Excess Air from Flue Gas O_2, CO_2 and CO

Turns dry-basis analyser readings into excess air by the simple O_2 formula and by the ASME PTC 4 nitrogen balance with CO correction.

Method: ASME PTC 4-2013 §5.11.4; U.S. Standard Atmosphere (20.95 % O_2)

Input parameters

Unit system: SI

Parameter	Value	Unit
Oxygen in dry flue gas Dry basis, as the analyser reads it.	3.0000	%
Carbon dioxide in dry flue gas (0 = not measured) Dry basis. Enter 0 if CO_2 is not measured: only the simple O_2 method is then shown, because the nitrogen balance needs CO_2.	10.500	%
Carbon monoxide in dry flue gas	10.000	ppm

Calculated results

Parameter	Value	Unit
Excess air, simple O_2 method	16.713	%
Excess air, PTC 4 nitrogen balance	15.054	%
Nitrogen in dry flue gas (by difference)	86.499	%
Air ratio λ = 1 + EA (PTC 4)	1.1505	

Formula and method

$$EA_{O_2} = \frac{y_{O_2}}{0.2095 - y_{O_2}}$$

$$y_{N_2} = 1 - y_{O_2} - y_{CO_2} - y_{CO} \qquad EA_{PTC4} = \frac{y_{O_2} - \frac{1}{2} y_{CO}}{\frac{0.2095}{0.7905}\, y_{N_2} - \left(y_{O_2} - \frac{1}{2} y_{CO}\right)} \qquad \lambda = 1 + EA_{PTC4}$$

Variables

y_{O_2}	oxygen in dry flue gas, volume fraction	–
y_{CO_2}	carbon dioxide in dry flue gas, volume fraction (0 = not measured)	–
y_{CO}	carbon monoxide in dry flue gas, volume fraction (1 ppm = 10^{-6})	–
y_{N_2}	nitrogen (with argon) in dry flue gas, by difference	–
EA_{O_2}	excess air fraction by the simple method	–
EA_{PTC4}	excess air fraction by the PTC 4 nitrogen balance	–
λ	air ratio, actual air over stoichiometric air	–

Method and standards

Air is taken as 20.95 % O_2 and 79.05 % atmospheric nitrogen (N_2 + Ar) by volume, as in ASME PTC 4-2013. The nitrogen in the flue gas all came with the air (fuel nitrogen is neglected), so the air supplied is y_N_2 / 0.7905 and the oxygen that came with it is 0.2095/0.7905 · y_N_2. The oxygen left over, after crediting half a mole of O_2 per mole of CO that did not burn, divided by the oxygen consumed gives the excess air.

Assumptions and limits

- Dry-basis readings; convert wet readings first.
- Fuel nitrogen is neglected in the balance (it adds to the "air" nitrogen and makes the excess air read slightly high; negligible for gas and oil).
- SO_2 and any other unmeasured species fall into the nitrogen by difference, slightly raising the PTC 4 value for high-sulphur fuels.
- No wet/dry or reference-O_2 conversion is done here; use the emission O_2 correction calculator for those.

- Undefined when O_2 reaches 20.95 % or when the readings leave no nitrogen.
- CO_2 = 0 is taken as not measured: only the simple O_2 method is shown, since nitrogen by difference would then include the CO_2.

References

• ASME PTC 4-2013 §5.11.4
• U.S. Standard Atmosphere (20.95 % O_2)

Report details

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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/combustion/flue-gas-analyzer-converter

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.