Galvanic Corrosion Rate from Cathode-to-Anode Area Ratio

Anode current density and corrosion penetration rate of a galvanic couple from the cathode reaction rate, the cathode-to-anode area ratio and Faraday's law.

Method: Mixed-potential area effect with Faraday's law

Input parameters

Unit system: SI

Parameter	Value	Unit
Cathodic current density on the noble metal	5.0000e-07	A/mm²
Cathode (noble metal) area	1.0000	m²
Anode (active metal) area	0.010000	m²
Anode molar mass	55.845	kg/kmol
Electrons per atom	2.0000	
Anode density	7,870.0	kg/m³

Calculated results

Parameter	Value	Unit
Area ratio	100.00	
Galvanic current	0.50000	A
Anode current density	50.000	A/m²
Anode penetration rate	58.022	mm/a
Rate with equal areas	0.58022	mm/a

Notes for this case

• Total anodic current equals total cathodic current. With the cathode reaction (often oxygen reduction, limited by diffusion) proceeding at i_c over the noble area, the anode carries I/A_a, so its attack rate scales with A_c/A_a. Penetration rate = i_aM/(nFρ). Small anodes in large cathodes (steel rivets in copper sheet) fail fast; the reverse is benign. Assumes the whole cathode is effective; in poorly conducting water only nearby areas count.

Formula and method

$$i_a = i_c \frac{A_c}{A_a}, \quad CR = \frac{i_a M}{nF\rho}$$

Variables

i_c	Cathodic current density on the noble metal	A/m²
A_c	Cathode (noble metal) area	m²
A_a	Anode (active metal) area	m²
M	Anode molar mass	kg/kmol
n	Electrons per atom	-
ρ	Anode density	kg/m³
A_c/A_a	Area ratio	-
I	Galvanic current	A
i_a	Anode current density	A/m²
CR	Anode penetration rate	m/s
$CR_{1:1}$	Rate with equal areas	m/s

Method and standards

Area effect.

Assumptions and limits

- Uniform current over each area; cathode reaction rate known.

References

Mixed-potential area effect with Faraday's law

Report details

Report reference	FCC-68BC-2T2E (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/materials/corrosion/galvanic-area-ratio-corrosion

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.