Neutron Moderation: Lethargy Gain and Collisions to Thermalise

Average logarithmic energy decrement, collisions to slow a neutron between two energies, moderating power and moderating ratio of a moderator.

Method: Elastic slowing-down kinematics

Input parameters

Unit system: SI

Parameter	Value	Unit
Mass number of the moderator nucleus	12.000	
Initial neutron energy	2.0000	MeV
Final neutron energy	0.025000	eV
Macroscopic scattering cross-section (0 if not needed)	0.38500	1/cm
Macroscopic absorption cross-section (0 if not needed)	2.7300e-04	1/cm

Calculated results

Parameter	Value	Unit
Collision parameter ((A − 1)/(A + 1))²	0.71598	
Average logarithmic energy decrement	0.15777	
Average number of collisions	115.34	
Largest fractional energy loss in one collision	28.402	%
Moderating power	0.060741	1/cm
Moderating ratio	222.49	

Notes for this case

- Elastic scattering, isotropic in the centre-of-mass frame: ξ = 1 + α ln α/(1 − α), n = ln(E₀/E)/ξ. For a mixture, ξ is the scattering-weighted average of its nuclides.

Formula and method

$$\alpha = \left(\frac{A-1}{A+1}\right)^2, \quad \xi = 1 + \frac{\alpha \ln \alpha}{1-\alpha}, \quad n = \frac{\ln(E_0/E)}{\xi}$$

Variables

A	Mass number of the moderator nucleus	-
E_0	Initial neutron energy	J
E	Final neutron energy	J
Σ_s	Macroscopic scattering cross-section (0 if not needed)	1/m
Σ_a	Macroscopic absorption cross-section (0 if not needed)	1/m
α	Collision parameter ((A − 1)/(A + 1))²	-
ξ	Average logarithmic energy decrement	-
n	Average number of collisions	-
$1-\alpha$	Largest fractional energy loss in one collision	-
$\xi\Sigma_s$	Moderating power	1/m
$\xi\Sigma_s/\Sigma_a$	Moderating ratio	-

Method and standards

Slowing-down kinematics.

Assumptions and limits

- Elastic scattering only; target nuclei at rest.

References

Elastic slowing-down kinematics

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/boilers-power-plant/nuclear-power/neutron-moderation-collisions

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Reopens the calculator with the inputs of this report.