Onda Correlations: Wetted Area, kL, kG and HOG for Packed Columns

Effective wetted area, liquid and gas film coefficients by Onda's correlations, the film transfer unit heights and the overall HOG for a random-packed column.

Input parameters

Unit system: SI

Parameter	Value	Unit
Liquid mass flux	8.0000	kg/(m²·s)
Gas mass flux	1.5000	kg/(m²·s)
Packing specific area	0.10200	m²/L
Nominal packing size	50.000	mm
Critical surface tension of the packing (ceramic 61, steel 75, polyethylene 33)	75.000	mN/m
Liquid surface tension	72.000	mN/m
Liquid viscosity	1.0000	mPa·s
Liquid density	998.00	kg/m³
Liquid diffusivity	2.0000e-09	m²/s
Gas viscosity	0.018000	mPa·s
Gas density	1.2000	kg/m³
Gas diffusivity	2.1000e-05	m²/s
Temperature	25.000	°C
Pressure	1.0130	bar
Liquid molar mass	18.000	kg/kmol
Gas molar mass	29.000	kg/kmol
Equilibrium line slope (y = mx)	1.2000	

Calculated results

Parameter	Value	Unit
Wetted fraction of packing area	72.514	%
Effective interfacial area	73.964	m²/m³
Liquid film coefficient	0.21258	mm/s
Gas film coefficient, kmol/(m²·s·bar)	0.001697	
Gas film transfer unit height	0.40671	m
Liquid film transfer unit height	0.50982	m
Stripping factor	0.13966	
Overall gas-phase transfer unit height	0.47791	m

Notes for this case

- Onda, Takeuchi and Okumoto (1968): K_s = 5.23 for packings above 15 mm and 2.00 below. Onda's predictions are typically within ±30 %; Designers recommend comparing with Cornell's method and using the larger height.

Formula and method

$$\frac{a_w}{a} = 1 - \exp\left[-1.45\left(\frac{\sigma_c}{\sigma_L}\right)^{0.75}\left(\frac{L_w^*}{a\mu_L}\right)^{0.1}\left(\frac{L_w^{*2}a}{\rho_L^2 g}\right)^{-0.05}\left(\frac{L_w^{*2}}{\rho_L\sigma_L a}\right)^{0.2}\right]$$

$$k_L\left(\frac{\rho_L}{\mu_L g}\right)^{1/3} = 0.0051\left(\frac{L_w^*}{a_w\mu_L}\right)^{2/3}\left(\frac{\mu_L}{\rho_L D_L}\right)^{-1/2}(ad_p)^{0.4}, \quad \frac{k_G RT}{aD_v} = K_5\left(\frac{V_w^*}{a\mu_v}\right)^{0.7}\left(\frac{\mu_v}{\rho_v D_v}\right)^{1/3}(ad_p)^{-2.0}$$

$$H_G = \frac{G_m}{k_G a_w P}, \quad H_L = \frac{L_m}{k_L a_w C_t}, \quad H_{OG} = H_G + m\frac{G_m}{L_m}H_L$$

Variables

L_w^*	Liquid mass flux	kg/(m²·s)
V_w^*	Gas mass flux	kg/(m²·s)
a	Packing specific area	m²/m³
d_p	Nominal packing size	m
σ_c	Critical surface tension of the packing (ceramic 61, steel 75, polyethylene 33)	N/m
σ_L	Liquid surface tension	N/m
μ_L	Liquid viscosity	Pa·s
ρ_L	Liquid density	kg/m³
D_L	Liquid diffusivity	m²/s
μ_v	Gas viscosity	Pa·s
ρ_v	Gas density	kg/m³
D_v	Gas diffusivity	m²/s
T	Temperature	K
P	Pressure	Pa
M_L	Liquid molar mass	kg/kmol
M_V	Gas molar mass	kg/kmol
m	Equilibrium line slope (y = mx)	-
a_w/a	Wetted fraction of packing area	-
a_w	Effective interfacial area	m²/m³
k_L	Liquid film coefficient	m/s
k_G	Gas film coefficient, kmol/(m²·s·bar)	-
H_G	Gas film transfer unit height	m
H_L	Liquid film transfer unit height	m
mG_m/L_m	Stripping factor	-
H_{OG}	Overall gas-phase transfer unit height	m

Method and standards

Onda's film coefficient and wetted-area correlations.

Assumptions and limits

- Random packings; Onda's data range.

Report details

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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/chemical/separation/onda-packed-column-mass-transfer

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Reopens the calculator with the inputs of this report.