Ethanol–Water Composition from Boiling Temperature

Liquid and vapour ethanol strengths from a tray or still temperature at about 1 atm, the inverse of the bubble-point curve; used to read column temperatures.

Method: Ethanol–water VLE at about 1 atm: Wilson equation (Perry's Chemical Engineers' Handbook, 9th ed., sec. 4) with energies 399 and 933 cal/mol fitted to FireCAD ethanol–water x–y–T data at 101.325 kPa; ethanol vapour pressure Perry's 9th ed. Table 2-8; water IAPWS-IF97; Checked against Gmehling and Onken; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Measured boiling temperature	87.000	°C
Pressure Model fitted at 1 atm; use 0.9–1.2 atm.	101.33	kPa

Calculated results

Parameter	Value	Unit
Liquid mole fraction	8.9996	%
Liquid strength	24.766	%
Liquid strength by mass	20.185	%
Vapour mole fraction	42.249	%
Condensed vapour strength	72.582	%

Notes for this case

- Near the azeotrope the temperature changes by only tenths of a degree over a wide strength range: read top-tray strength by density, not temperature.

Formula and method

$$T_b(x_1, P) = T_{\text{measured}}$$

Variables

T	Measured boiling temperature	K
P	Pressure	Pa
x_1	Liquid mole fraction	-
q_x	Liquid strength	-
p_x	Liquid strength by mass	-
y_1	Vapour mole fraction	-
q_y	Condensed vapour strength	-

Method and standards

Inverse of the bubble-point curve by bisection.

Assumptions and limits

- Wilson energies fitted at 1 atm; 0.9–1.2 atm only.
- Binary ethanol–water; congeners and dissolved solids ignored.
- Near the azeotrope the bubble curve is so flat that an error of a few tenths of a degree, in the reading or in the fitted model, moves the strength a long way; no uncertainty is computed, so read strong liquids by density.

References

• Ethanol–water VLE at about 1 atm: Wilson equation (Perry's Chemical Engineers' Handbook, 9th ed., sec. 4) with energies 399 and 933 cal/mol fitted to FireCAD ethanol–water x–y–T data at 101.325 kPa; ethanol vapour pressure Perry's 9th ed. Table 2-8; water IAPWS-IF97
• Checked against Gmehling and Onken

- DECHEMA Chemistry Data Series vol. I/1
- as quoted in Perry's 9th ed. sec. 13 (simple batch distillation example)

Report details

Report reference	FCC-4MMY-JSTZ (the same inputs always give the same reference)
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Calculator	Ethanol–Water Composition from Boiling Temperature
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	2 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/sugar-ethanol/ethanol-distillation/ethanol-water-composition-from-temperature

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.