Thermal Neutron Diffusion Time and Prompt Lifetime

Thermal neutron diffusion (absorption) time of a medium from its 2,200 m/s absorption cross-section, and the prompt neutron lifetime of a finite core with leakage.

Method: One-group neutron lifetime

Input parameters

Unit system: SI

Parameter	Value	Unit
Macroscopic absorption cross-section at 2,200 m/s	0.019700	1/cm
Thermal diffusion area	8.1000	cm²
Geometric buckling (per cm²)	0.003000	
Slowing-down time (0 to ignore)	10.000	µs

Calculated results

Parameter	Value	Unit
Diffusion time in an infinite medium	230.73	µs
Prompt neutron lifetime with leakage	235.26	µs
Thermal non-leakage probability	97.628	%

Notes for this case

- For a 1/v absorber vΣ_a is constant, so t_d = 1/(v₀Σ_a,0) with v₀ = 2,200 m/s whatever the temperature. Leakage shortens the lifetime: ℓ = t_d/(1 + L²B²). Slowing-down time is small in water but matters in graphite.

Formula and method

$$t_d = \frac{1}{v_0 \Sigma_{a,0}}, \quad \ell_p = \frac{t_d}{1 + L^2 B^2} + t_s$$

Variables

$\Sigma_{a,0}$	Macroscopic absorption cross-section at 2,200 m/s	1/m
L^2	Thermal diffusion area	m²
B^2	Geometric buckling (per cm²)	-
t_s	Slowing-down time (0 to ignore)	s
t_d	Diffusion time in an infinite medium	s
ℓ_p	Prompt neutron lifetime with leakage	s
P_{TNL}	Thermal non-leakage probability	-

Method and standards

Neutron lifetime.

Assumptions and limits

- 1/v absorption; one thermal group.

References

One-group neutron lifetime

Report details

Report reference	FCC-QSR0-6ZJA (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/boilers-power-plant/nuclear-power/neutron-lifetime-diffusion-time

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.