Neutron Activation: Induced Activity after Irradiation and Decay

Activity induced by neutron capture from target mass, abundance, cross-section, flux and irradiation time, after decay, with the saturation activity.

Method: Activation equation with saturation and decay

Input parameters

Unit system: SI

Parameter	Value	Unit
Target element mass	1.0000	g
Molar mass of the element	58.933	kg/kmol
Isotopic abundance of the target nuclide	100.00	%
Activation cross-section	37.200	b
Neutron flux	1.0000e+12	1/(cm²·s)
Half-life of the product	5.2714	a
Irradiation time	30.000	d
Decay time after irradiation	7.0000	d

Calculated results

Parameter	Value	Unit
Target nuclei	1.0219e+22	
Reaction rate Nσφ (saturation activity)	380.13	GBq
Activity at the end of irradiation	4.0834	GBq
Activity after the decay time	4.0731	GBq
Fraction of saturation reached	1.0742	%
Specific activity of the element after decay	4.0731	GBq/g

Notes for this case

• A = Nσφ(1 − e^(−λt_i))e^(−λt_d), neglecting burn-up of target and product (valid when σφt_i ⍰ 1). Irradiating for one half-life gives 50 % of saturation, two give 75 %.

Formula and method

$$A = N\sigma\phi\left(1 - e^{-\lambda t_i}\right)e^{-\lambda t_d}, \quad N = \frac{m}{M}N_A\theta$$

Variables

m	Target element mass	kg
M	Molar mass of the element	kg/kmol
θ	Isotopic abundance of the target nuclide	-
σ	Activation cross-section	m²
ϕ	Neutron flux	1/(m²·s)
$T_{1/2}$	Half-life of the product	s
t_i	Irradiation time	s
t_d	Decay time after irradiation	s
N	Target nuclei	-

R	Reaction rate Nσφ (saturation activity)	Bq
A_0	Activity at the end of irradiation	Bq
A	Activity after the decay time	Bq
A_0/A_{sat}	Fraction of saturation reached	-
a	Specific activity of the element after decay	Bq/kg

Method and standards

Activation and decay.

Assumptions and limits

- No burn-up; constant flux; single product.

References

Activation equation with saturation and decay

Report details

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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-activation-activity

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.