Electrostatic Charge Relaxation Time of a Liquid

Time constant for charge on a liquid to decay (τ = ε_r ε₀/κ) from its relative permittivity and conductivity, and the time for the charge to fall to a set fraction.

Method: Charge relaxation τ = ε_r ε₀/κ (electrostatics; Perry's sec. 23 on static electricity)

Input parameters

Unit system: SI

Parameter	Value	Unit
Relative permittivity	2.0000	
Electrical conductivity (pS/m)	1.0000	
Fraction of charge remaining	1.0000	%

Calculated results

Parameter	Value	Unit
Relaxation time constant	17.708	s
Time to fall to the fraction	81.550	s
1 = low-conductivity (≤ 50 pS/m) accumulator	1.0000	

Notes for this case

- Low-conductivity liquids (below about 50 pS/m) hold charge for seconds: limit filling velocities and allow relaxation time before gauging. Screening estimate only, not a safety study or a basis for protective design.

Formula and method

$$\tau = \frac{\varepsilon_r \varepsilon_0}{\kappa}, \quad t_f = \tau \ln \frac{1}{f}$$

Variables

ε_r	Relative permittivity	-
κ	Electrical conductivity (pS/m)	-
f	Fraction of charge remaining	-
τ	Relaxation time constant	s
t_f	Time to fall to the fraction	s
class	1 = low-conductivity (≤ 50 pS/m) accumulator	-

Method and standards

Ohmic charge relaxation.

Assumptions and limits

- Ohmic relaxation; hyperbolic relaxation at very low conductivity is slower.

References

- Charge relaxation τ = ε_r ε₀/κ (electrostatics; Perry's sec. 23 on static electricity)

Report details

Report reference	FCC-4WV5-JP58 (the same inputs always give the same reference)
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Release checks	2 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/chemical/process-safety/static-charge-relaxation

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.