Boiling Point Elevation of a Solution (Ebullioscopic)

Rise in boiling point of water when a non-volatile solute dissolves, from the molality and van 't Hoff factor, with the ebullioscopic constant from IF97 at the pressure.

Method: Ideal dilute solution (Raoult and Clausius–Clapeyron); IAPWS-IF97 (water and steam)

Input parameters

Unit system: SI

Parameter	Value	Unit
Pressure (absolute)	1.0132	bar
Solute per kg of water	0.050000	kg/kg
Molar mass of the solute Default: sodium chloride.	58.440	kg/kmol
van 't Hoff factor (ions or particles per formula unit)	2.0000	

Calculated results

Parameter	Value	Unit
Molality of the solute	0.85558	mol/kg
Boiling point of pure water at the pressure	99.974	°C
Ebullioscopic constant R T_b² / h_fg (K·kg/mol)	0.51298	
Boiling point elevation i K_b b	0.87778	K
Boiling point of the solution	100.85	°C

Notes for this case

- Ideal dilute-solution law: good to about 1 mol/kg. Concentrated liquors (black liquor, sugar syrup, caustic) rise more; use a Dühring chart for them.

Formula and method

$$b = \frac{w}{M_s}, \quad K_b = \frac{R\,T_b^2}{h_{fg}}$$

$$\Delta T_b = i\,K_b\,b$$

Variables

p	Pressure (absolute)	Pa
w	Solute per kg of water	kg/kg
M_s	Molar mass of the solute	kg/kmol
i	van 't Hoff factor (ions or particles per formula unit)	-
b	Molality of the solute	mol/kg
T_b	Boiling point of pure water at the pressure	K
K_b	Ebullioscopic constant R T_b² / h_fg (K·kg/mol)	-
ΔT_b	Boiling point elevation i K_b b	K
T	Boiling point of the solution	K

Method and standards

Dilute-solution limit of Raoult's law combined with the Clausius–Clapeyron equation; T_b and h_fg of water from IF97.

Assumptions and limits

- Dilute ideal solution, non-volatile solute.

References

- Ideal dilute solution (Raoult and Clausius–Clapeyron)
- IAPWS-IF97 (water and steam)

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/solutions/boiling-point-elevation

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Reopens the calculator with the inputs of this report.