CO_2 Corrosion Rate of Carbon Steel (de Waard–Milliams)

CO_2 corrosion rate of bare carbon steel from temperature and CO_2 partial pressure, with the protective-scale correction above the scaling temperature.

Method: de Waard–Milliams CO_2 corrosion model

Input parameters

Unit system: SI

Parameter	Value	Unit
Temperature	60.000	°C
Total pressure	50.000	bar
CO_2 mole fraction in the gas	2.0000	%
Protective scale correction	Apply above the scaling temperature	

Calculated results

Parameter	Value	Unit
CO_2 partial pressure	1.0000	bar
Nomogram corrosion rate	4.6470	mm/a
Scaling temperature	85.059	°C
Scale factor	1.0000	
Corrected corrosion rate	4.6470	mm/a

Notes for this case

• The de Waard–Milliams nomogram equation log V = 5.8 − 1710/T + 0.67 log p_CO_2 (V in mm/a, T in K, p in bar) gives the rate on bare steel in condensed water with no inhibitor or scale. Above the scaling temperature log T_scale = 2400/(6.7 + 0.6 log p_CO_2), protective iron carbonate forms and the rate falls by F_scale = 10^(2400/T − 0.6 log p − 6.7). Later versions add corrections for fugacity, pH, flow, glycol and oil wetting; treat this as a conservative screening rate.

Formula and method

$$\log V = 5.8 - \frac{1710}{T} + 0.67 \log p_{CO_2}, \quad \log T_{scale} = \frac{2400}{6.7 + 0.6 \log p_{CO_2}}$$

Variables

T	Temperature	K
p	Total pressure	Pa
y_{CO_2}	CO_2 mole fraction in the gas	-
scale	Protective scale correction	-
p_{CO_2}	CO_2 partial pressure	Pa
V_{nom}	Nomogram corrosion rate	m/s
T_{scale}	Scaling temperature	K
F_{scale}	Scale factor	-
V	Corrected corrosion rate	m/s

Method and standards

CO_2 corrosion.

Assumptions and limits

- Bare steel, condensed water, no inhibitor; no flow or pH corrections.

References

de Waard–Milliams CO_2 corrosion model

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/materials/corrosion/co2-corrosion-de-waard-milliams

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.