Important Flow Regime Formulas PDF

Formulas
Examples
with Units

List of 17
Important Flow Regime Formulas

1) Circumferential stress developed in pipe wall Formula

Evaluate Formula

Formula

$$\sigma_c = \frac{p \cdot D}{2 \cdot t_p}$$

Example with Units

$$6.8E{+}7\,\text{N/m}^2 = \frac{1.7E{+}7\,\text{N/m}^2 \cdot 0.12\,\text{m}}{2 \cdot 0.015\,\text{m}}$$

2) Coefficient of contraction for sudden contraction Formula

Evaluate Formula

Formula

$$C_c = \frac{V_2'}{V_2' + \sqrt{h_c \cdot 2 \cdot [g]}}$$

Example with Units

$$0.5995 = \frac{2.89\,\text{m/s}}{2.89\,\text{m/s} + \sqrt{0.19\,\text{m} \cdot 2 \cdot 9.8066\,\text{m/s}^2}}$$

3) Discharge in Equivalent Pipe Formula

Evaluate Formula

Formula

$$Q = \sqrt{\frac{H_l \cdot \left(\pi^2\right) \cdot 2 \cdot \left(D_{eq}^5\right) \cdot [g]}{4 \cdot 16 \cdot \mu \cdot L}}$$

Example with Units

$$0.0248\,\text{m}^3\text{/s} = \sqrt{\frac{20\,\text{m} \cdot \left(3.1416^2\right) \cdot 2 \cdot \left(0.165\,\text{m}^5\right) \cdot 9.8066\,\text{m/s}^2}{4 \cdot 16 \cdot 0.01 \cdot 1200\,\text{m}}}$$

4) Force required to accelerate water in pipe Formula

Evaluate Formula

Formula

$$F = M_w \cdot a_l$$

Example with Units

$$0.0925\,\text{N} = 0.05\,\text{kg} \cdot 1.85\,\text{m/s}^2$$

5) Longitudinal Stress developed in Pipe wall Formula

Evaluate Formula

Formula

$$\sigma_l = \frac{p \cdot D}{4 \cdot t_p}$$

Example with Units

$$3.4E{+}7\,\text{N/m}^2 = \frac{1.7E{+}7\,\text{N/m}^2 \cdot 0.12\,\text{m}}{4 \cdot 0.015\,\text{m}}$$

6) Retarding force for gradual closure of valves Formula

Evaluate Formula

Formula

$$F_r = \rho' \cdot A \cdot L \cdot \frac{V_f}{t_c}$$

Example with Units

$$319.889\,\text{N} = 1010\,\text{kg/m}^3 \cdot 0.0113\,\text{m}^2 \cdot 1200\,\text{m} \cdot \frac{12.5\,\text{m/s}}{535.17\,\text{s}}$$

7) Time required to close Valve for Gradual Closure of Valves Formula

Evaluate Formula

Formula

$$t_c = \frac{\rho' \cdot L \cdot V_f}{I}$$

Example with Units

$$535.7143\,\text{s} = \frac{1010\,\text{kg/m}^3 \cdot 1200\,\text{m} \cdot 12.5\,\text{m/s}}{28280\,\text{N/m}^2}$$

8) Time taken by pressure wave to travel Formula

Evaluate Formula

Formula

$$t = 2 \cdot \frac{L}{C}$$

Example with Units

$$125.6545\,\text{s} = 2 \cdot \frac{1200\,\text{m}}{19.1\,\text{m/s}}$$

9) Velocity at Outlet for Head Loss at Exit of Pipe Formula

Evaluate Formula

Formula

$$v = \sqrt{h_o \cdot 2 \cdot [g]}$$

Example with Units

$$12.4949\,\text{m/s} = \sqrt{7.96\,\text{m} \cdot 2 \cdot 9.8066\,\text{m/s}^2}$$

10) Velocity at section 1-1 for sudden enlargement Formula

Evaluate Formula

Formula

$$V_1' = V_2' + \sqrt{h_e \cdot 2 \cdot [g]}$$

Example with Units

$$4.6052\,\text{m/s} = 2.89\,\text{m/s} + \sqrt{0.15\,\text{m} \cdot 2 \cdot 9.8066\,\text{m/s}^2}$$

11) Velocity at section 2-2 for sudden contraction Formula

Evaluate Formula

Formula

$$V_2' = \frac{\sqrt{h_c \cdot 2 \cdot [g]}}{\left(\frac{1}{C_c}\right) - 1}$$

Example with Units

$$2.8956\,\text{m/s} = \frac{\sqrt{0.19\,\text{m} \cdot 2 \cdot 9.8066\,\text{m/s}^2}}{\left(\frac{1}{0.6}\right) - 1}$$

12) Velocity at section 2-2 for sudden enlargement Formula

Evaluate Formula

Formula

$$V_2' = V_1' - \sqrt{h_e \cdot 2 \cdot [g]}$$

Example with Units

$$2.4648\,\text{m/s} = 4.18\,\text{m/s} - \sqrt{0.15\,\text{m} \cdot 2 \cdot 9.8066\,\text{m/s}^2}$$

13) Velocity of Flow at Outlet of Nozzle Formula

Evaluate Formula

Formula

$$V_f = \sqrt{2 \cdot [g] \cdot \frac{H_{bn}}{1 + \left(4 \cdot \mu \cdot L \cdot \frac{{a_2}^2}{D \cdot \left(A^2\right)}\right)}}$$

Example with Units

$$19.3447\,\text{m/s} = \sqrt{2 \cdot 9.8066\,\text{m/s}^2 \cdot \frac{28.5\,\text{m}}{1 + \left(4 \cdot 0.01 \cdot 1200\,\text{m} \cdot \frac{3.97\text{E-}4\,\text{m}^{2\,2}}{0.12\,\text{m} \cdot \left(0.0113\,\text{m}^{2\,2}\right)}\right)}}$$

14) Velocity of Flow at outlet of Nozzle for Efficiency and Head Formula

Evaluate Formula

Formula

$$V_f = \sqrt{\eta_n \cdot 2 \cdot [g] \cdot H_{bn}}$$

Example with Units

$$21.1467\,\text{m/s} = \sqrt{0.8 \cdot 2 \cdot 9.8066\,\text{m/s}^2 \cdot 28.5\,\text{m}}$$

15) Velocity of Fluid for Head Loss due to Obstruction in Pipe Formula

Evaluate Formula

Formula

$$V_f = \frac{\sqrt{H_o \cdot 2 \cdot [g]}}{\left(\frac{A}{C_c \cdot \left(A - A'\right)}\right) - 1}$$

Example with Units

$$12.4919\,\text{m/s} = \frac{\sqrt{7.36\,\text{m} \cdot 2 \cdot 9.8066\,\text{m/s}^2}}{\left(\frac{0.0113\,\text{m}^2}{0.6 \cdot \left(0.0113\,\text{m}^2 - 0.0017\,\text{m}\right)}\right) - 1}$$

16) Velocity of fluid in pipe for head loss at entrance of pipe Formula

Evaluate Formula

Formula

$$v = \sqrt{\frac{h_i \cdot 2 \cdot [g]}{0.5}}$$

Example with Units

$$12.4949\,\text{m/s} = \sqrt{\frac{3.98\,\text{m} \cdot 2 \cdot 9.8066\,\text{m/s}^2}{0.5}}$$

17) Velocity of liquid at vena-contracta Formula

Evaluate Formula

Formula

$$V_c = \frac{A \cdot V_f}{C_c \cdot \left(A - A'\right)}$$

Example with Units

$$24.5226\,\text{m/s} = \frac{0.0113\,\text{m}^2 \cdot 12.5\,\text{m/s}}{0.6 \cdot \left(0.0113\,\text{m}^2 - 0.0017\,\text{m}\right)}$$

Variables used in list of Flow Regime Formulas above

- **A** Cross Sectional Area of Pipe *(Square Meter)*
- **A'** Maximum Area of Obstruction *(Meter)*
- a_2 Nozzle Area at Outlet *(Square Meter)*
- a_l Acceleration of Liquid *(Meter per Square Second)*
- **C** Velocity of Pressure Wave *(Meter per Second)*
- C_c Coefficient of Contraction in Pipe
- **D** Diameter of Pipe *(Meter)*
- D_{eq} Diameter of Equivalent Pipe *(Meter)*
- **F** Force *(Newton)*
- F_r Retarding Force on Liquid in Pipe *(Newton)*
- H_{bn} Head at Base of Nozzle *(Meter)*
- h_c Loss of Head Sudden Contraction *(Meter)*
- h_e Loss of Head Sudden Enlargement *(Meter)*
- h_i Head Loss at Pipe Entrance *(Meter)*
- H_l Loss of Head in Equivalent Pipe *(Meter)*
- h_o Head Loss at Pipe Exit *(Meter)*
- H_o Loss of Head Due to Obstruction in Pipe *(Meter)*
- **I** Intensity of Pressure of Wave *(Newton per Square Meter)*
- **L** Length of Pipe *(Meter)*
- M_w Mass of Water *(Kilogram)*
- **p** Pressure Rise at Valve *(Newton per Square Meter)*
- **Q** Discharge through Pipe *(Cubic Meter per Second)*
- **t** Time Taken to Travel *(Second)*
- t_c Time Required to Close Valve *(Second)*
- t_p Thickness of Liquid Carrying Pipe *(Meter)*
- **v** Velocity *(Meter per Second)*
- V_1' Velocity of Fluid at Section 1 *(Meter per Second)*

Constants, Functions, Measurements used in list of Flow Regime 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: **Weight** in Kilogram (kg) *Weight Unit Conversion*
- Measurement: **Time** in Second (s) *Time Unit Conversion*
- Measurement: **Area** in Square Meter (m²) *Area Unit Conversion*
- Measurement: **Pressure** in Newton per Square Meter (N/m²) *Pressure Unit Conversion*
- Measurement: **Speed** in Meter per Second (m/s) *Speed Unit Conversion*
- Measurement: **Acceleration** in Meter per Square Second (m/s²) *Acceleration 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: **Density** in Kilogram per Cubic Meter (kg/m³) *Density Unit Conversion*
- Measurement: **Stress** in Newton per Square Meter (N/m²) *Stress Unit Conversion*

- V_2' Velocity of Fluid at Section 2 *(Meter per Second)*
- V_c Velocity of Liquid Vena Contracta *(Meter per Second)*
- V_f Flow Velocity through Pipe *(Meter per Second)*
- η_n Efficiency for Nozzle
- μ Coefficient of Friction of Pipe
- ρ' Density of Fluid Inside the Pipe *(Kilogram per Cubic Meter)*
- σ_c Circumferential Stress *(Newton per Square Meter)*
- σ_l Longitudinal Stress *(Newton per Square Meter)*

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