Plug Flow Reactor (PFR) Volume for a Conversion

Space time and volume of a plug flow (tubular) reactor for a target conversion with first- or second-order kinetics, and the CSTR volume for comparison.

Method: PFR design equation V = F_A0 ∫dX/(−r_A) integrated for n = 1; 2 (Fogler; Levenspiel)

Input parameters

Unit system: SI

Parameter	Value	Unit
Feed volumetric flow	10.000	m³/h
Target conversion	80.000	%
Reaction order	First order	
Rate constant k·C_A0^(n−1)	0.20000	1/min

Calculated results

Parameter	Value	Unit
Space time	8.0472	min
Reactor volume	1.3412	m³
CSTR volume for the same duty	3.3333	m³

Notes for this case

- Constant density, isothermal, no axial mixing.

Formula and method

$$\tau = -\frac{\ln(1-X)}{k} \ (n=1), \quad \tau = \frac{X}{kC_{A0}(1-X)} \ (n=2)$$

Variables

$\dot{V}$	Feed volumetric flow	m³/s
X	Target conversion	-
n	Reaction order	-
k'	Rate constant k·C_A0^(n−1)	1/s
τ	Space time	s
V	Reactor volume	m³
V_{CSTR}	CSTR volume for the same duty	m³

Method and standards

Integrated design equation.

Assumptions and limits

- Isothermal, constant density.

References

- PFR design equation V = F_A0 ∫dX/(−r_A) integrated for n = 1
- 2 (Fogler; Levenspiel)

Report details

Report reference	FCC-5TS1-QCMW (the same inputs always give the same reference)
Generated	17 November 2026, 19:44 UTC
Calculator	Plug Flow Reactor (PFR) Volume for a Conversion
Method last reviewed	12 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	2 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/pfr-volume

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.