Batch Enzyme Reaction Time (Integrated Michaelis–Menten)

Time for a batch enzyme reaction to reach a conversion from the integrated Michaelis–Menten equation, with the substrate left.

Method: Integrated Michaelis–Menten equation

Input parameters

Unit system: SI

Parameter	Value	Unit
Initial substrate	100.00	mmol/L
Conversion wanted	90.000	%
Michaelis constant	10.000	mmol/L
Maximum rate (per minute in the unit below)	2.0000	mmol/L
Time unit of V_max	1.0000	min

Calculated results

Parameter	Value	Unit
Batch time	56.513	min
Substrate left	10.0000	mmol/L
Time if the rate stayed at V_max (zero order)	45.000	min
Time if first order throughout (S ≫ K_m)	11.513	min

Notes for this case

• Integrating dS/dt = −V_max S/(K_m + S) gives V_max t = K_m ln(S₀/S) + (S₀ − S). The second term is the zero-order part, dominant while S ≫ K_m; the logarithmic term is the first-order tail that makes the last few per cent slow. Product inhibition and enzyme decay lengthen real batch times.

Formula and method

$$V_{max}\, t = K_m \ln\frac{S_0}{S} + (S_0 - S)$$

Variables

S_0	Initial substrate	mol/m³
X	Conversion wanted	-
K_m	Michaelis constant	mol/m³
V_{max}	Maximum rate (per minute in the unit below)	mol/m³
per	Time unit of V_max	s
t	Batch time	s
S	Substrate left	mol/m³
t_0	Time if the rate stayed at V_max (zero order)	s
t_1	Time if first order throughout (S ≫ K_m)	s

Method and standards

Integrated Michaelis–Menten.

Assumptions and limits

- No inhibition or enzyme decay; well mixed.

References

Integrated Michaelis–Menten equation

Report details

Report reference	FCC-EB3R-NW7S (the same inputs always give the same reference)
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Calculator	Batch Enzyme Reaction Time (Integrated Michaelis–Menten)
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
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/chemical/bioprocess/integrated-michaelis-menten-time

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.