Water Electrolyser Hydrogen Production and Specific Energy

Hydrogen and oxygen production, specific energy in kWh per kg and per Nm³, efficiency, water use and heat of a water electrolyser from power and cell voltage.

Method: Faraday's law and thermoneutral voltage of water electrolysis

Input parameters

Unit system: SI

Parameter	Value	Unit
Electrical power to the stacks	5.0000	MW
Cell voltage	1.9000	V
Faraday (current) efficiency	98.000	%

Calculated results

Parameter	Value	Unit
Hydrogen production	96.994	kg/h
Hydrogen production (normal volume)	1,078.4	Nm³/h
Specific energy (stack)	51.550	kWh/kg
Specific energy per Nm³ (kWh/Nm³)	4.6366	
Efficiency on the higher heating value	76.391	%
Efficiency on the lower heating value	64.634	%
Water consumed (stoichiometric)	866.74	kg/h
Oxygen produced	769.74	kg/h
Heat to remove (above the thermoneutral voltage)	1,180.4	kW

Notes for this case

• ṅ_H₂ = η_F P/(2FV_c). Thermoneutral voltage 1.481 V (HHV); above it the cell makes heat, below it the cell needs heat. Plant figures add rectifier, compression and auxiliary loads (typically 10–20 % more).

Formula and method

$$\dot{n}_{H_2} = \frac{\eta_F P}{2FV_c}, \quad \eta_{HHV} = \eta_F \frac{1.481}{V_c}, \quad e = \frac{P}{\dot{m}_{H_2}}$$

Variables

P	Electrical power to the stacks	W
V_c	Cell voltage	V
η_F	Faraday (current) efficiency	-
$\dot{m}_{H_2}$	Hydrogen production	kg/s
$\dot{V}_{H_2}$	Hydrogen production (normal volume)	Nm³/s
e	Specific energy (stack)	J/kg
e_V	Specific energy per Nm³ (kWh/Nm³)	-
η_{HHV}	Efficiency on the higher heating value	-
η_{LHV}	Efficiency on the lower heating value	-
$\dot{m}_{H_2O}$	Water consumed (stoichiometric)	kg/s
$\dot{m}_{O_2}$	Oxygen produced	kg/s

$\dot{Q}$	Heat to remove (above the thermoneutral voltage)	W

Method and standards

Faraday's law for electrolysis.

Assumptions and limits

- Steady operation; Faraday losses as a single efficiency.

References

Faraday's law and thermoneutral voltage of water electrolysis

Report details

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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/electrolyser-hydrogen-production

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.