Cathodic Protection Attenuation along a Coated Pipeline

Attenuation constant, characteristic resistance, drain current and protected length either side of a drain point on a long coated pipeline (Uhlig model).

Method: Pipeline attenuation (transmission-line) equations

Input parameters

Unit system: SI

Parameter	Value	Unit
Pipe outside diameter	508.00	mm
Wall thickness	9.5000	mm
Steel resistivity	18.000	µΩ·cm
Coating resistance	10,000	Ω·m²
Potential shift at the drain point	0.60000	V
Minimum shift needed	0.30000	V

Calculated results

Parameter	Value	Unit
Pipe longitudinal resistance	0.012099	mΩ/m
Coating leakage resistance (length basis)	6,265.9	Ω·m
Attenuation constant	4.3941e-05	1/m
Characteristic resistance	0.27533	Ω
Drain current (both directions)	4.3583	A
Protected length each side	15.774	km

Notes for this case

• Transmission-line model of an infinitely long pipe: ΔE(x) = ΔE₀e^(−αx), α = √(R_s/R_L), Z_c = √(R_sR_L), current each way ΔE₀/Z_c. R_s = ρ_s/[πt(D − t)], R_L = r_c/(πD). Coating resistance falls with age (from 10^5 Ω·m² new to 10^3 or less), which shortens spacing between drain points; insulating joints and the far end change the infinite-line result.

Formula and method

$$\alpha = \sqrt{\frac{R_s}{R_L}}, \quad Z_c = \sqrt{R_s R_L}, \quad L_p = \frac{1}{\alpha}\ln\frac{\Delta E_0}{\Delta E_{min}}, \quad I_0 = \frac{2\Delta E_0}{Z_c}$$

Variables

D	Pipe outside diameter	m
t	Wall thickness	m
ρ_s	Steel resistivity	Ω·m
r_c	Coating resistance	Ω·m²
ΔE_0	Potential shift at the drain point	V
ΔE_{min}	Minimum shift needed	V
R_s	Pipe longitudinal resistance	Ω/m
R_L	Coating leakage resistance (length basis)	Ω·m
α	Attenuation constant	1/m
Z_c	Characteristic resistance	Ω
I_0	Drain current (both directions)	A

L_p	Protected length each side	m

Method and standards

Attenuation.

Assumptions and limits

- Long uniform line; uniform coating and soil; potential shifts, not absolute potentials.

References

Pipeline attenuation (transmission-line) equations

Report details

Report reference	FCC-73TX-KV22 (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/cp-pipeline-attenuation

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.