Activated Carbon Adsorber: Bed Life and Carbon Use

Bed life of an activated carbon adsorber for a VOC from the carbon mass, working capacity and VOC load, with contact time and the carbon used per year.

Method: Cooper and Alley; Air Pollution Control: A Design Approach; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Gas flow (same conditions as the concentration: both actual or both normal)	3,000.0	m³/h
VOC concentration	500.00	mg/m³
Bed volume	2.0000	m³
Carbon bulk density	450.00	kg/m³
Working capacity (kg VOC per kg carbon)	0.10000	kg/kg
Operating hours per day	16.000	h

Calculated results

Parameter	Value	Unit
Carbon in the bed	900.00	kg
VOC load	1.5000	kg/h
Bed life (operating hours)	60.000	h
Bed life (calendar days)	3.7500	
Contact time	2.4000	s
Carbon used per year (365 days)	87.600	t

Notes for this case

- Working capacity is well below the equilibrium capacity (often a third to a half) because of the mass-transfer zone and humidity; take it from the supplier's isotherm at the gas humidity. Keep relative humidity below about 50 %.

Formula and method

$$t_b = \frac{m_c w_c}{QC}, \quad m_c = \rho_b V, \quad t_c = \frac{V}{Q}$$

Variables

Q	Gas flow (same conditions as the concentration: both actual or both normal)	m³/s
C	VOC concentration	kg/m³
V	Bed volume	m³
ρ_b	Carbon bulk density	kg/m³
w_c	Working capacity (kg VOC per kg carbon)	kg/kg
h_d	Operating hours per day	s
m_c	Carbon in the bed	kg
$\dot{m}_{VOC}$	VOC load	kg/s
t_b	Bed life (operating hours)	s
t_d	Bed life (calendar days)	-
t_c	Contact time	s
$\dot{m}_{c,yr}$	Carbon used per year (365 days)	kg

Method and standards

Mass balance.

Assumptions and limits

- Constant load; working capacity from data.
- Flow and concentration on one basis: both at actual conditions or both at normal conditions (m^3 at 0 °C, 1 atm).

References

• Cooper and Alley
• Air Pollution Control: A Design Approach
• 4th ed. (Waveland, 2011)
• ch. 12 (adsorption: working capacity and bed life)

Report details

Report reference	FCC-J3YM-QJBK (the same inputs always give the same reference)
Generated	17 November 2026, 19:36 UTC
Calculator	Activated Carbon Adsorber: Bed Life and Carbon Use
Method last reviewed	13 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/environmental/air-pollution/carbon-adsorber-life

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.