Batch Reactor Time for a Conversion (Order n)

Reaction time of a constant-volume batch reactor for a target conversion with nth-order kinetics, and batches per day with the turnaround time.

Method: Integrated rate law for −r_A = k C_A^n at constant volume (Levenspiel, Chemical Reaction Engineering)

Input parameters

Unit system: SI

Parameter	Value	Unit
Target conversion	95.000	%
Reaction order	1.0000	
Rate constant k·C_A0^(n−1)	0.50000	1/h
Turnaround (fill, heat, empty, clean)	2.0000	h

Calculated results

Parameter	Value	Unit
Reaction time	5.9915	h
Cycle time	7.9915	h
Batches per day	3.0032	

Formula and method

$$t = \frac{(1-X)^{1-n}-1}{(n-1)k'} \ (n \neq 1), \quad t = -\frac{\ln(1-X)}{k'} \ (n = 1)$$

Variables

X	Target conversion	-
n	Reaction order	-
k'	Rate constant k·C_A0^(n−1)	1/s
t_a	Turnaround (fill, heat, empty, clean)	s
t_r	Reaction time	s
t_c	Cycle time	s
N_d	Batches per day	-

Method and standards

Integrated rate law.

Assumptions and limits

- Isothermal, constant volume.
- k′ is the lumped constant k C_A0^(n−1) in 1/time; convert a rate constant in concentration units first.

References

- Integrated rate law for −r_A = k C_A^n at constant volume (Levenspiel, Chemical Reaction Engineering)

Report details

Report reference	FCC-7WTJ-M7D5 (the same inputs always give the same reference)
Generated	17 November 2026, 19:34 UTC
Calculator	Batch Reactor Time for a Conversion (Order n)
Method last reviewed	12 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	4 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/reactors/batch-reaction-time

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.