EV Battery Capacity Fade: Calendar and Cycle Ageing

State of health from a square-root-of-time calendar term and a linear cycle term fitted to the user's data, the remaining range and the years to end of life.

Method: Semi-empirical calendar (√t) and cycle ageing

Input parameters

Unit system: SI

Parameter	Value	Unit
Calendar fade coefficient (per √year)	2.0000	%
Cycle fade per equivalent full cycle	20.000	ppm
Equivalent full cycles per year	250.00	
Age (years)	5.0000	
End-of-life state of health	70.000	%
Range when new	400.00	km

Calculated results

Parameter	Value	Unit
Calendar loss	4.4721	%
Cycle loss	2.5000	%
State of health	93.028	%
Range now	372.11	km
Years to end of life	36.000	

Notes for this case

• SOH = 1 − a√t − b·N_y·t: calendar ageing (SEI growth) follows roughly √t, cycle ageing roughly the charge throughput. Fit a and b to the cell maker's or your own test data at the operating temperature and state of charge; heat, high SOC storage and fast charging raise both. End of life is solved from the quadratic in √t.

Formula and method

$$SOH = 1 - a\sqrt{t} - bN_y t, \quad \sqrt{t_{EOL}} = \frac{-a + \sqrt{a^2 + 4bN_y(1 - SOH_{EOL})}}{2bN_y}$$

Variables

a	Calendar fade coefficient (per √year)	-
b	Cycle fade per equivalent full cycle	-
N_y	Equivalent full cycles per year	-
t	Age (years)	-
SOH_{EOL}	End-of-life state of health	-
R_0	Range when new	m
Q_{cal}	Calendar loss	-
Q_{cyc}	Cycle loss	-
SOH	State of health	-
R	Range now	m
t_{EOL}	Years to end of life	-

Method and standards

Capacity fade.

Assumptions and limits

- Additive calendar and cycle terms; before the ageing knee.

References

Semi-empirical calendar (√t) and cycle ageing

Report details

Report reference	FCC-GV04-MH42 (the same inputs always give the same reference)
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Calculator	EV Battery Capacity Fade: Calendar and Cycle Ageing
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Software release	FireCAD Calc, release of 22 November 2026
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/automotive/electric-vehicles/ev-battery-capacity-fade

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.