Magnetohydrodynamic (MHD) Generator Power Density

Open-circuit field, current density and power density of an MHD generator channel from gas conductivity, velocity, magnetic field and load factor.

Method: Ideal Faraday MHD generator

Input parameters

Unit system: SI

Parameter	Value	Unit
Gas electrical conductivity	200,000	µS/cm
Gas velocity	800.00	m/s
Magnetic flux density	5.0000	T
Load factor (load voltage over open-circuit)	75.000	%
Active channel volume	10.000	m³

Calculated results

Parameter	Value	Unit
Open-circuit field uB	4,000.0	
Current density	2.0000	A/cm²
Power density	60.000	MW/m³
Electrical power	600.00	MW
Power density at k = 0.5	80.000	MW/m³

Notes for this case

• Faraday channel with continuous electrodes: J = σuB(1 − k), P/V = σu²B²k(1 − k); the electrical (local) efficiency equals k. Seeded combustion gas reaches about 10–50 S/m at 2,500–3,000 K; Hall effects and electrode losses lower real output.

Formula and method

$$\frac{P}{V} = \sigma u^2 B^2 k(1-k), \quad J = \sigma u B(1-k)$$

Variables

σ	Gas electrical conductivity	S/m
u	Gas velocity	m/s
B	Magnetic flux density	T
k	Load factor (load voltage over open-circuit)	-
V	Active channel volume	m³
E_{oc}	Open-circuit field uB	-
J	Current density	A/m²
P/V	Power density	W/m³
P	Electrical power	W
$(P/V)_{max}$	Power density at k = 0.5	W/m³

Method and standards

MHD generation.

Assumptions and limits

- Ideal Faraday generator; uniform properties.

References

Ideal Faraday MHD generator

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/electrical/power/mhd-generator-power

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.