GAC Carbon Usage Rate, Throughput and Bed Life from Freundlich

Equilibrium loading, minimum carbon usage rate, specific throughput, carbon mass, water treated and bed life of a GAC contactor from Freundlich constants.

Input parameters

Unit system: SI

Parameter	Value	Unit
Influent concentration	0.010000	mg/L
Freundlich capacity, (mg/g)(L/mg)^(1/n)	40.000	
Freundlich intensity 1/n	0.30000	
GAC bed density	480.00	kg/m³
Flow	1,000.0	L/min
Empty-bed contact time	15.000	min

Calculated results

Parameter	Value	Unit
Equilibrium carbon loading	10.048	
Carbon usage rate (minimum)	9.9527e-04	g/L
Specific throughput	1,004.8	L/g
Bed volume	15.000	m³
Carbon in the bed	7,200.0	kg
Water treated to breakthrough (ideal)	7,234,233	m³
Bed life (ideal)	5,023.8	d
Bed volumes treated	482,282	

Notes for this case

- q_e in mg/g. This is the best case: a single compound, a sharp mass transfer zone and no competition. Natural organic matter and the mass transfer zone often cut real bed life by half or more; confirm with RSSCT or pilot columns.

Formula and method

$$q_e = K C_0^{1/n}, \quad CUR = \frac{C_0}{q_e}$$

$$M_{GAC} = Q \cdot EBCT \cdot \rho_b, \quad V_t = \frac{M_{GAC}}{CUR}, \quad t_{bed} = \frac{V_t}{Q}$$

Variables

C_0	Influent concentration	kg/m³
K	Freundlich capacity, (mg/g)(L/mg)^(1/n)	-
$1/n$	Freundlich intensity 1/n	-
ρ_b	GAC bed density	kg/m³
Q	Flow	m³/s
$EBCT$	Empty-bed contact time	s
q_e	Equilibrium carbon loading	-

CUR	Carbon usage rate (minimum)	kg/m³
$1/CUR$	Specific throughput	m³/kg
V_b	Bed volume	m³
M_{GAC}	Carbon in the bed	kg
V_t	Water treated to breakthrough (ideal)	m³
t_{bed}	Bed life (ideal)	s
BV	Bed volumes treated	-

Method and standards

Equilibrium (ideal) carbon usage from the Freundlich isotherm.

Assumptions and limits

- Single solute, equilibrium loading at the influent concentration, no mass transfer zone.

Report details

Report reference	FCC-AE7Q-NMWA (the same inputs always give the same reference)
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Calculator	GAC Carbon Usage Rate, Throughput and Bed Life from Freundlich
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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/environmental/drinking-water/gac-carbon-usage-rate

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.