Hydronic Pipe Sizing by Friction Rate

Water flow for a heating or chilled-water load, and the pipe diameter and velocity that give a chosen friction rate (Darcy–Weisbach with Colebrook).

Method: ASHRAE Handbook—Fundamentals (2017); ch. 22 (pipe sizing, Darcy–Weisbach with Colebrook)

Input parameters

Unit system: SI

Parameter	Value	Unit
Heat load	100.00	kW
Water temperature difference	6.0000	K
Water specific heat	4.1900	kJ/(kg·K)
Water density	999.00	kg/m³
Water viscosity	1.3000	cP
Friction rate	300.00	Pa/m
Pipe roughness	0.045000	mm

Calculated results

Parameter	Value	Unit
Water mass flow	3.9777	kg/s
Water volume flow	14.334	m³/h
Pipe inside diameter	62.613	mm
Velocity	1.2931	m/s

Notes for this case

- Typical design friction rates are 100–400 Pa/m with velocities of 0.5–1.5 m/s in small pipes and up to 3 m/s in mains. Pick the next larger standard bore.

Formula and method

$$\dot{m} = \frac{Q}{c_p \Delta T}, \quad \frac{\Delta p}{L} = \frac{f}{D}\frac{\rho v^2}{2}$$

Variables

Q	Heat load	W
ΔT	Water temperature difference	K
c_p	Water specific heat	J/(kg·K)
ρ	Water density	kg/m³
μ	Water viscosity	Pa·s
$\Delta p/L$	Friction rate, in Pa/m (1 ft of water per 100 ft = 98.1 Pa/m)	-
ε	Pipe roughness	m
$\dot{m}$	Water mass flow	kg/s
$\dot{V}$	Water volume flow	m³/s
D	Pipe inside diameter	m
v	Velocity	m/s

Method and standards

Energy balance and Darcy–Weisbach.

Assumptions and limits

- Turbulent flow; water properties entered.
- The friction rate is in Pa/m in every unit system: 1 ft of water per 100 ft is 98.1 Pa/m, so a US figure of 4 ft/100 ft is about 390 Pa/m.

References

• ASHRAE Handbook—Fundamentals (2017)
• ch. 22 (pipe sizing, Darcy–Weisbach with Colebrook)

Report details

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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/chillers/hydronic-pipe-sizing

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.