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Ducts Formulas

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List of 29 Ducts Formulas

Ducts

Continuity Equation for Ducts

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

Open Calculator

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

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

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

Open Calculator

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

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

3) Velocity of Air at Duct Section 1 using Continuity Equation

Open Calculator

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

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

4) Velocity of Air at Duct Section 2 using Continuity Equation

Open Calculator

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

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

Parameters of Ducts

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

Open Calculator

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

ex $$0.866503\text{m} = 1.256 \cdot \left(\frac{(0.9\text{m})^3 \cdot (0.7\text{m})^3}{0.9\text{m} + 0.7\text{m}} \right)^{0.2}$$

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

Open Calculator

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

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

7) Friction Factor for Laminar Flow in Duct

Open Calculator

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

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

8) Friction Factor for Turbulent Flow in Duct

Open Calculator

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

ex $$0.105795 = \frac{0.3164}{(80)^{0.25}}$$

9) Quantity of Air given Velocity

Open Calculator

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

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

10) Reynolds Number given Friction Factor for Laminar Flow

Open Calculator

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

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

11) Reynolds Number in Duct

Open Calculator

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

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

12) Velocity Pressure in Ducts

Open Calculator

fx $$\mathrm{P_v} = 0.6 \cdot \mathrm{V_m^2}$$

ex $$13.76147\mathrm{mmAq} = 0.6 \cdot (15\mathrm{m/s})^2$$

Pressure

13) Dynamic Loss Coefficient given Dynamic Pressure Loss

Open Calculator

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

ex $$0.02 = \frac{1.498471\mathrm{mmAq}}{0.6 \cdot (35\mathrm{m/s})^2}$$

14) Dynamic Loss Coefficient given Equivalent Additional Length

Open Calculator

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

ex $$0.02 = \frac{0.8 \cdot 0.00175\mathrm{m}}{0.07\mathrm{m}}$$

15) Dynamic Pressure Loss

Open Calculator

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

ex $$1.498471\text{mmAq} = 0.02 \cdot 0.6 \cdot (35\text{m/s})^2$$

16) Length of Duct given Pressure Loss due to Friction

Open Calculator

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

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

17) Pressure Drop in Circular Duct

Open Calculator

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

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

18) Pressure Drop in Square Duct

Open Calculator

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

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

19) Pressure Loss at Discharge or Exit

Open Calculator

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

ex $$74.92355\text{mmAq} = 0.6 \cdot (35\text{m/s})^2$$

20) Pressure Loss at Suction

Open Calculator

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

ex $$1.498471\text{mmAq} = 0.02 \cdot 0.6 \cdot (35\text{m/s})^2$$

21) Pressure Loss Coefficient at Inlet of Duct

Open Calculator

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

ex $$0.280277 = \left(1 - \frac{1.452941\text{m}^2}{0.95\text{m}^2}\right)^2$$

22) Pressure Loss Coefficient at Outlet of Duct

Open Calculator

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

ex $$0.119822 = \left(\frac{0.95\text{m}^2}{1.452941\text{m}^2} - 1\right)^2$$

23) Pressure Loss due to Friction in Ducts

Open Calculator

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

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

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

Open Calculator

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

ex $$1.981653\text{mmAq} = 0.6 \cdot (17\text{m/s})^2 \cdot 0.4 \cdot 0.280277$$

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

Open Calculator

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

ex $$1.981643\text{mmAq} = 0.6 \cdot (26\text{m/s})^2 \cdot 0.4 \cdot 0.119822$$

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

Open Calculator

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

$$0.353517\text{mmAq} = 0.6 \cdot (17\text{m/s})^2 \cdot 0.02$$

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

Open Calculator

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

$$4.954108\text{mmAq} = 0.6 \cdot (26\text{m/s})^2 \cdot 0.119822$$

28) Pressure Loss due to Sudden Enlargement

Open Calculator

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

$$4.954128\text{mmAq} = 0.6 \cdot (17\text{m/s} - 26\text{m/s})^2$$

29) Total Pressure required at Inlet to Duct

Open Calculator

$$P_t = \Delta P_f + P_v$$

$$24.26147\text{mmAq} = 10.5\text{mmAq} + 13.76147\text{mmAq}$$

Variables Used

- **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)*
- 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)*

Constants, Functions, Measurements used

- 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

Check other formula lists

- **Air Refrigeration Formulas**
- **Ducts Formulas**

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