 

Open Calculator

 $m = 1.400029 m^3/s = rac{2.4 kg/d}{8.34 \cdot 0.002379 mg/L}$ 

#### 20) Wastewater Flow given Hydraulic Loading

 $\mathbf{W}_{\mathrm{w}} = \mathbf{H} \cdot \mathbf{A} \cdot rac{1440}{1+lpha}$ 

Open Calculator

ex  $1.333333 ext{m}^3/ ext{s} = 4 ext{m}^3/ ext{d} \cdot 50 ext{m}^2 \cdot rac{1440}{1+1.5}$ 

#### 21) Wastewater Flow given Recirculation Ratio

 $W_{
m w} = rac{{
m Q_r}}{lpha}$ 

Open Calculator 🗗

 $oxed{1.666667 ext{m}^3/ ext{s}} = rac{2.5 ext{m}^3/ ext{s}}{1.5}$ 



#### Variables Used

- A Area (Square Meter)
- E Overall Efficiency
- E<sub>1</sub> Efficiency of First Filter Stage
- E<sub>2</sub> Efficiency of Second Filter Stage
- Ef Efficiency of First Filter Stage BOD Loading
- F Recirculation Factor
- H Hydraulic Loading (Cubic Meter per Day)
- Q<sub>i</sub> Influent BOD (Milligram per Liter)
- Qie Influent BOD Efficiency (Milligram per Liter)
- Q<sub>o</sub> Effluent BOD (Milligram per Liter)
- **Q**<sub>r</sub> Recirculation Flow (Cubic Meter per Second)
- V<sub>T</sub> Volume (Cubic Meter)
- W BOD Loading to Filter (Kilogram per Day)
- W BOD Loading to the Second Stage Filter (Kilogram per Day)
- W<sub>w</sub> Waste Water Flow (Cubic Meter per Second)
- W BOD Loading to Filter 2 (Kilogram per Day)
- α Recirculation Ratio





#### Constants, Functions, Measurements used

- Function: sqrt, sqrt(Number)

  A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Measurement: Volume in Cubic Meter (m³)

  Volume Unit Conversion
- Measurement: Area in Square Meter (m²)
   Area Unit Conversion
- Measurement: Volumetric Flow Rate in Cubic Meter per Second (m³/s),
   Cubic Meter per Day (m³/d)
   Volumetric Flow Rate Unit Conversion
- Measurement: Mass Flow Rate in Kilogram per Day (kg/d)
   Mass Flow Rate Unit Conversion
- Measurement: Density in Milligram per Liter (mg/L)
   Density Unit Conversion





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