Tray Column Diameter from Souders–Brown Flooding

Flooding velocity, net area and diameter of a tray column from the vapour load, densities, flood C-factor with surface-tension correction and design flood fraction.

Method: Perry's Chemical Engineers' Handbook; 9th ed. (McGraw-Hill, 2019); ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Vapour mass flow	25,500	kg/h
Vapour density	0.48100	kg/m³
Liquid density	841.00	kg/m³
Flood C-factor at σ = 20 mN/m (from the tray chart)	0.095000	m/s
Liquid surface tension	25.000	mN/m
Design fraction of flood	80.000	%
Downcomer share of the tower area	12.000	%

Calculated results

Parameter	Value	Unit
C-factor corrected for surface tension	0.099336	m/s
Flooding velocity on the net area	4.1525	m/s
Net area	4.4330	m²
Tower area	5.0375	m²
Tower diameter	2.5326	m

Notes for this case

- C_SB comes from a flooding chart (Fair, or the vendor's) at the flow parameter and tray spacing; check downcomer backup separately.

Formula and method

$$u_{flood} = C_{SB}\left(\frac{\sigma}{20}\right)^{0.2}\sqrt{\frac{\rho_L-\rho_G}{\rho_G}},\quad A_N = \frac{\dot{m}_V}{\rho_G f u_{flood}},\quad A_T = \frac{A_N}{1-A_D/A_T}$$

Variables

$\dot{m}_V$	Vapour mass flow	kg/s
ρ_G	Vapour density	kg/m³
ρ_L	Liquid density	kg/m³
C_{SB}	Flood C-factor at σ = 20 mN/m (from the tray chart)	m/s
σ	Liquid surface tension	N/m
f	Design fraction of flood	-
A_D/A_T	Downcomer share of the tower area	-
$C_{SB,\sigma}$	C-factor corrected for surface tension	m/s
u_{flood}	Flooding velocity on the net area	m/s
A_N	Net area	m²
A_T	Tower area	m²
D_T	Tower diameter	m

Method and standards

Souders–Brown entrainment flooding as in Perry's sec. 14.

Assumptions and limits

- Spray-regime entrainment flood; σ in mN/m.
- The flow parameter and tray spacing are not inputs: read C_SB from the flooding chart for them. Downcomer backup and weeping are not checked.

References

- Perry's Chemical Engineers' Handbook
- 9th ed. (McGraw-Hill, 2019)
- sec. 14 (equipment for distillation and gas absorption)
- Eq. (14-80) and the surface-tension correction (σ/20)^0.2 of the worked example

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/chemical/separation/tray-column-diameter-flooding

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.