Stack (Chimney) Diameter from Exit Velocity

Inside diameter of a stack or flue for a flue gas flow and design exit velocity, with the actual and normal gas volumes and the velocity in a chosen diameter.

Method: Continuity equation; ideal gas (CODATA 2018 gas constant)

Input parameters

Unit system: SI

Parameter	Value	Unit
Flue gas mass flow	60,000	kg/h
Flue gas molar mass About 30 kg/kmol for coal and oil flue gas, 27.5–28.5 for natural gas.	30.000	kg/kmol
Flue gas temperature at the exit	150.00	°C
Pressure at the exit (absolute) The site barometric pressure.	1.0132	bar
Design exit velocity	15.000	m/s
Chosen inside diameter to check (0 = skip)	0	m

Calculated results

Parameter	Value	Unit
Required inside diameter	1.2796	m
Flow area	1.2860	m²
Actual flue gas volume flow	69,445	m³/h
Normal flue gas volume flow (0 °C, 1 atm)	44,828	Nm³/h
Flue gas density at the exit	0.86399	kg/m³

Formula and method

$$\rho_g = \frac{p\,M_g}{R\,T_g} \qquad \dot{V}_g = \frac{\dot{m}_g}{\rho_g} \qquad A = \frac{\dot{V}_g}{v} \qquad D = \sqrt{\frac{4A}{\pi}}$$

$$\dot{V}_{g,N} = \frac{\dot{m}_g\,V_{m,N}}{M_g} \qquad v_{sel} = \frac{4\,\dot{V}_g}{\pi\,D_{sel}^2}$$

Variables

$\dot{m}_g$	flue gas mass flow	kg/s
M_g	flue gas molar mass	kg/kmol
T_g	flue gas temperature at the exit	K
p	absolute pressure at the exit	Pa
v	design exit velocity	m/s
D_{sel}	chosen inside diameter to check	m
D	required inside diameter	m
A	flow area	m²
$\dot{V}_g$	actual flue gas volume flow	m³/s
$\dot{V}_{g,N}$	normal flue gas volume flow (0 °C, 101.325 kPa)	Nm³/s
ρ_g	flue gas density at the exit	kg/m³
v_{sel}	exit velocity in the chosen diameter	m/s

R	universal gas constant	J/(mol·K)
$V_{m,N}$	molar volume at 0 °C, 101.325 kPa (22.414 m³/kmol)	m³/kmol

Method and standards

Continuity for a circular duct and the ideal-gas density at the exit temperature and pressure. Normal volume with the ideal-gas molar volume at 0 °C and 101.325 kPa (CODATA 2018).

Assumptions and limits

- Circular inside section; for a rectangular flue use the equivalent diameter.
- Uniform velocity over the section.
- Ideal gas; the molar mass of wet flue gas is about 30 kg/kmol for coal and oil and 27.5–28.5 kg/kmol for natural gas.

References

- Continuity equation; ideal gas (CODATA 2018 gas constant)

Report details

Report reference	FCC-A011-EJ5T (the same inputs always give the same reference)
Generated	17 November 2026, 19:44 UTC
Calculator	Stack (Chimney) Diameter from Exit Velocity
Method last reviewed	10 November 2026
Software release	FireCAD Calc, release of 17 November 2026
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/boilers-power-plant/emissions-stacks/stack-diameter

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Reopens the calculator with the inputs of this report.