Bubble and Dew Point of a Binary Mixture (Raoult's Law)

Bubble-point and dew-point temperatures of an ideal two-component liquid mixture at a pressure, with the first vapour and first liquid compositions, from Antoine constants.

Method: Raoult's law (ideal solution); NIST Chemistry WebBook Antoine parameters

Input parameters

Unit system: SI

Parameter	Value	Unit
Pressure (absolute)	1.0132	bar
Mole fraction of component 1 (the lighter one)	50.000	%
Component 1: A Defaults: benzene, 287.7–354.07 K, NIST Chemistry WebBook (Williamham et al., 1945).	4.0181	
Component 1: B	1,203.8	
Component 1: C	-53.226	
Component 2: A Defaults: toluene, 308.52–384.66 K, NIST Chemistry WebBook (Williamham et al., 1945).	4.0783	
Component 2: B	1,343.9	
Component 2: C	-53.773	

Calculated results

Parameter	Value	Unit
Bubble-point temperature	92.116	°C
First vapour: mole fraction of component 1	71.358	%
Dew-point temperature	98.774	°C
First liquid: mole fraction of component 1	29.100	%
Relative volatility at the bubble point	2.4914	

Notes for this case

- Ideal liquid and ideal gas (Raoult's law): good for close relatives such as benzene–toluene, wrong for water with organics or azeotropes.
- Check that both temperatures lie inside the range of each set of Antoine constants; outside it the vapour pressures are extrapolated (the default benzene set is for 287.7–354.07 K, so the default case is an extrapolation).

Formula and method

$$\sum x_i\, p_i^{sat}(T_{bub}) = p, \quad \sum \frac{y_i}{p_i^{sat}(T_{dew})} = \frac{1}{p}$$

$$\log_{10} p^{sat} = A - \frac{B}{T + C}$$

Variables

p	Pressure (absolute)	Pa
z_1	Mole fraction of component 1 (the lighter one)	-
A_1	Component 1: A	-
B_1	Component 1: B	-
C_1	Component 1: C	-

A_2	Component 2: A	-
B_2	Component 2: B	-
C_2	Component 2: C	-
T_{bub}	Bubble-point temperature	K
y_1	First vapour: mole fraction of component 1	-
T_{dew}	Dew-point temperature	K
x_1	First liquid: mole fraction of component 1	-
α_{12}	Relative volatility at the bubble point	-

Method and standards

Raoult's law with Antoine vapour pressures, solved for temperature.

Assumptions and limits

- Ideal liquid and vapour.
- Antoine constants in the bar and K form; a result below absolute zero (constants entered in the mmHg and °C form) is rejected.
- Each set of constants holds only over its temperature range; the page does not check it. The default benzene set ends at 354.07 K, so the default case is extrapolated.

References

- Raoult's law (ideal solution)
- NIST Chemistry WebBook Antoine parameters

Report details

Report reference	FCC-J0B5-X8S3 (the same inputs always give the same reference)
Generated	17 November 2026, 19:45 UTC
Calculator	Bubble and Dew Point of a Binary Mixture (Raoult's Law)
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/raoult-bubble-dew-point

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.