Film Mass Transfer Coefficient in a Packed Bed (Gnielinski)

Liquid film mass transfer coefficient to particles in a packed bed (GAC, ion exchange, limestone contactors) by Gnielinski's correlation.

Method: Gnielinski's packed-bed correlation for the liquid film coefficient

Input parameters

Unit system: SI

Parameter	Value	Unit
Particle diameter	1.2000	mm
Bed porosity	42.000	%
Particle sphericity	75.000	%
Superficial velocity	10.000	m/h
Water density	999.10	kg/m³
Water viscosity	1.1380	mPa·s
Solute diffusivity	7.0000e-10	m²/s

Calculated results

Parameter	Value	Unit
Reynolds number ρφd_pv/(εμ)	5.2259	
Schmidt number	1,627.2	
Sherwood number (single particle)	19.316	
Film mass transfer coefficient	2.1070e-05	m/s
Specific particle area 6(1 − ε)/(φd_p)	3,866.7	m²/m³
Volumetric coefficient	0.081472	1/s

Notes for this case

- Gnielinski: k_f = [1 + 1.5(1 − ε)](D_l/d_p)(2 + 0.644 Re^½ Sc^⅓), valid for Re·Sc above about 500 and porosities up to about 0.9.

Formula and method

$$k_f = [1 + 1.5(1 - \varepsilon)]\frac{D_l}{d_p}\left(2 + 0.644\, Re^{1/2} Sc^{1/3}\right)$$

$$Re = \frac{\rho \phi d_p v}{\varepsilon \mu}, \quad Sc = \frac{\mu}{\rho D_l}$$

Variables

d_p	Particle diameter	m
ε	Bed porosity	-
ϕ	Particle sphericity	-
v	Superficial velocity	m/s
ρ	Water density	kg/m³
μ	Water viscosity	Pa·s
D_l	Solute diffusivity	m²/s
Re	Reynolds number ρφd_pv/(εμ)	-
Sc	Schmidt number	-

Sh	Sherwood number (single particle)	-
k_f	Film mass transfer coefficient	m/s
a	Specific particle area 6(1 − ε)/(φd_p)	m^2/m^3
$k_f a$	Volumetric coefficient	1/s

Method and standards

Correlation for external (film) mass transfer to particles in fixed beds.

Assumptions and limits

- Fixed beds of roughly spherical particles; liquid phase.

References

Gnielinski's packed-bed correlation for the liquid film coefficient

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/packed-bed-film-mass-transfer

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.