Important Turbulent Flow Formulas PDF

Formulas
Examples
with Units

List of 18
Important Turbulent Flow Formulas

1) Average Height of Irregularities for Turbulent Flow in Pipes Formula

Evaluate Formula

Formula

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

Example with Units

$$0.0012\,\text{m} = \frac{7.25\,\text{St} \cdot 10}{6\,\text{m/s}}$$

2) Blasius Equation Formula

Evaluate Formula

Formula

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

Example

$$0.1777 = \frac{0.316}{10^{\frac{1}{4}}}$$

3) Boundary Layer Thickness of Laminar Sublayer Formula

Evaluate Formula

Formula

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

Example with Units

$$0.0014\,\text{m} = \frac{11.6 \cdot 7.25\,\text{St}}{6\,\text{m/s}}$$

4) Centreline Velocity Formula

Evaluate Formula

Formula

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

Example with Units

$$3.0803\,\text{m/s} = 1.43 \cdot 2\,\text{m/s} \cdot \sqrt{1 + 0.16}$$

5) Centreline Velocity given Shear and Mean Velocity Formula

Evaluate Formula

Formula

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

Example with Units

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

6) Discharge through Pipe given Head Loss in Turbulent Flow Formula

Evaluate Formula

Formula

$$Q = \frac{P}{\rho_f \cdot [g] \cdot h_f}$$

Example with Units

$$3.0045\,\text{m}^3\text{/s} = \frac{170\,\text{W}}{1.225\,\text{kg/m}^3 \cdot 9.8066\,\text{m/s}^2 \cdot 4.71\,\text{m}}$$

7) Frictional Factor given Reynolds Number Formula

Evaluate Formula

Formula

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

Example

$$0.1313 = 0.0032 + \frac{0.221}{10^{0.237}}$$

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

Evaluate Formula

Formula

$$h_f = \frac{P}{\rho_f \cdot [g] \cdot Q}$$

Example with Units

$$4.7171\,\text{m} = \frac{170\,\text{W}}{1.225\,\text{kg/m}^3 \cdot 9.8066\,\text{m/s}^2 \cdot 3\,\text{m}^3\text{/s}}$$

9) Mean Velocity given Centreline Velocity Formula

Evaluate Formula

Formula

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

Example with Units

$$1.8699\,\text{m/s} = \frac{2.88\,\text{m/s}}{1.43 \cdot \sqrt{1 + 0.16}}$$

10) Mean Velocity given Shear Velocity Formula

Evaluate Formula

Formula

$$V = 3.75 \cdot V_{'} - U_{max}$$

Example with Units

$$19.62\,\text{m/s} = 3.75 \cdot 6\,\text{m/s} - 2.88\,\text{m/s}$$

11) Power Required to Maintain Turbulent Flow Formula

Evaluate Formula

Formula

$$P = \rho_f \cdot [g] \cdot Q \cdot h_f$$

Example with Units

$$169.7458\,\text{W} = 1.225\,\text{kg/m}^3 \cdot 9.8066\,\text{m/s}^2 \cdot 3\,\text{m}^3\text{/s} \cdot 4.71\,\text{m}$$

12) Roughness Reynold Number for Turbulent Flow in Pipes Formula

Evaluate Formula

Formula

$$Re = \frac{k \cdot V_{'}}{v'}$$

Example with Units

$$6 = \frac{0.000725\,\text{m} \cdot 6\,\text{m/s}}{7.25\,\text{St}}$$

13) Shear Stress Developed for Turbulent Flow in Pipes Formula

Evaluate Formula

Formula

$$\tau = \rho_f \cdot V_{'}^2$$

Example with Units

$$44.1\,\text{Pa} = 1.225\,\text{kg/m}^3 \cdot 6\,\text{m/s}^2$$

14) Shear Stress due to Viscosity Formula

Evaluate Formula

Formula

$$\tau = \mu \cdot d_v$$

Example with Units

$$44\,\text{Pa} = 22\,\text{P} \cdot 20\,\text{m/s}$$

15) Shear Stress in Turbulent Flow Formula

Evaluate Formula

Formula

$$\tau = \frac{\rho_f \cdot f \cdot v^2}{2}$$

Example with Units

$$44.4616\,\text{Pa} = \frac{1.225\,\text{kg/m}^3 \cdot 0.16 \cdot 21.3\,\text{m/s}^2}{2}$$

16) Shear Velocity for Turbulent Flow in Pipes Formula

Evaluate Formula

Formula

$$V_* = \sqrt{\frac{\tau}{\rho_f}}$$

Example with Units

$$5.9932\,\text{m/s} = \sqrt{\frac{44\,\text{Pa}}{1.225\,\text{kg/m}^3}}$$

17) Shear Velocity given Centreline Velocity Formula

Evaluate Formula

Formula

$$V_s = \frac{U_{max} - V}{3.75}$$

Example with Units

$$0.2347\,\text{m/s} = \frac{2.88\,\text{m/s} - 2\,\text{m/s}}{3.75}$$

18) Shear Velocity given Mean Velocity Formula

Evaluate Formula

Formula

$$V_s = V \cdot \sqrt{\frac{f}{8}}$$

Example with Units

$$0.2828\,\text{m/s} = 2\,\text{m/s} \cdot \sqrt{\frac{0.16}{8}}$$

Variables used in list of Turbulent Flow Formulas above

- d_v 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'** Kinematic Viscosity *(Stokes)*
- **V** Mean Velocity *(Meter per Second)*
- V_* Shear Velocity *(Meter per Second)*
- V_s Shear Velocity 1 *(Meter per Second)*
- **δ** Boundary Layer Thickness *(Meter)*
- **μ** Viscosity *(Poise)*
- ρ_f Density of Fluid *(Kilogram per Cubic Meter)*
- τ Shear Stress *(Pascal)*

Constants, Functions, Measurements used in list of Turbulent Flow Formulas above

- constant(s): **[g]**, 9.80665
  Gravitational acceleration on Earth
- Functions: **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)
  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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