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Laminar Flow of Fluid in an Open Channel Formulas

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List of 23 Laminar Flow of Fluid in an Open Channel Formulas

Laminar Flow of Fluid in an Open Channel

1) Bed Shear Stress

$$fx \quad \tau = \gamma_f \cdot s \cdot d_{\text{section}}$$

Open Calculator 

$$ex \quad 490.5\text{Pa} = 9.81\text{kN/m}^3 \cdot 0.01 \cdot 5\text{m}$$

2) Bed Slope given Bed Shear Stress

$$fx \quad s = \frac{\tau}{d_{\text{section}} \cdot \gamma_f}$$

Open Calculator 

$$ex \quad 0.01 = \frac{490.5\text{Pa}}{5\text{m} \cdot 9.81\text{kN/m}^3}$$


3) Diameter of Section given Bed Shear Stress

$$fx \quad d_{\text{section}} = \frac{\tau}{s \cdot \gamma_f}$$

Open Calculator 

$$ex \quad 5\text{m} = \frac{490.5\text{Pa}}{0.01 \cdot 9.81\text{kN/m}^3}$$




4) Diameter of Section given Discharge per Unit Channel Width 

$$\text{fx } d_{\text{section}} = \left(\frac{3 \cdot \mu \cdot v}{S \cdot \gamma_f} \right)^{\frac{1}{3}}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$\text{ex } 4.99694\text{m} = \left(\frac{3 \cdot 10.2\text{P} \cdot 4\text{m}^2/\text{s}}{0.01 \cdot 9.81\text{kN}/\text{m}^3} \right)^{\frac{1}{3}}$$

5) Diameter of Section given Mean Velocity of Flow 

$$\text{fx } d_{\text{section}} = \frac{\left(R^2 + \left(\mu \cdot V_{\text{mean}} \cdot \frac{S}{\gamma_f} \right) \right)}{R}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$\text{ex } 11.30461\text{m} = \frac{\left((1.01\text{m})^2 + \left(10.2\text{P} \cdot 10\text{m}/\text{s} \cdot \frac{10}{9.81\text{kN}/\text{m}^3} \right) \right)}{1.01\text{m}}$$


6) Diameter of Section given Potential Head Drop 

$$\text{fx } d_{\text{section}} = \sqrt{\frac{3 \cdot \mu \cdot V_{\text{mean}} \cdot L}{\gamma_f \cdot h_L}}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$\text{ex } 4.962437\text{m} = \sqrt{\frac{3 \cdot 10.2\text{P} \cdot 10\text{m}/\text{s} \cdot 15\text{m}}{9.81\text{kN}/\text{m}^3 \cdot 1.9\text{m}}}$$



7) Diameter of Section given Slope of Channel 

$$fx \quad d_{\text{section}} = \left(\frac{\tau}{s \cdot \gamma_f} \right) + R$$

Open Calculator 

$$ex \quad 6.01\text{m} = \left(\frac{490.5\text{Pa}}{0.01 \cdot 9.81\text{kN/m}^3} \right) + 1.01\text{m}$$

8) Discharge per unit channel width 

$$fx \quad v = \frac{\gamma_f \cdot s \cdot d_{\text{section}}^3}{3 \cdot \mu}$$

Open Calculator 


$$ex \quad 4.007353\text{m}^2/\text{s} = \frac{9.81\text{kN/m}^3 \cdot 0.01 \cdot (5\text{m})^3}{3 \cdot 10.2\text{P}}$$

9) Dynamic Viscosity given Discharge per Unit Channel Width 

$$fx \quad \mu = \frac{\gamma_f \cdot s \cdot d_{\text{section}}^3}{3 \cdot v}$$

Open Calculator 

$$ex \quad 10.21875\text{P} = \frac{9.81\text{kN/m}^3 \cdot 0.01 \cdot (5\text{m})^3}{3 \cdot 4\text{m}^2/\text{s}}$$

10) Dynamic Viscosity given Mean Velocity of Flow in Section 

$$fx \quad \mu = \frac{\gamma_f \cdot dh|dx \cdot (d_{\text{section}} \cdot R - R^2)}{V_{\text{mean}}}$$

Open Calculator 

$$ex \quad 10.21146\text{P} = \frac{9.81\text{kN/m}^3 \cdot 0.2583 \cdot (5\text{m} \cdot 1.01\text{m} - (1.01\text{m})^2)}{10\text{m/s}}$$



11) Length of Pipe given Potential Head Drop 

$$fx \quad L = \frac{h_L \cdot \gamma_f \cdot (d_{\text{section}}^2)}{3 \cdot \mu \cdot V_{\text{mean}}}$$

Open Calculator 

$$ex \quad 15.22794\text{m} = \frac{1.9\text{m} \cdot 9.81\text{kN/m}^3 \cdot ((5\text{m})^2)}{3 \cdot 10.2\text{P} \cdot 10\text{m/s}}$$

12) Mean Velocity of Flow in Section 

$$fx \quad V_{\text{mean}} = \frac{\gamma_f \cdot dh|dx \cdot (d_{\text{section}} \cdot R - R^2)}{\mu}$$

Open Calculator 


$$ex \quad 10.01123\text{m/s} = \frac{9.81\text{kN/m}^3 \cdot 0.2583 \cdot (5\text{m} \cdot 1.01\text{m} - (1.01\text{m})^2)}{10.2\text{P}}$$

13) Potential Head Drop 

$$fx \quad h_L = \frac{3 \cdot \mu \cdot V_{\text{mean}} \cdot L}{\gamma_f \cdot d_{\text{section}}^2}$$

Open Calculator 

$$ex \quad 1.87156\text{m} = \frac{3 \cdot 10.2\text{P} \cdot 10\text{m/s} \cdot 15\text{m}}{9.81\text{kN/m}^3 \cdot (5\text{m})^2}$$

14) Shear Stress given Slope of Channel 

$$fx \quad \tau = \gamma_f \cdot s \cdot (d_{\text{section}} - R)$$

Open Calculator 

$$ex \quad 391.419\text{Pa} = 9.81\text{kN/m}^3 \cdot 0.01 \cdot (5\text{m} - 1.01\text{m})$$



15) Slope of Channel given Discharge per Unit Channel Width 

$$fx \quad S = \frac{3 \cdot \mu \cdot v}{\gamma_f \cdot d_{\text{section}}^3}$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0_img.jpg\)](#)


$$ex \quad 0.009982 = \frac{3 \cdot 10.2P \cdot 4\text{m}^2/\text{s}}{9.81\text{kN}/\text{m}^3 \cdot (5\text{m})^3}$$

16) Slope of Channel given Mean Velocity of Flow 

$$fx \quad S = \frac{\mu \cdot V_{\text{mean}}}{\left(d_{\text{section}} \cdot R - \frac{R^2}{2}\right) \cdot \gamma_f}$$

[Open Calculator !\[\]\(e1d6102fe77919492c04879c8450f1f5_img.jpg\)](#)

$$ex \quad 0.229024 = \frac{10.2P \cdot 10\text{m}/\text{s}}{\left(5\text{m} \cdot 1.01\text{m} - \frac{(1.01\text{m})^2}{2}\right) \cdot 9.81\text{kN}/\text{m}^3}$$

17) Slope of Channel given Shear Stress 

$$fx \quad S = \frac{\tau}{\gamma_f \cdot (d_{\text{section}} - R)}$$

[Open Calculator !\[\]\(ab4e2b3fc7e7887b7a72f548aa6f5e60_img.jpg\)](#)

$$ex \quad 0.012531 = \frac{490.5\text{Pa}}{9.81\text{kN}/\text{m}^3 \cdot (5\text{m} - 1.01\text{m})}$$



Laminar Flow Through Porous Media

18) Coefficient of Permeability given Velocity

$$fx \quad k = \frac{V_{\text{mean}}}{H}$$

[Open Calculator !\[\]\(83f22ed94ec5517769dd76d702c6bfd8_img.jpg\)](#)

$$ex \quad 10\text{cm/s} = \frac{10\text{m/s}}{100}$$

19) Hydraulic Gradient given Velocity

$$fx \quad H = \frac{V_{\text{mean}}}{k}$$

[Open Calculator !\[\]\(3cb60d42b10e53f9522bb0b392c1c4cd_img.jpg\)](#)

$$ex \quad 100 = \frac{10\text{m/s}}{10\text{cm/s}}$$

20) Mean Velocity using Darcy's Law

$$fx \quad V_{\text{mean}} = k \cdot H$$

[Open Calculator !\[\]\(0d7ca0919e6c47bbd874bfa0189fe22e_img.jpg\)](#)

$$ex \quad 10\text{m/s} = 10\text{cm/s} \cdot 100$$



Lubrication Mechanics Slipper Bearing

21) Dynamic Viscosity given Pressure Gradient

$$\text{fx } \mu = dp|dr \cdot \frac{h^3}{12 \cdot (0.5 \cdot V_{\text{mean}} \cdot h - Q)}$$

[Open Calculator !\[\]\(96cc62f861fdd6e50510c0224a756dff_img.jpg\)](#)

$$\text{ex } 10.43536\text{P} = 17\text{N/m}^3 \cdot \frac{(1.81\text{m})^3}{12 \cdot (0.5 \cdot 10\text{m/s} \cdot 1.81\text{m} - 1.000001\text{m}^3/\text{s})}$$

22) Pressure Gradient

$$\text{fx } dp|dr = \left(12 \cdot \frac{\mu}{h^3} \right) \cdot (0.5 \cdot V_{\text{mean}} \cdot h - Q)$$

[Open Calculator !\[\]\(f95dab70c751fda7d824b8b03650f7aa_img.jpg\)](#)

$$\text{ex } 16.61658\text{N/m}^3 = \left(12 \cdot \frac{10.2\text{P}}{(1.81\text{m})^3} \right) \cdot (0.5 \cdot 10\text{m/s} \cdot 1.81\text{m} - 1.000001\text{m}^3/\text{s})$$

23) Rate of Flow given Pressure Gradient

$$\text{fx } Q = 0.5 \cdot V_{\text{mean}} \cdot h - \left(dp|dr \cdot \frac{h^3}{12 \cdot \mu} \right)$$

[Open Calculator !\[\]\(e9474ce1d70442456f8fe9c393ea149c_img.jpg\)](#)

$$\text{ex } 0.814249\text{m}^3/\text{s} = 0.5 \cdot 10\text{m/s} \cdot 1.81\text{m} - \left(17\text{N/m}^3 \cdot \frac{(1.81\text{m})^3}{12 \cdot 10.2\text{P}} \right)$$



Variables Used

- d_{section} Diameter of Section (Meter)
- $dh|dx$ Piezometric Gradient
- $dp|dr$ Pressure Gradient (Newton per Cubic Meter)
- h Height of Channel (Meter)
- H Hydraulic Gradient
- h_L Head Loss due to Friction (Meter)
- k Coefficient of Permeability (Centimeter per Second)
- L Length of Pipe (Meter)
- Q Discharge in Pipe (Cubic Meter per Second)
- R Horizontal Distance (Meter)
- s Slope of Bed
- S Slope of Surface of Constant Pressure
- V_{mean} Mean Velocity (Meter per Second)
- γ_f Specific Weight of Liquid (Kilonewton per Cubic Meter)
- μ Dynamic Viscosity (Poise)
- ν Kinematic Viscosity (Square Meter per Second)
- τ Shear Stress (Pascal)



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:** **Length** in Meter (m)

Length Unit Conversion 

- **Measurement:** **Speed** in Meter per Second (m/s), Centimeter per Second (cm/s)

Speed Unit Conversion 

- **Measurement:** **Volumetric Flow Rate** in Cubic Meter per Second (m³/s)

Volumetric Flow Rate Unit Conversion 


- **Measurement:** **Dynamic Viscosity** in Poise (P)

Dynamic Viscosity Unit Conversion 

- **Measurement:** **Kinematic Viscosity** in Square Meter per Second (m²/s)

Kinematic Viscosity Unit Conversion 

- **Measurement:** **Specific Weight** in Kilonewton per Cubic Meter (kN/m³)

Specific Weight Unit Conversion 

- **Measurement:** **Pressure Gradient** in Newton per Cubic Meter (N/m³)







Pressure Gradient Unit Conversion 

- **Measurement:** **Stress** in Pascal (Pa)

Stress Unit Conversion 



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