Zirconia Oxygen Probe EMF and Oxygen Content

Cell EMF of a zirconia oxygen analyser from the oxygen content and cell temperature by the Nernst equation, and the oxygen content from a measured EMF.

Method: Nernst equation for an oxygen concentration cell; E = (R T / 4F) ln(p_ref / p)

Input parameters

Unit system: SI

Parameter	Value	Unit
Cell temperature	750.00	°C
Oxygen in the sample (by volume)	3.0000	%
Oxygen in the reference gas 20.95 % is dry air. Humid instrument or ambient air holds about 20.6–20.7 %; enter that if the reference air is not dried.	20.950	%
Measured cell EMF (to find O_2)	50.000	mV

Calculated results

Parameter	Value	Unit
Cell EMF for the oxygen entered	42.839	mV
Oxygen for the EMF entered	2.1679	%

Notes for this case

- Wet-basis oxygen at the cell: in-situ probes read wet flue gas, extractive analysers usually dry gas.

Formula and method

$$E = \frac{RT}{4F} \ln \frac{O_{2,ref}}{O_2}$$

Variables

T	Cell temperature	K
O_2	Oxygen in the sample (by volume)	-
$O_{2,ref}$	Oxygen in the reference gas	-
E	Measured cell EMF (to find O_2)	V
E_{O_2}	Cell EMF for the oxygen entered	V
$O_{2,E}$	Oxygen for the EMF entered	-

Method and standards

Nernst equation with four electrons per O_2 molecule.

Assumptions and limits

- The default reference, 20.95 % O_2, is dry air. Reference air carrying moisture has slightly less oxygen (about 20.6–20.7 % at typical humidity), which shifts the reading by a few tenths of a millivolt; analysers usually calibrate this out.
- Ideal cell, no offset.

References

- Nernst equation for an oxygen concentration cell
- E = (R T / 4F) ln(p_ref / p)

Report details

Report reference	FCC-T9J4-GC6S (the same inputs always give the same reference)
Generated	17 November 2026, 19:46 UTC
Calculator	Zirconia Oxygen Probe EMF and Oxygen Content
Method last reviewed	12 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/instrumentation/analysers/zirconia-oxygen-probe

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.