Important Ducts Formulas PDF

Formulas
Examples
with Units

List of 29
Important Ducts Formulas

1) Continuity Equation for Ducts Formulas

1.1) Cross-Sectional Area of Duct at Section 1 using Continuity Equation Formula

Evaluate Formula

Formula

$$A_1 = \frac{A_2 \cdot V_2}{V_1}$$

Example with Units

$$1.4529\,\text{m}^2 = \frac{0.95\,\text{m}^2 \cdot 26\,\text{m/s}}{17\,\text{m/s}}$$

1.2) Cross-Sectional Area of Duct at Section 2 using Continuity Equation Formula

Evaluate Formula

Formula

$$A_2 = \frac{A_1 \cdot V_1}{V_2}$$

Example with Units

$$0.95\,\text{m}^2 = \frac{1.452941\,\text{m}^2 \cdot 17\,\text{m/s}}{26\,\text{m/s}}$$

1.3) Velocity of Air at Duct Section 1 using Continuity Equation Formula

Evaluate Formula

Formula

$$V_1 = \frac{A_2 \cdot V_2}{A_1}$$

Example with Units

$$17\,\text{m/s} = \frac{0.95\,\text{m}^2 \cdot 26\,\text{m/s}}{1.452941\,\text{m}^2}$$

1.4) Velocity of Air at Duct Section 2 using Continuity Equation Formula

Evaluate Formula

Formula

$$V_2 = \frac{A_1 \cdot V_1}{A_2}$$

Example with Units

$$26\,\text{m/s} = \frac{1.452941\,\text{m}^2 \cdot 17\,\text{m/s}}{0.95\,\text{m}^2}$$

2) Parameters of Ducts Formulas

2.1) Equivalent Diameter of Circular Duct for Rectangular Duct when Quantity of Air is Same Formula

Evaluate Formula

Formula

$$D_e = 1.256 \cdot \left(\frac{a^3 \cdot b^3}{a + b}\right)^{0.2}$$

Example with Units

$$0.8665\,\text{m} = 1.256 \cdot \left(\frac{0.9\,\text{m}^3 \cdot 0.7\,\text{m}^3}{0.9\,\text{m} + 0.7\,\text{m}}\right)^{0.2}$$

2.2) Equivalent Diameter of Circular Duct for Rectangular Duct when Velocity of Air is Same Formula

Evaluate Formula

Formula

$$D_e = \frac{2 \cdot a \cdot b}{a + b}$$

Example with Units

$$0.7875\,\text{m} = \frac{2 \cdot 0.9\,\text{m} \cdot 0.7\,\text{m}}{0.9\,\text{m} + 0.7\,\text{m}}$$

2.3) Friction Factor for Laminar Flow in Duct Formula

Evaluate Formula

Formula

$$f_{laminar} = \frac{64}{Re}$$

Example

$$0.8 = \frac{64}{80}$$

2.4) Friction Factor for Turbulent Flow in Duct Formula

Evaluate Formula

Formula

$$f_{turbulent} = \frac{0.3164}{Re^{0.25}}$$

Example

$$0.1058 = \frac{0.3164}{80^{0.25}}$$

2.5) Quantity of Air given Velocity Formula

Evaluate Formula

Formula

$$Q = V \cdot A_{cs}$$

Example with Units

$$18.55\,\text{m}^3/\text{s} = 35\,\text{m/s} \cdot 0.53\,\text{m}^2$$

2.6) Reynolds Number given Friction Factor for Laminar Flow Formula

Evaluate Formula

Formula

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

Example

$$80 = \frac{64}{0.8}$$

2.7) Reynolds Number in Duct Formula

Evaluate Formula

Formula

$$Re = \frac{d \cdot V_m}{\upsilon}$$

Example with Units

$$80.0001 = \frac{533.334\,\text{m} \cdot 15\,\text{m/s}}{100\,\text{m}^2/\text{s}}$$

2.8) Velocity Pressure in Ducts Formula

Evaluate Formula

Formula

$$P_v = 0.6 \cdot V_m^2$$

Example with Units

$$13.7615\,\text{mmAq} = 0.6 \cdot 15\,\text{m/s}^2$$

3) Pressure Formulas

3.1) Dynamic Loss Coefficient given Dynamic Pressure Loss Formula

Evaluate Formula

Formula

$$C = \frac{P_d}{0.6 \cdot V^2}$$

Example with Units

$$0.02 = \frac{1.498471\,\text{mmAq}}{0.6 \cdot 35\,\text{m/s}^2}$$

3.2) Dynamic Loss Coefficient given Equivalent Additional Length Formula

Evaluate Formula

Formula

$$C = \frac{f \cdot L_e}{m}$$

Example with Units

$$0.02 = \frac{0.8 \cdot 0.00175\,\text{m}}{0.07\,\text{m}}$$

3.3) Dynamic Pressure Loss Formula

Evaluate Formula

Formula

$$P_d = C \cdot 0.6 \cdot V^2$$

Example with Units

$$1.4985\,\text{mmAq} = 0.02 \cdot 0.6 \cdot 35\,\text{m/s}^2$$

3.4) Length of Duct given Pressure Loss due to Friction Formula

Evaluate Formula

Formula

$$L = \frac{2 \cdot \Delta P_f \cdot m}{f \cdot \rho_{air} \cdot V_m^2}$$

Example with Units

$$0.0654\,\text{m} = \frac{2 \cdot 10.5\,\text{mmAq} \cdot 0.07\,\text{m}}{0.8 \cdot 1.225\,\text{kg/m}^3 \cdot 15\,\text{m/s}^2}$$

3.5) Pressure Drop in Circular Duct Formula

Evaluate Formula

Formula

$$\Delta P_c = \frac{0.6 \cdot f \cdot L \cdot V_m^2}{\frac{d}{4}}$$

Example with Units

$$0.0054\,\text{mmAq} = \frac{0.6 \cdot 0.8 \cdot 0.0654\,\text{m} \cdot 15\,\text{m/s}^2}{\frac{533.334\,\text{m}}{4}}$$

3.6) Pressure Drop in Square Duct Formula

Evaluate Formula

Formula

$$\Delta P_s = \frac{0.6 \cdot f \cdot L \cdot V_m^2}{\frac{s^2}{2 \cdot (s + s)}}$$

Example with Units

$$0.32\,\text{mmAq} = \frac{0.6 \cdot 0.8 \cdot 0.0654\,\text{m} \cdot 15\,\text{m/s}^2}{\frac{9\,\text{m}^2}{2 \cdot (9\,\text{m} + 9\,\text{m})}}$$

3.7) Pressure Loss at Discharge or Exit Formula

Evaluate Formula

Formula

$$\Delta P_{dis} = 0.6 \cdot V^2$$

Example with Units

$$74.9235\,\text{mmAq} = 0.6 \cdot 35\,\text{m/s}^2$$

3.8) Pressure Loss at Suction Formula

Evaluate Formula

Formula

$$P_d = C \cdot 0.6 \cdot V^2$$

Example with Units

$$1.4985\,\text{mmAq} = 0.02 \cdot 0.6 \cdot 35\,\text{m/s}^2$$

3.9) Pressure Loss Coefficient at Inlet of Duct Formula

Evaluate Formula

Formula

$$C_1 = \left(1 - \frac{A_1}{A_2}\right)^2$$

Example with Units

$$0.2803 = \left(1 - \frac{1.452941\,\text{m}^2}{0.95\,\text{m}^2}\right)^2$$

3.10) Pressure Loss Coefficient at Outlet of Duct Formula

Evaluate Formula

Formula

$$C_2 = \left(\frac{A_2}{A_1} - 1\right)^2$$

Example with Units

$$0.1198 = \left(\frac{0.95\,\text{m}^2}{1.452941\,\text{m}^2} - 1\right)^2$$

3.11) Pressure Loss due to Friction in Ducts Formula

Evaluate Formula

Formula

$$\Delta P_f = \frac{f \cdot L \cdot \rho_{air} \cdot V_m^2}{2 \cdot m}$$

Example with Units

$$10.5\,\text{mmAq} = \frac{0.8 \cdot 0.0654\,\text{m} \cdot 1.225\,\text{kg/m}^3 \cdot 15\,\text{m/s}^2}{2 \cdot 0.07\,\text{m}}$$

3.12) Pressure Loss due to Gradual Contraction given Pressure Loss Coefficient at Section 1 Formula

Evaluate Formula

Formula

$$\Delta P_{gc} = 0.6 \cdot V_1^2 \cdot C_r \cdot C_1$$

Example with Units

$$1.9817\,\text{mmAq} = 0.6 \cdot 17\,\text{m/s}^2 \cdot 0.4 \cdot 0.280277$$

3.13) Pressure Loss due to Gradual Contraction given Velocity of Air at Point 2 Formula

Evaluate Formula

Formula

$$\Delta P_{gc} = 0.6 \cdot V_2^2 \cdot C_r \cdot C_2$$

Example with Units

$$1.9816\,\text{mmAq} = 0.6 \cdot 26\,\text{m/s}^2 \cdot 0.4 \cdot 0.119822$$

3.14) Pressure Loss due to Sudden Contraction given Velocity of Air at Point 1 Formula

Evaluate Formula

Formula

$$\Delta P_{sc\,1} = 0.6 \cdot V_1^2 \cdot C$$

Example with Units

$$0.3535\,\text{mmAq} = 0.6 \cdot 17\,\text{m/s}^2 \cdot 0.02$$

3.15) Pressure Loss due to Sudden Contraction given Velocity of Air at point 2 Formula

Evaluate Formula

Formula

$$\Delta P_{sc\,2} = 0.6 \cdot V_2^2 \cdot C_2$$

Example with Units

$$4.9541\,\text{mmAq} = 0.6 \cdot 26\,\text{m/s}^2 \cdot 0.119822$$

3.16) Pressure Loss due to Sudden Enlargement Formula

Evaluate Formula

Formula

$$\Delta P_{se} = 0.6 \cdot \left(V_1 - V_2 \right)^2$$

Example with Units

$$4.9541\,\text{mmAq} = 0.6 \cdot \left(17\,\text{m/s} - 26\,\text{m/s} \right)^2$$

3.17) Total Pressure required at Inlet to Duct Formula

Evaluate Formula

Formula

$$P_t = \Delta P_f + P_v$$

Example with Units

$$24.2615\,\text{mmAq} = 10.5\,\text{mmAq} + 13.76147\,\text{mmAq}$$

Variables used in list of Ducts Formulas above

- **a** Longer Side *(Meter)*
- A_1 Cross-Sectional Area of Duct at Section 1 *(Square Meter)*
- A_2 Cross-Sectional Area of Duct at Section 2 *(Square Meter)*
- A_{cs} Cross-Sectional Area of Duct *(Square Meter)*
- **b** Shorter Side *(Meter)*
- **C** Dynamic Loss Coefficient
- C_1 Pressure Loss Coefficient at 1
- C_2 Pressure Loss Coefficient at 2
- C_r Pressure Loss Coefficient
- **d** Diameter of Circular Duct *(Meter)*
- D_e Equivalent Diameter of Duct *(Meter)*
- **f** Friction Factor in Duct
- $f_{laminar}$ Friction Factor for Laminar Flow
- $f_{turbulent}$ Friction Factor for Turbulent Flow in Duct
- **L** Length of Duct *(Meter)*
- L_e Equivalent Additional Length *(Meter)*
- **m** Hydraulic Mean Depth *(Meter)*
- P_d Dynamic Pressure Loss *(Millimeter Water (4 °C))*
- P_t Total Pressure Required *(Millimeter Water (4 °C))*
- P_v Velocity Pressure in Duct *(Millimeter Water (4 °C))*
- **Q** Quantity of Air *(Cubic Meter per Second)*
- **Re** Reynolds Number
- **S** Side *(Meter)*
- **V** Velocity of Air *(Meter per Second)*
- V_1 Velocity of Air at Section 1 *(Meter per Second)*
- V_2 Velocity of Air at Section 2 *(Meter per Second)*
- V_m Mean Velocity of Air *(Meter per Second)*

Constants, Functions, Measurements used in list of Ducts Formulas above

- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Pressure** in Millimeter Water (4 °C) (mmAq)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Volumetric Flow Rate** in Cubic Meter per Second (m³/s)
  Volumetric Flow Rate Unit Conversion
- Measurement: **Kinematic Viscosity** in Square Meter per Second (m²/s)
  Kinematic Viscosity Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion

- ΔP_c Pressure Drop in Circular Duct *(Millimeter Water (4 °C))*
- ΔP_{dis} Pressure Loss at Discharge *(Millimeter Water (4 °C))*
- ΔP_f Pressure Loss Due to Friction in Ducts *(Millimeter Water (4 °C))*
- ΔP_{gc} Pressure Loss due to Gradual Contraction *(Millimeter Water (4 °C))*
- ΔP_s Pressure Drop in Square Duct *(Millimeter Water (4 °C))*
- $\Delta P_{sc\ 1}$ Pressure Loss due to Sudden Contraction at point 1 *(Millimeter Water (4 °C))*
- $\Delta P_{sc\ 2}$ Pressure Loss due to Sudden Contraction at point 2 *(Millimeter Water (4 °C))*
- ΔP_{se} Pressure Loss due to Sudden Enlargement *(Millimeter Water (4 °C))*
- ρ_{air} Air Density *(Kilogram per Cubic Meter)*
- υ Kinematic Viscosity *(Square Meter per Second)*

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