Corrosion Rate from Polarisation Resistance (Stern–Geary)

Corrosion current density and corrosion rate of a metal from its linear polarisation resistance and Tafel slopes by the Stern–Geary equation and Faraday's law.

Method: Stern and Geary (1957); ASTM G59 and G102 (Faraday's-law conversion to penetration rate); Jones; Principles and Prevention of Corrosion; …

Input parameters

Unit system: SI

Parameter	Value	Unit
Anodic Tafel slope (mV/decade)	120.00	
Cathodic Tafel slope (mV/decade)	120.00	
Polarisation resistance (Ω·cm²)	2,000.0	
Equivalent weight (g per equivalent)	27.920	kg/kmol
Metal density	7,870.0	kg/m³

Calculated results

Parameter	Value	Unit
Stern–Geary constant (mV)	26.058	
Corrosion current density (µA/cm²)	13.029	
Corrosion rate (mm/year)	0.15118	

Notes for this case

• Equivalent weight = atomic mass / valence (iron 55.845/2 = 27.92). If Tafel slopes are unknown, B of about 26 mV (active steel) is often used. LPR suits conductive liquids; it misses localised (pitting) attack.

Formula and method

$$B = \frac{\beta_a \beta_c}{2.303(\beta_a + \beta_c)}, \quad i_{corr} = \frac{B}{R_p}, \quad CR = \frac{i_{corr} EW}{F\rho}$$

Variables

β_a	Anodic Tafel slope (mV/decade)	-
β_c	Cathodic Tafel slope (mV/decade)	-
R_p	Polarisation resistance (Ω·cm²)	-
EW	Equivalent weight (g per equivalent)	kg/kmol
ρ	Metal density	kg/m³
B	Stern–Geary constant (mV)	-
i_{corr}	Corrosion current density (µA/cm²)	-
CR	Corrosion rate (mm/year)	-

Method and standards

Stern–Geary and Faraday.

Assumptions and limits

- Uniform corrosion; activation control.
- Faraday constant from CODATA (96 485.332 12 C/mol). Tafel slopes, R_p, B, i_corr and CR are entered and shown in the units named in their labels (mV/decade, Ω·cm², mV, µA/cm², mm/year), not converted by the unit lists.

References

• Stern and Geary (1957); ASTM G59 and G102 (Faraday's-law conversion to penetration rate); Jones
• Principles and Prevention of Corrosion

• 2nd ed. (Prentice Hall, 1996)

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/materials/corrosion/corrosion-rate-polarisation-resistance

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Reopens the calculator with the inputs of this report.