Furnace Door Opening: Hot Gas Leakage and Heat Loss

Hot gas outflow through an open furnace door above the neutral plane driven by the buoyancy of the furnace atmosphere, and the heat carried out.

Method: Buoyancy-driven flow through an opening

Input parameters

Unit system: SI

Parameter	Value	Unit
Opening width	1.5000	m
Opening height above the neutral plane	0.60000	m
Furnace gas temperature	1,200.0	°C
Ambient temperature	30.000	°C
Discharge coefficient	0.60000	
Gas specific heat	1.2500	kJ/(kg·K)

Calculated results

Parameter	Value	Unit
Pressure difference at the top	5.4416	Pa
Outflow velocity at the top	6.7393	m/s
Hot gas escaping	2,092.9	kg/h
Heat lost with the gas	850.24	kW

Notes for this case

• Above the neutral plane the furnace is at higher pressure than outside by gz(ρ_a − ρ_g); integrating the outflow velocity over the opening gives ṁ = C_dWρ_g(2/3)√(2g(ρ_a − ρ_g)/ρ_g)h^(3/2) (densities ≈ 353/T). Below the neutral plane cold air flows in. Keep furnace pressure near zero at the hearth and openings short and narrow.

Formula and method

$$\Delta p(z) = gz(\rho_a - \rho_g), \quad \dot{m} = C_d W \rho_g \frac{2}{3}\sqrt{\frac{2g(\rho_a - \rho_g)}{\rho_g}}\, h^{3/2}$$

Variables

W	Opening width	m
h	Opening height above the neutral plane	m
T_g	Furnace gas temperature	K
T_a	Ambient temperature	K
C_d	Discharge coefficient	-
c_p	Gas specific heat	J/(kg·K)
Δp_{top}	Pressure difference at the top	Pa
v_{top}	Outflow velocity at the top	m/s
$\dot{m}_g$	Hot gas escaping	kg/s
$\dot{Q}$	Heat lost with the gas	W

Method and standards

Door losses.

Assumptions and limits

- Ideal-gas densities 353/T; quiescent surroundings.

References

Buoyancy-driven flow through an opening

Report details

Report reference	FCC-771F-GHFB (the same inputs always give the same reference)
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Release checks	3 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/materials/steelmaking-foundry/furnace-door-gas-leakage

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.