PEM Fuel Cell Exit Air Humidity

Water vapour pressure and relative humidity of the cathode exit air of a PEM fuel cell from air stoichiometry, exit pressure, cell temperature and inlet humidity.

Method: Cathode water balance of a PEM fuel cell

Input parameters

Unit system: SI

Parameter	Value	Unit
Air stoichiometry	2.0000	
Exit air pressure (absolute)	110.00	kPa
Cell (exit air) temperature	70.000	°C
Inlet air relative humidity	0	%
Inlet air temperature	20.000	°C

Calculated results

Parameter	Value	Unit
Inlet water-to-dry-air mole ratio	0	
Exit water vapour partial pressure	20.860	kPa
Saturation pressure at the cell temperature	31.201	kPa
Exit relative humidity	66.857	%

Notes for this case

• All product water leaves as vapour in the cathode air; mole balance per mole of O_2 used gives P_w = (2 + ψλ/y_O_2)/(1 + λ(1 + ψ)/y_O_2)·P_exit, which is Larminie and Dicks' 0.420λ-type formula with y_O_2 = 0.21. Above 100 % the excess condenses (flooding risk); far below, the membrane dries out. Water and steam properties from IAPWS-IF97.

Formula and method

$$P_w = \frac{2 + \psi\lambda / y_{O_2}}{1 + \lambda(1+\psi)/y_{O_2}} P_{exit}, \quad \psi = \frac{P_{w,in}}{P_{in} - P_{w,in}}$$

Variables

λ	Air stoichiometry	-
P_{exit}	Exit air pressure (absolute)	Pa
T	Cell (exit air) temperature	K
ϕ_{in}	Inlet air relative humidity	-
T_{in}	Inlet air temperature	K
ψ	Inlet water-to-dry-air mole ratio	-
P_w	Exit water vapour partial pressure	Pa
P_{sat}	Saturation pressure at the cell temperature	Pa
ϕ	Exit relative humidity	-

Method and standards

Cathode water balance.

Assumptions and limits

- All product water evaporated; uniform exit state.

References

Cathode water balance of a PEM fuel cell

Report details

Report reference	FCC-A7Y0-CW3X (the same inputs always give the same reference)
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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/environmental/hydrogen-fuel-cells/pem-exit-air-humidity

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.