Reflux Condenser (Dephlegmator): Tube Flooding Check

Checks whether the tubes of a vertical reflux condenser with vapour rising and condensate falling will flood, from the flooding criterion of the two velocities.

Method: Counter-current flooding criterion [u_v^½ ρ_v^¼ + u_L^½ ρ_L^¼] < 0.6[g d_i(ρ_L − ρ_v)]^¼

Input parameters

Unit system: SI

Parameter	Value	Unit
Vapour entering the tubes	14,400	kg/h
Condensate returning down the tubes	10,800	kg/h
Number of tubes	300.00	
Tube inside diameter	40.000	mm
Vapour density	3.0000	kg/m³
Liquid density	780.00	kg/m³

Calculated results

Parameter	Value	Unit
Vapour velocity (vapour alone)	3.5368	m/s
Liquid velocity (liquid alone)	0.010202	m/s
Flooding group of the flows	3.0088	
Flooding limit	2.5070	
Flows as a share of the flooding limit	120.02	%
Fewest tubes that avoid flooding	433.00	

Notes for this case

- Flooding criterion for counter-current vapour and condensate in vertical tubes; velocities are superficial (each phase alone in the full tube area), at the tube inlet where both flows are largest.
- The tubes will flood: add tubes, use larger tubes or reduce the vapour load.

Formula and method

$$u_v^{1/2}\rho_v^{1/4} + u_L^{1/2}\rho_L^{1/4} < 0.6\,[g\,d_i(\rho_L - \rho_v)]^{1/4}$$

$$u_v = \frac{\dot{m}_v}{n_t\,\pi d_i^2/4\,\rho_v}, \quad u_L = \frac{\dot{m}_l}{n_t\,\pi d_i^2/4\,\rho_L}$$

Variables

$\dot{m}_v$	Vapour entering the tubes	kg/s
$\dot{m}_l$	Condensate returning down the tubes	kg/s
n_t	Number of tubes	-
d_i	Tube inside diameter	m
ρ_v	Vapour density	kg/m³
ρ_L	Liquid density	kg/m³
u_v	Vapour velocity (vapour alone)	m/s
u_L	Liquid velocity (liquid alone)	m/s
$u_v^{1/2}\rho_v^{1/4} + u_L^{1/2}\rho_L^{1/4}$	Flooding group of the flows	-

$0.6[gd_i(\rho_L - \rho_v)]^{1/4}$	Flooding limit	-
ratio	Flows as a share of the flooding limit	-
$n_{t,min}$	Fewest tubes that avoid flooding	-

Method and standards

Empirical flooding limit for counter-current two-phase flow in vertical tubes.

Assumptions and limits

- Vertical tubes, vapour up and condensate down; rough guide only.

References

Counter-current flooding criterion [u_v^½ ρ_v^¼ + u_L^½ ρ_L^¼] < 0.6[g d_i(ρ_L − ρ_v)]^¼

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/process-heat-exchangers/reflux-condenser-flooding

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Reopens the calculator with the inputs of this report.