Compressed Hydrogen Tank Mass and Energy (Abel-Noble)

Mass of hydrogen in a compressed gas tank at pressure and temperature by the Abel-Noble equation, the usable mass down to a minimum pressure and its energy.

Method: Abel–Noble equation of state for compressed hydrogen

Input parameters

Unit system: SI

Parameter	Value	Unit
Tank internal volume	122.00	L
Tank pressure	70.000	MPa
Gas temperature	15.000	°C
Minimum (residual) pressure	2.0000	MPa
Co-volume (about 7.69 × 10⁻³ m³/kg for hydrogen)	0.007691	m³/kg

Calculated results

Parameter	Value	Unit
Compressibility factor	1.4530	
Hydrogen density	40.538	kg/m³
Hydrogen mass at p	4.9457	kg
Usable mass down to p_min	4.7430	kg
Usable energy on the lower heating value	158.03	kWh
Mass if it were an ideal gas	7.1861	kg

Notes for this case

• Abel–Noble: p(v − b) = RT, so Z = 1 + bp/(RT). It represents hydrogen well near room temperature up to about 100 MPa; for cold gas or design work use a reference equation of state. Usable energy at the lower heating value (about 120 MJ/kg).

Formula and method

$$\rho = \frac{p}{RT + bp}, \quad Z = 1 + \frac{bp}{RT}, \quad m_u = V[\rho(p) - \rho(p_{min})]$$

Variables

V	Tank internal volume	m³
p	Tank pressure	Pa
T	Gas temperature	K
p_{min}	Minimum (residual) pressure	Pa
b	Co-volume (about 7.69 × 10⁻³ m³/kg for hydrogen)	m³/kg
Z	Compressibility factor	-
ρ	Hydrogen density	kg/m³
m	Hydrogen mass at p	kg
m_u	Usable mass down to p_min	kg
E	Usable energy on the lower heating value	J
m_{ideal}	Mass if it were an ideal gas	kg

Method and standards

Abel–Noble real-gas density.

Assumptions and limits

- Uniform temperature; pure hydrogen.

References

Abel–Noble equation of state for compressed hydrogen

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/hydrogen-tank-storage-abel-noble

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.