# Stack (Chimney) Natural Draught

Theoretical natural draught of a stack or chimney from its height, the flue gas and ambient temperatures, and the site altitude or barometric pressure.

**Method:** ISO 2533:1975 (standard atmosphere); IUPAC atomic weights; ...

## Input parameters

Unit system: SI

| Parameter | Value | Unit |
|---|---|---|
| Stack height above the gas inlet | 60.000 | m |
| Ambient air temperature | 30.000 | °C |
| Mean flue gas temperature in the stack | 150.00 | °C |
| Flue gas molar mass<br>About 30 kg/kmol for coal and oil flue gas, 27.5–28.5 for natural gas; the combustion calculators give it. | 30.000 | kg/kmol |
| Site pressure from | Altitude (ISO 2533 standard atmosphere) | |
| Site altitude above sea level | 0 | m |
| Barometric pressure at the site (absolute) | 1.0132 | bar |

## Calculated results

| Parameter | Value | Unit |
|---|---|---|
| Theoretical natural draught | 18.026 | mmWC |
| Ambient air density | 1.1644 | kg/m³ |
| Flue gas density in the stack | 0.86399 | kg/m³ |
| Barometric pressure used | 1.0132 | bar |

## Formula and method

$$\Delta p = g\,H\,(\rho_a - \rho_g) \qquad \rho = \frac{p\,M}{R\,T}$$

$$p = p_0 \left(1 - \frac{L\,z}{T_0}\right)^{\frac{g\,M_{ISA}}{R^*\,L}}$$

### Variables

| | | |
|---|---|---|
| $H$ | stack height above the gas inlet | m |
| $T_a$ | ambient air temperature | K |
| $T_g$ | mean flue gas temperature in the stack | K |
| $M_g$ | flue gas molar mass | kg/kmol |
| $\mathrm{site}$ | site pressure from altitude or entered | – |
| $z$ | site altitude above sea level | m |
| $p_s$ | barometric pressure entered | Pa |
| $\Delta p$ | theoretical natural draught | Pa |
| $\rho_a$ | ambient air density | kg/m³ |
| $\rho_g$ | flue gas density in the stack | kg/m³ |
| $p$ | barometric pressure used | Pa |
| $g$ | standard gravity, 9.806 65 | m/s² |

| | | |
|---|---|---|
| $R$ | universal gas constant, 8.314 462 618 | J/(mol·K) |
| $M$ | molar mass (dry air 28.96 kg/kmol, or $M_g$) | kg/kmol |
| $p_0$$, $$T_0$$, $$L$ | ISO 2533 sea-level pressure 101 325 Pa, temperature 288.15 K, lapse rate 0.0065 K/m | – |
| $M_{ISA}$$, $$R^*$ | ISO 2533 air molar mass 28.964 42 kg/kmol and gas constant 8.314 32 J/(mol·K) | – |

### Method and standards

Hydrostatic pressure difference between a column of ambient air and a column of flue gas of the same height, both ideal gases at the site pressure. The site pressure is either entered or taken from the ISO 2533:1975 standard atmosphere at the altitude; ISO 2533's own constants are used in the barometric formula so that its tabulated pressures are reproduced. Dry air molar mass from the ASME PTC 4 composition and IUPAC atomic weights.

### Assumptions and limits

- Theoretical (static) draught; friction, exit velocity head and fittings losses are not deducted.
- Mean gas temperature over the height; cooling along a tall unlined steel stack lowers it.
- Dry ambient air; humidity lowers the air density, by about 1–1.5 % in hot humid air (30 °C, 80 % RH), which reduces the draught by a few per cent.
- Pressure variation over the stack height is neglected (about 1 % per 80 m): for very tall stacks, 300–500 m, both densities fall by 4–6 % at the top and the draught is overstated by roughly 2–3 %.

### References

• ISO 2533:1975 (standard atmosphere)
• IUPAC atomic weights
• CODATA 2018 (gas constant)

## Report details

| | |
|---|---|
| Report reference | FCC-HVAH-HZVK (the same inputs always give the same reference) |
| Generated | 17 November 2026, 19:48 UTC |
| Calculator | Stack (Chimney) Natural Draught |
| 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-natural-draught

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.