CO_2 from O_2 in Flue Gas (and CO_2 max)

CO_2 in dry flue gas for a given O_2 reading, the maximum CO_2 at stoichiometric combustion and the excess air, from the fuel's ultimate analysis.

Method: Combustion stoichiometry of the dry flue gas; ASME PTC 4 air composition

Input parameters

Unit system: SI

Parameter	Value	Unit
O_2 in dry flue gas	5.0000	%
Carbon	45.000	%
Hydrogen	3.5000	%
Oxygen	5.0000	%
Nitrogen	1.0000	%
Sulphur	0.50000	%
Ash	35.000	%
Moisture	10.000	%

Calculated results

Parameter	Value	Unit
CO_2 in dry flue gas	13.793	%
Maximum CO_2 (stoichiometric)	18.117	%
Excess air	30.356	%

Formula and method

$$n_{O_2} = \frac{C}{M_C} + \frac{H}{2M_{H_2}} + \frac{S}{M_S} - \frac{O}{M_{O_2}} \qquad n_a = \frac{n_{O_2}}{0.2095}$$

$$n_{d,0} = \frac{C}{M_C} + \frac{S}{M_S} + \frac{N}{M_{N_2}} + 0.7905\, n_a \qquad EA = \frac{O_2\, n_{d,0}}{n_a\,(0.2095 - O_2)}$$

$$CO_2 = \frac{C/M_C}{n_{d,0} + EA\, n_a} \qquad CO_{2,max} = \frac{C/M_C}{n_{d,0}}$$

Variables

O_2	O_2 in dry flue gas	–
$C\$, \$H\$, \$O\$, \$N\$, \$S\$, \$A\$, \$M$	ultimate analysis as fired, mass fractions (A and M only complete the 100 % check)	–
CO_2	CO_2 in dry flue gas	–
$CO_{2,max}$	maximum CO_2 (stoichiometric)	–
EA	excess air	–
n_{O_2}	oxygen needed per kg of fuel	kmol/kg
n_a	theoretical air per kg of fuel	kmol/kg
$n_{d,0}$	dry flue gas at zero excess air	kmol/kg
$M_C\$, \$M_{H_2}\$, \$M_S\$, \$M_{O_2}\$, \$M_{N_2}$	molar masses	kg/kmol

Method and standards

Dry flue gas balance with air of 20.95 % O_2 and 79.05 % "atmospheric nitrogen" (N_2, Ar and CO_2 of air) as in ASME PTC 4; molar

masses from IUPAC 2013 atomic weights.

Assumptions and limits

- Complete combustion (no CO); dry basis; sulphur counted as SO_2 but not in the CO_2 reading; the 0.04 % CO_2 of the air is counted with the nitrogen.
- The analysis must sum to 100 %. Ash and moisture do not enter the dry gas balance: the result depends only on the ratios of C, H, O, N and S.
- An Orsat (KOH) reading absorbs CO_2 and SO_2 together; for a high-sulphur fuel compare it with CO_2 plus the SO_2 share.

References

- Combustion stoichiometry of the dry flue gas
- ASME PTC 4 air composition

Report details

Report reference	FCC-6BD0-RCG6 (the same inputs always give the same reference)
Generated	17 November 2026, 19:36 UTC
Calculator	CO_2 from O_2 in Flue Gas (and CO_2 max)
Method last reviewed	11 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/combustion/o2-co2-relationship

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.