Rapid Small-Scale Column Test (RSSCT) Design for GAC

Scales a full-scale GAC adsorber to a rapid small-scale column test: EBCT, velocity, run time, bed length, flow, carbon mass and water volume.

Input parameters

Unit system: SI

Parameter	Value	Unit
Full-scale (large column) GAC particle diameter	1.0000	mm
RSSCT GAC particle diameter	0.21000	mm
Full-scale empty-bed contact time	10.000	min
Full-scale superficial velocity	5.0000	m/h
Full-scale run time to simulate	100.00	d
RSSCT column diameter	11.000	mm
GAC bulk density	490.00	kg/m³
Diffusivity exponent (0 constant, 1 proportional to particle size)	1.0000	

Calculated results

Parameter	Value	Unit
Time scale factor	0.21000	
RSSCT empty-bed contact time	2.1000	min
RSSCT superficial velocity (Re matched)	23.810	m/h
RSSCT run time	21.000	d
RSSCT bed length	83.333	cm
RSSCT flow	37.712	mL/min
GAC mass in the RSSCT	38.805	g
Water volume needed	1,140.4	L

Notes for this case

- EBCT and run time scale with (d_SC/d_LC)^(2−X); the velocity scales with d_LC/d_SC to keep the Reynolds number equal. With X = 0 (constant diffusivity) the Stanton, Peclet and Reynolds numbers are all matched.
- With X > 0 the Reynolds number cannot be matched as well; a lower RSSCT velocity (Re_SC ≥ 0.1) may be used to limit head loss, keeping the scaled EBCT.

Formula and method

$$\frac{EBCT_{SC}}{EBCT_{LC}} = \frac{t_{SC}}{t_{LC}} = \left(\frac{d_{SC}}{d_{LC}}\right)^{2-X}, \quad \frac{v_{SC}}{v_{LC}} = \frac{d_{LC}}{d_{SC}}$$

$$L_{SC} = v_{SC} EBCT_{SC}, \quad Q_{SC} = v_{SC}\frac{\pi D_{SC}^2}{4}, \quad M_{SC} = Q_{SC} EBCT_{SC} \rho_b, \quad V_W = Q_{SC} t_{SC}$$

Variables

d_{LC}	Full-scale (large column) GAC particle diameter	m
d_{SC}	RSSCT GAC particle diameter	m
$EBCT_{LC}$	Full-scale empty-bed contact time	s
v_{LC}	Full-scale superficial velocity	m/s

t_{LC}	Full-scale run time to simulate	s
D_{SC}	RSSCT column diameter	m
ρ_b	GAC bulk density	kg/m³
X	Diffusivity exponent (0 constant, 1 proportional to particle size)	-
$(d_{SC}/d_{LC})^{2-X}$	Time scale factor	-
$EBCT_{SC}$	RSSCT empty-bed contact time	s
v_{SC}	RSSCT superficial velocity (Re matched)	m/s
t_{SC}	RSSCT run time	s
L_{SC}	RSSCT bed length	m
Q_{SC}	RSSCT flow	m³/s
M_{SC}	GAC mass in the RSSCT	kg
V_W	Water volume needed	m³

Method and standards

Dimensional-similarity scaling of a GAC column to crushed carbon in a small column.

Assumptions and limits

- Intraparticle diffusion controls; same carbon crushed for the RSSCT.

Report details

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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/rssct-scaling

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.