Minimum Reflux Ratio of a Binary Column (Pinch at the q-Line)

Minimum reflux ratio of a binary distillation with constant relative volatility from the pinch where the q-line meets the equilibrium curve, and a design reflux.

Method: McCabe–Thiele: pinch at the intersection of the q-line and the equilibrium curve y = αx/(1 + (α − 1)x); R_min = (x_D − y*)/(y* − x*)

Input parameters

Unit system: SI

Parameter	Value	Unit
Relative volatility	2.5000	
Feed (light component mole fraction)	40.000	%
Distillate purity	95.000	%
Feed condition q (1 saturated liquid, 0 saturated vapour)	1.0000	
Design reflux multiple	1.3000	

Calculated results

Parameter	Value	Unit
Pinch liquid composition	40.000	%
Pinch vapour composition	62.500	%
Minimum reflux ratio	1.4444	
Design reflux ratio	1.8778	

Notes for this case

- Assumes the pinch is at the feed (no tangent pinch), constant α and constant molal overflow.

Formula and method

$$y = \frac{\alpha x}{1 + (\alpha - 1)x}, \quad y = \frac{q}{q-1}x - \frac{x_F}{q-1}, \quad R_{min} = \frac{x_D - y^*}{y^* - x^*}$$

Variables

α	Relative volatility	-
x_F	Feed (light component mole fraction)	-
x_D	Distillate purity	-
q	Feed condition q (1 saturated liquid, 0 saturated vapour)	-
R/R_{min}	Design reflux multiple	-
x^*	Pinch liquid composition	-
y^*	Pinch vapour composition	-
R_{min}	Minimum reflux ratio	-
R	Design reflux ratio	-

Method and standards

McCabe–Thiele pinch.

Assumptions and limits

- Constant α and molal overflow.
- The design multiple R/R_min is at least 1.

References

• McCabe–Thiele: pinch at the intersection of the q-line and the equilibrium curve y = αx/(1 + (α − 1)x); R_min = (x_D − y*)/(y* − x*)

Report details

Report reference	FCC-RPEB-7GH4 (the same inputs always give the same reference)
Generated	17 November 2026, 19:44 UTC
Calculator	Minimum Reflux Ratio of a Binary Column (Pinch at the q-Line)
Method last reviewed	12 November 2026
Software release	FireCAD Calc, release of 17 November 2026
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/minimum-reflux-binary

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.