# Duct Sizing by the Equal-Friction Method

Round duct diameter for an air flow at a chosen friction rate (Colebrook friction factor), the velocity, and the equivalent rectangular duct for an aspect ratio.

**Method:** ASHRAE Handbook—Fundamentals (2017); ch. 21 (Darcy–Weisbach, Colebrook, Huebscher equivalent diameter, equal-friction method)

## Input parameters

Unit system: SI

| Parameter | Value | Unit |
|---|---|---|
| Air flow | 7,200.0 | m³/h |
| Friction rate | 1.0000 | Pa/m |
| Duct roughness | 0.090000 | mm |
| Air density | 1.2000 | kg/m³ |
| Air viscosity | 1.8100e-05 | Pa·s |
| Rectangular aspect ratio | 2.0000 | |

## Calculated results

| Parameter | Value | Unit |
|---|---|---|
| Round duct diameter | 573.54 | mm |
| Velocity | 7.7413 | m/s |
| Reynolds number | 294,360 | |
| Rectangular duct, long side | 752.99 | mm |
| Rectangular duct, short side | 376.49 | mm |

### Notes for this case

• Darcy–Weisbach with the Colebrook friction factor; rectangular size from Huebscher's equivalent diameter D_e = 1.30(ab)^0.625/(a + b)^0.25. Typical friction rates: 0.8–1.0 Pa/m for low-pressure supply ducts. Round the result up to a standard size.

## Formula and method

$$\frac{\Delta p}{L} = \frac{f}{D}\frac{\rho v^2}{2}, \quad \frac{1}{\sqrt{f}} = -2\log_{10}\left(\frac{\varepsilon}{3.7D} + \frac{2.51}{Re\sqrt{f}}\right), \quad D_e = \frac{1.30(ab)^{0.625}}{(a+b)^{0.25}}$$

### Variables

| | | |
|---|---|---|
| $\dot{V}$ | Air flow | m³/s |
| $\Delta p/L$ | Friction rate, in Pa/m (1 in WC per 100 ft = 8.17 Pa/m) | - |
| $\varepsilon$ | Duct roughness | m |
| $\rho$ | Air density | kg/m³ |
| $\mu$ | Air viscosity | Pa·s |
| $a/b$ | Rectangular aspect ratio | - |
| $D$ | Round duct diameter | m |
| $v$ | Velocity | m/s |
| $Re$ | Reynolds number | - |
| $a$ | Rectangular duct, long side | m |
| $b$ | Rectangular duct, short side | m |

### Method and standards

Colebrook and Huebscher.

### Assumptions and limits

- Fully developed turbulent flow; standard air.
- The friction rate is entered in Pa/m in every unit system; 1 in WC per 100 ft is 8.17 Pa/m.

### References

• ASHRAE Handbook—Fundamentals (2017)
• ch. 21 (Darcy–Weisbach, Colebrook, Huebscher equivalent diameter, equal-friction method)

## Report details

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|---|---|
| Report reference | FCC-JTM1-W4R3 (the same inputs always give the same reference) |
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| Release checks | 2 reference cases of this calculator, computed independently, are checked on every release |

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

### This calculator online

https://calc.firecad.com/hvac/ducts/duct-equal-friction-sizing

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.