Important Fluid in Motion Formulas PDF

Formulas
Examples
with Units

List of 17
Important Fluid in Motion Formulas

1) Flow Rate Formulas

1.1) Rate of Flow Formula

Evaluate Formula

Formula

$$Q_f = A \cdot V_{avg}$$

Example with Units

$$24.102\,\text{m}^3/\text{s} = 1.3\,\text{m}^2 \cdot 18.54\,\text{m/s}$$

1.2) Rate of Flow given Head loss in Laminar Flow Formula

Evaluate Formula

Formula

$$Q_f = h_l \cdot \gamma_f \cdot \pi \cdot \frac{d_p^{\,4}}{128 \cdot \mu \cdot L_p}$$

Example with Units

$$23.0932\,\text{m}^3/\text{s} = 1.195\,\text{m} \cdot 108.2\,\text{N/m}^3 \cdot 3.1416 \cdot \frac{1.01\,\text{m}^{\,4}}{128 \cdot 1.43\,\text{N} \cdot 0.10\,\text{m}}$$

1.3) Rate of Flow given Hydraulic Transmission Power Formula

Evaluate Formula

Formula

$$Q_f = \frac{P}{\gamma_l \cdot \left(H_e - h_l \right)}$$

Example with Units

$$24.1935\,\text{m}^3/\text{s} = \frac{3000\,\text{W}}{310\,\text{N/m}^3 \cdot \left(1.595\,\text{m} - 1.195\,\text{m} \right)}$$

1.4) Volumetric Flow Rate at Vena Contracta Formula

Evaluate Formula

Formula

$$V_f = C_d \cdot A_{vc} \cdot \sqrt{2 \cdot [g] \cdot H_w}$$

Example with Units

$$30.0124\,\text{m}^3/\text{s} = 0.66 \cdot 6.43\,\text{m}^2 \cdot \sqrt{2 \cdot 9.8066\,\text{m/s}^2 \cdot 2.55\,\text{m}}$$

1.5) Volumetric Flow Rate of Circular Orifice Formula

Evaluate Formula

Formula

$$V_f = 0.62 \cdot a \cdot \sqrt{2 \cdot [g] \cdot H_w}$$

Example with Units

$$29.9955\,\text{m}^3/\text{s} = 0.62 \cdot 6.841\,\text{m}^2 \cdot \sqrt{2 \cdot 9.8066\,\text{m/s}^2 \cdot 2.55\,\text{m}}$$

1.6) Volumetric Flow Rate of Rectangular Notch Formula

Evaluate Formula

Formula

$$V_f = 0.62 \cdot b \cdot H \cdot \frac{2}{3} \cdot \sqrt{2 \cdot [g] \cdot H_w}$$

Example with Units

$$30.0067\,\text{m}^3/\text{s} = 0.62 \cdot 3.88\,\text{m} \cdot 2.6457\,\text{m} \cdot \frac{2}{3} \cdot \sqrt{2 \cdot 9.8066\,\text{m/s}^2 \cdot 2.55\,\text{m}}$$

1.7) Volumetric Flow Rate of Triangular Right Angled Notch Formula

Evaluate Formula

Formula

$$V_f = 2.635 \cdot H^{\frac{5}{2}}$$

Example with Units

$$30.0008\,\text{m}^3/\text{s} = 2.635 \cdot 2.6457\,\text{m}^{\frac{5}{2}}$$

1.8) Volumetric Flow Rate of Venacontracta given Contraction and Velocity Formula

Evaluate Formula

Formula

$$V_f = C_c \cdot C_v \cdot A_{vc} \cdot \sqrt{2 \cdot [g] \cdot H_w}$$

Example with Units

$$30.1215\,\text{m}^3/\text{s} = 0.72 \cdot 0.92 \cdot 6.43\,\text{m}^2 \cdot \sqrt{2 \cdot 9.8066\,\text{m/s}^2 \cdot 2.55\,\text{m}}$$

2) Hydrodynamics Basics Formulas

2.1) Metacentric Height given Time Period of Rolling Formula

Evaluate Formula

Formula

$$H_m = \frac{\left(K_g \cdot \pi\right)^2}{\left(\frac{T_r}{2}\right)^2 \cdot [g]}$$

Example with Units

$$0.7304\,\text{m} = \frac{\left(4.43\,\text{m} \cdot 3.1416\right)^2}{\left(\frac{10.4\,\text{s}}{2}\right)^2 \cdot 9.8066\,\text{m/s}^2}$$

2.2) Moment of Momentum Equation Formula

Evaluate Formula

Formula

$$T = \rho_1 \cdot Q \cdot \left(v_1 \cdot R_1 - v_2 \cdot R_2\right)$$

Example with Units

$$504.2688\,\text{N*m} = 4\,\text{kg/m}^3 \cdot 1.072\,\text{m}^3/\text{s} \cdot \left(20\,\text{m/s} \cdot 8.1\,\text{m} - 12\,\text{m/s} \cdot 3.7\,\text{m}\right)$$

2.3) Poiseuille's Formula Formula

Evaluate Formula

Formula

$$Q_v = \Delta p \cdot \frac{\pi}{8} \cdot \frac{r_p^4}{\mu_v \cdot L}$$

Example with Units

$$10.0059\,\text{m}^3/\text{s} = 3.21\,\text{Pa} \cdot \frac{3.1416}{8} \cdot \frac{2.22\,\text{m}^4}{1.02\,\text{Pa*s} \cdot 3\,\text{m}}$$

2.4) Power Formula

Evaluate Formula

Formula

$$P_w = F_e \cdot \Delta v$$

Example with Units

$$900\,\text{W} = 2.5\,\text{N} \cdot 360\,\text{m/s}$$

2.5) Power Developed by Turbine Formula

Evaluate Formula

Formula

$$P_T = \rho_1 \cdot Q \cdot V_{wi} \cdot v_t$$

Example with Units

$$120.064\,\text{W} = 4\,\text{kg/m}^3 \cdot 1.072\,\text{m}^3/\text{s} \cdot 2\,\text{m/s} \cdot 14\,\text{m/s}$$

2.6) Power Required to Overcome Frictional Resistance in Laminar Flow Formula

Evaluate Formula

Formula

$$P_w = \gamma \cdot R_f \cdot h_f$$

Example with Units

$$900\,\text{W} = 31.25\,\text{N/m}^3 \cdot 24\,\text{m}^3/\text{s} \cdot 1.2\,\text{m}$$

2.7) Reynolds Number Formula

Evaluate Formula

Formula

$$Re = \frac{\rho_1 \cdot v_{fd} \cdot d_p}{\mu_v}$$

Example with Units

$$500.0094 = \frac{4\,\text{kg/m}^3 \cdot 126.24\,\text{m/s} \cdot 1.01\,\text{m}}{1.02\,\text{Pa*s}}$$

2.8) Reynolds Number given Frictional Factor of Laminar Flow Formula

Evaluate Formula

Formula

$$Re = \frac{64}{f}$$

Example

$$500 = \frac{64}{0.128}$$

2.9) Reynolds Number given Length Formula

Evaluate Formula

Formula

$$Re = \rho_1 \cdot v_f \cdot \frac{L}{V_k}$$

Example with Units

$$500 = 4\,\text{kg/m}^3 \cdot 60\,\text{m/s} \cdot \frac{3\,\text{m}}{14.4\,\text{kSt}}$$

Variables used in list of Fluid in Motion Formulas above

- **a** Area of Orifice *(Square Meter)*
- **A** Cross Sectional Area *(Square Meter)*
- A_{vc} Area of Jet at Vena Contracta *(Square Meter)*
- **b** Thickness of Dam *(Meter)*
- C_c Coefficient of Contraction
- C_d Coefficient of Discharge
- C_v Coefficient of Velocity
- d_p Diameter of Pipe *(Meter)*
- **f** Friction Factor
- F_e Force on Fluid Element *(Newton)*
- **H** Head of Water Above Sill of Notch *(Meter)*
- H_e Total Head at Entrance *(Meter)*
- h_f Head Loss *(Meter)*
- h_l Head Loss of Fluid *(Meter)*
- H_m Metacentric Height *(Meter)*
- H_w Head *(Meter)*
- K_g Radius of Gyration *(Meter)*
- **L** Length *(Meter)*
- L_p Length of Pipe *(Meter)*
- **P** Power *(Watt)*
- P_T Power Developed by Turbine *(Watt)*
- P_w Power Generated *(Watt)*
- **Q** Discharge *(Cubic Meter per Second)*
- Q_f Rate of Flow *(Cubic Meter per Second)*
- Q_v Volumetric Flow Rate of Feed to Reactor *(Cubic Meter per Second)*
- R_1 Radius of Curvature at Section 1 *(Meter)*
- R_2 Radius of Curvature at Section 2 *(Meter)*
- R_f Rate of Flow of Fluid *(Cubic Meter per Second)*
- r_p Pipe Radius *(Meter)*
- **Re** Reynolds Number

Constants, Functions, Measurements used in list of Fluid in Motion Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- 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: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Pressure** in Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Power** in Watt (W)
  Power Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Second (m³/s)
  Volumetric Flow Rate Unit Conversion
- Measurement: **Dynamic Viscosity** in Pascal Second (Pa*s)
  Dynamic Viscosity Unit Conversion
- Measurement: **Kinematic Viscosity** in Kilostokes (kSt)
  Kinematic Viscosity Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion
- Measurement: **Torque** in Newton Meter (N*m)
  Torque Unit Conversion
- Measurement: **Specific Weight** in Newton per Cubic Meter (N/m³)
  Specific Weight Unit Conversion

- **T** Torque Exerted on Wheel *(Newton Meter)*
- T_r Time Period of Rolling *(Second)*
- v_1 Velocity at Section 1-1 *(Meter per Second)*
- v_2 Velocity at Section 2-2 *(Meter per Second)*
- V_{avg} Average Velocity *(Meter per Second)*
- v_f Velocity *(Meter per Second)*
- V_f Volumetric Flow Rate *(Cubic Meter per Second)*
- v_{fd} Fluid Velocity *(Meter per Second)*
- V_k Kinematic Viscosity *(Kilostokes)*
- V_{wi} Velocity of Whirl at Inlet *(Meter per Second)*
- **γ** Specific Weight of Liquid 1 *(Newton per Cubic Meter)*
- γ_f Specific Weight *(Newton per Cubic Meter)*
- γ_l Specific Weight of Liquid *(Newton per Cubic Meter)*
- **Δp** Pressure Changes *(Pascal)*
- **Δv** Change in Velocity *(Meter per Second)*
- **μ** Viscous Force *(Newton)*
- μ_v Dynamic Viscosity *(Pascal Second)*
- v_t Tangential Velocity at Inlet *(Meter per Second)*
- ρ_1 Density of Liquid *(Kilogram per Cubic Meter)*

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