Fixed-Bed Adsorber by the Bed-Depth Service-Time Model

Service time to breakthrough of a fixed-bed adsorber from bed depth, velocity, feed concentration and the BDST constants N_0 and K, with critical depth.

Method: Bohart–Adams model in Hutchins' BDST form (Hutchins, Chem. Eng. 80(19): 133, 1973); Perry's Chemical Engineers' Handbook; 9th ed. (McGraw-Hill, 2019); ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Bed depth	1.5000	m
Superficial velocity	10.000	m/h
Feed concentration	50.000	mg/L
Breakthrough concentration	5.0000	mg/L
Bed capacity N_0	20.000	g/L
Rate constant (m³/(kg·h))	5.0000	

Calculated results

Parameter	Value	Unit
Service time to breakthrough	51.211	h
Critical bed depth (t = 0)	0.21972	m
Bed volumes treated	341.41	

Notes for this case

- N_0 and K come from column tests at two or three bed depths (Hutchins' plot of t against Z). The model ignores axial dispersion and changes in velocity.

Formula and method

$$t_b = \frac{N_0 Z}{C_0 v} - \frac{1}{K C_0} \ln\left(\frac{C_0}{C_b} - 1\right), \quad Z_0 = \frac{v}{K N_0} \ln\left(\frac{C_0}{C_b} - 1\right)$$

Variables

Z	Bed depth	m
v	Superficial velocity	m/s
C_0	Feed concentration	kg/m³
C_b	Breakthrough concentration	kg/m³
N_0	Bed capacity N_0	kg/m³
K	Rate constant (m³/(kg·h))	-
t_b	Service time to breakthrough	s
Z_0	Critical bed depth (t = 0)	m
BV	Bed volumes treated	-

Method and standards

BDST equation.

Assumptions and limits

- Constant flow and feed; plug flow.
- K is entered as a number in m³/(kg·h); it does not change with the unit system.
- The critical depth is shown only when the breakthrough concentration is below half the feed.

References

• Bohart–Adams model in Hutchins' BDST form (Hutchins, Chem. Eng. 80(19): 133, 1973); Perry's Chemical Engineers' Handbook
• 9th ed. (McGraw-Hill, 2019)
• sec. 16

Report details

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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/unit-operations/bdst-adsorber-design

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Reopens the calculator with the inputs of this report.