Flash Fraction and Two-Phase Release of a Superheated Liquid

Fraction of a pressurised liquid that flashes to vapour on release, by the simple and the integrated balance, and the choked two-phase discharge through a hole.

Method: Crowl and Louvar; Chemical Process Safety: Fundamentals with Applications; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Liquid temperature in the vessel	25.000	°C
Normal boiling point	-42.050	°C
Mean liquid heat capacity	2.6000	kJ/(kg·K)
Latent heat at the boiling point	426.00	kJ/kg
Change in specific volume on vaporisation (v_g − v_f) at the vessel condition	0.040000	m³/kg
Hole diameter	25.400	mm

Calculated results

Parameter	Value	Unit
Flash fraction (simple balance)	40.923	%
Flash fraction (integrated, constant latent heat)	33.584	%
Two-phase mass flux (equilibrium, choked)	12,096	kg/(m²·s)
Two-phase discharge rate	6.1292	kg/s

Notes for this case

- The flashing liquid also carries off spray: the airborne mass is often taken as about twice the flash fraction. The two-phase flux is the equilibrium rate model for discharge through holes or pipes longer than about 10 cm; a sharp hole in a thin wall passes more, nearer the liquid rate.
- A screening estimate for training and early design, not a hazard or risk study.

Formula and method

$$f_v = \frac{\bar{C}_p(T_0 - T_b)}{\Delta H_v}, \quad f_v = 1 - \exp\left[-\frac{\bar{C}_p(T_0 - T_b)}{\Delta H_v}\right], \quad Q_m = A\frac{\Delta H_v}{v_{fg}}\sqrt{\frac{1}{\bar{C}_p T_0}}$$

Variables

T_0	Liquid temperature in the vessel	K
T_b	Normal boiling point	K
$\bar{C}_p$	Mean liquid heat capacity	J/(kg·K)
ΔH_v	Latent heat at the boiling point	J/kg
v_{fg}	Change in specific volume on vaporisation (v_g − v_f) at the vessel condition	m³/kg
d	Hole diameter	m
f_v	Flash fraction (simple balance)	-
G	Two-phase mass flux (equilibrium, choked)	kg/(m²·s)
Q_m	Two-phase discharge rate	kg/s

Method and standards

Energy balance on adiabatic flashing and the equilibrium two-phase discharge (Fauske and Epstein) as given by Crowl and Louvar.

Assumptions and limits

- Adiabatic flashing; equilibrium flow.

References

- Crowl and Louvar
- Chemical Process Safety: Fundamentals with Applications
- 2nd ed. (Prentice Hall, 2002)
- ch. 4
- eqs. 4-90
- 4-93 and 4-104 (Fauske and Epstein equilibrium rate model)

Report details

Report reference	FCC-T2JX-87S9 (the same inputs always give the same reference)
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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/process-safety/flash-fraction-superheated-liquid

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Reopens the calculator with the inputs of this report.