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Turbulent Flow Formulas

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List of 18 Turbulent Flow Formulas

Turbulent Flow

1) Average Height of Irregularities for Turbulent Flow in Pipes

$$\text{fx } k = \frac{v \cdot \text{Re}}{V_*}$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b_img.jpg\)](#)

$$\text{ex } 0.001208\text{m} = \frac{7.25\text{St} \cdot 10}{6\text{m/s}}$$

2) Blasius Equation

$$\text{fx } f = \frac{0.316}{\text{Re}^{\frac{1}{4}}}$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d_img.jpg\)](#)

$$\text{ex } 0.1777 = \frac{0.316}{(10)^{\frac{1}{4}}}$$

3) Boundary Layer Thickness of Laminar Sublayer

$$\text{fx } \delta = \frac{11.6 \cdot v}{V_*}$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d_img.jpg\)](#)

$$\text{ex } 0.001402\text{m} = \frac{11.6 \cdot 7.25\text{St}}{6\text{m/s}}$$



4) Centreline Velocity

$$fx \quad U_{\max} = 1.43 \cdot V \cdot \sqrt{1 + f}$$

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

$$ex \quad 2.888458\text{m/s} = 1.43 \cdot 2\text{m/s} \cdot \sqrt{1 + 0.02}$$

5) Centreline Velocity given Shear and Mean Velocity

$$fx \quad U_{\max} = 3.75 \cdot V_* + V$$

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

$$ex \quad 24.5\text{m/s} = 3.75 \cdot 6\text{m/s} + 2\text{m/s}$$

6) Discharge through Pipe given Head Loss in Turbulent Flow

$$fx \quad Q = \frac{P}{\rho_{\text{fluid}} \cdot [g] \cdot h_f}$$

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

$$ex \quad 1.010797\text{m}^3/\text{s} = \frac{170\text{W}}{1.225\text{kg}/\text{m}^3 \cdot [g] \cdot 14\text{m}}$$

7) Frictional Factor given Reynolds Number

$$fx \quad f = 0.0032 + \frac{0.221}{\text{Re}^{0.237}}$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

$$ex \quad 0.131254 = 0.0032 + \frac{0.221}{(10)^{0.237}}$$




8) Head Loss due to Friction given Power Required in Turbulent Flow 

$$fx \quad h_f = \frac{P}{\rho_{\text{fluid}} \cdot [g] \cdot Q}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)


$$ex \quad 4.717055m = \frac{170W}{1.225kg/m^3 \cdot [g] \cdot 3m^3/s}$$

9) Mean Velocity given Centreline Velocity 

$$fx \quad V = \frac{U_{\text{max}}}{1.43 \cdot \sqrt{1 + f}}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

$$ex \quad 16.61786m/s = \frac{24m/s}{1.43 \cdot \sqrt{1 + 0.02}}$$

10) Mean Velocity given Shear Velocity 

$$fx \quad V = U_{\text{max}} - 3.75 \cdot V_*$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$ex \quad 1.5m/s = 24m/s - 3.75 \cdot 6m/s$$

11) Power Required to Maintain Turbulent Flow 

$$fx \quad P = \rho_{\text{fluid}} \cdot [g] \cdot Q \cdot h_f$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b_img.jpg\)](#)

$$ex \quad 504.5521W = 1.225kg/m^3 \cdot [g] \cdot 3m^3/s \cdot 14m$$



12) Roughness Reynold Number for Turbulent Flow in Pipes

$$fx \quad Re = \frac{k \cdot V_*}{v}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$ex \quad 6 = \frac{0.000725m \cdot 6m/s}{7.25St}$$

13) Shear Stress Developed for Turbulent Flow in Pipes

$$fx \quad \tau = \rho_{fluid} \cdot V_*^2$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$ex \quad 44.1Pa = 1.225kg/m^3 \cdot (6m/s)^2$$

14) Shear Stress due to Viscosity

$$fx \quad \tau = \mu \cdot dv$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

$$ex \quad 20.4Pa = 10.2P \cdot 20m/s$$

15) Shear Stress in Turbulent Flow

$$fx \quad \tau = \frac{\rho_{fluid} \cdot f \cdot v^2}{2}$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80_img.jpg\)](#)

$$ex \quad 44.1Pa = \frac{1.225kg/m^3 \cdot 0.02 \cdot (60m/s)^2}{2}$$



16) Shear Velocity for Turbulent Flow in Pipes

[Open Calculator !\[\]\(eafc244b53721dd1ec133f0772f70fc7_img.jpg\)](#)

$$\text{fx } V_* = \sqrt{\frac{\tau}{\rho_{\text{fluid}}}}$$

$$\text{ex } 8.717798\text{m/s} = \sqrt{\frac{93.1\text{Pa}}{1.225\text{kg/m}^3}}$$

17) Shear Velocity given Centreline Velocity

[Open Calculator !\[\]\(10f8862fc183b400327470ea85afe9ae_img.jpg\)](#)

$$\text{fx } V_* = \frac{U_{\text{max}} - V}{3.75}$$

$$\text{ex } 5.866667\text{m/s} = \frac{24\text{m/s} - 2\text{m/s}}{3.75}$$

18) Shear Velocity given Mean Velocity

[Open Calculator !\[\]\(35dc653d59570f8f891c312eeece91a2_img.jpg\)](#)

$$\text{fx } V_* = V \cdot \sqrt{\frac{f}{8}}$$

$$\text{ex } 0.1\text{m/s} = 2\text{m/s} \cdot \sqrt{\frac{0.02}{8}}$$











Variables Used

- **dv** Change in Velocity (*Meter per Second*)
- **f** Friction Factor
- **h_f** Head Loss due to Friction (*Meter*)
- **k** Average Height Irregularities (*Meter*)
- **P** Power (*Watt*)
- **Q** Discharge (*Cubic Meter per Second*)
- **Re** Roughness Reynold Number
- **U_{max}** Centreline Velocity (*Meter per Second*)
- **v** Velocity (*Meter per Second*)
- **V** Mean Velocity (*Meter per Second*)
- **V_*** Shear Velocity (*Meter per Second*)
- **δ** Boundary Layer Thickness (*Meter*)
- **μ** Viscosity (*Poise*)
- **ν** Kinematic Viscosity (*Stokes*)
- **ρ_{fluid}** Density of Fluid (*Kilogram per Cubic Meter*)
- **τ** Shear Stress (*Pascal*)



Constants, Functions, Measurements used

- **Constant:** [g], 9.80665 Meter/Second²
Gravitational acceleration on Earth
- **Function:** sqrt, sqrt(Number)
Square root function
- **Measurement: Length** in Meter (m)
Length Unit Conversion 
- **Measurement: Speed** in Meter per Second (m/s)
Speed Unit Conversion 
- **Measurement: Power** in Watt (W)
Power 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 Stokes (St)
Kinematic Viscosity Unit Conversion 
- **Measurement: Density** in Kilogram per Cubic Meter (kg/m³)
Density Unit Conversion 
- **Measurement: Stress** in Pascal (Pa)
Stress Unit Conversion 



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