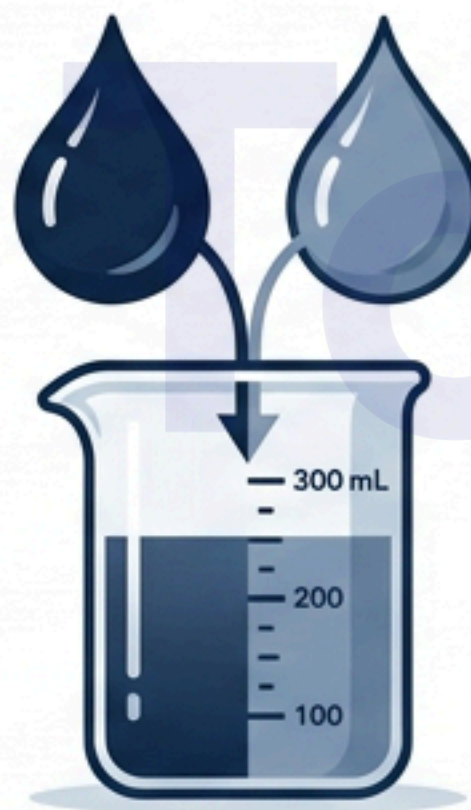


1.5.1 Ideal Solutions

The macroscopic, thermodynamic, and microscopic principles of perfect mixing.



Read-Time: 2 Mins | Topic: Liquid-Liquid Binary Solutions

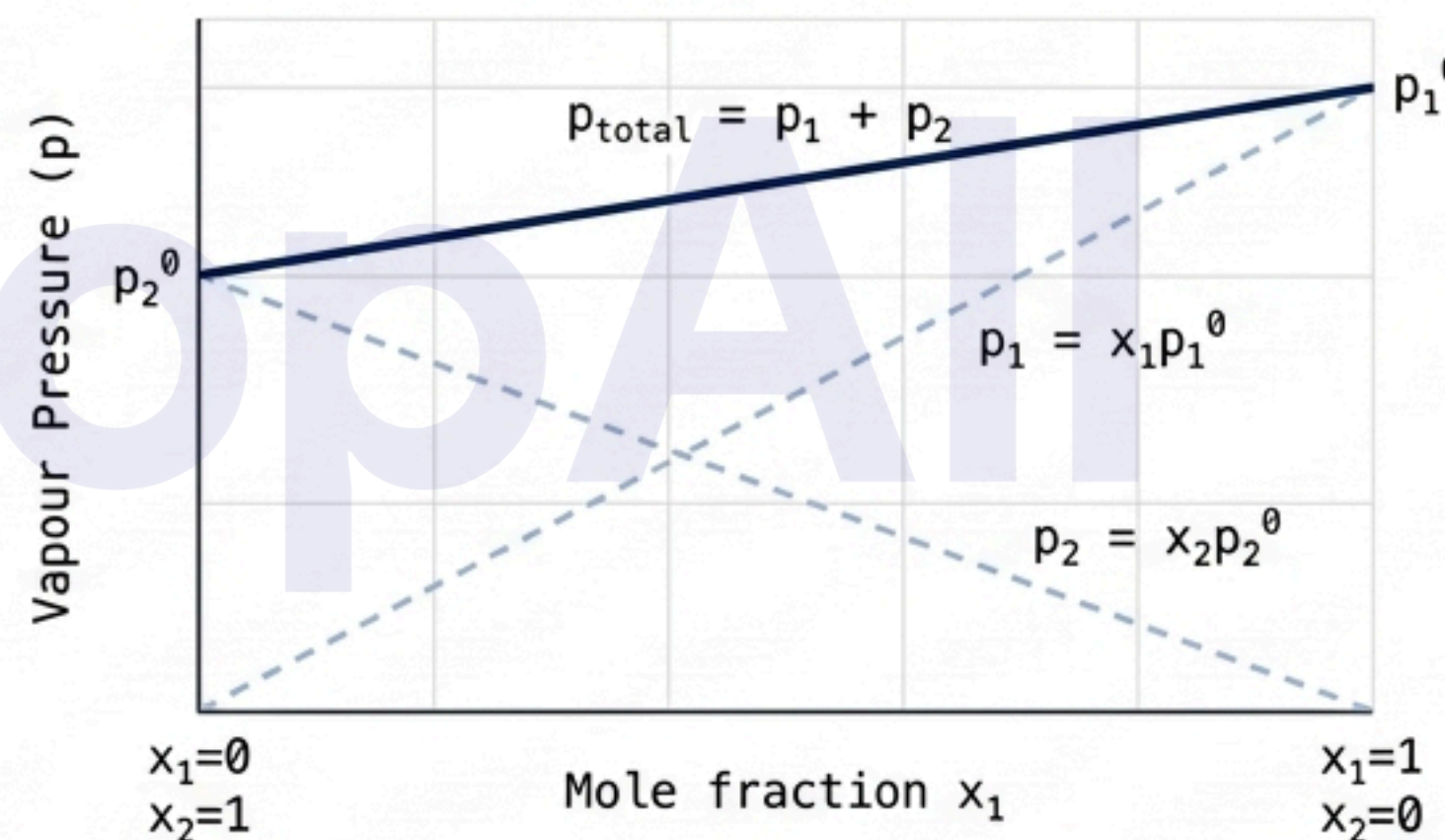
Strict Obedience to Raoult's Law

An ideal solution is defined as one that obeys Raoult's law strictly over the entire range of concentration.

$$p_i = x_i p_i^0$$

$$p_{\text{total}} = p_1 + p_2 = x_1 p_1^0 + x_2 p_2^0$$

Vapour Pressure vs. Mole Fraction



Key Takeaway: The total vapour pressure varies perfectly linearly with the mole fraction of the components.

Perfect Energy and Spatial Conservation

Enthalpy of Mixing

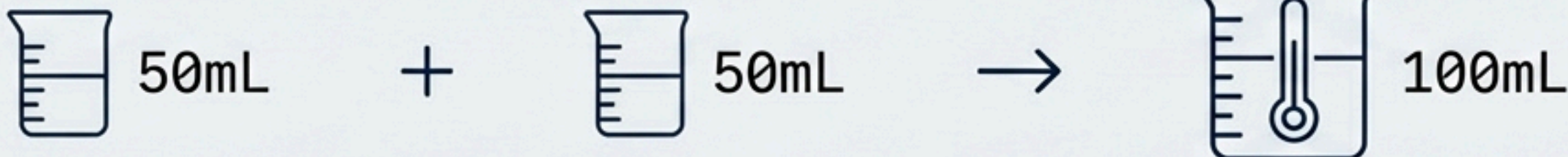
$$\Delta_{\text{mix}} H = 0$$

No heat is absorbed or evolved when the pure components are mixed. The thermal energy of the system remains completely undisturbed.

Volume of Mixing

$$\Delta_{\text{mix}} V = 0$$

The total volume is strictly additive. Mixing exactly 50 mL of Liquid A and 50 mL of Liquid B yields exactly 100 mL of solution—with **no expansion** or contraction.



Key Takeaway: Mixing an ideal solution creates zero thermodynamic disturbance.



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Let's Test Them Now.**

$$E=mc^2$$



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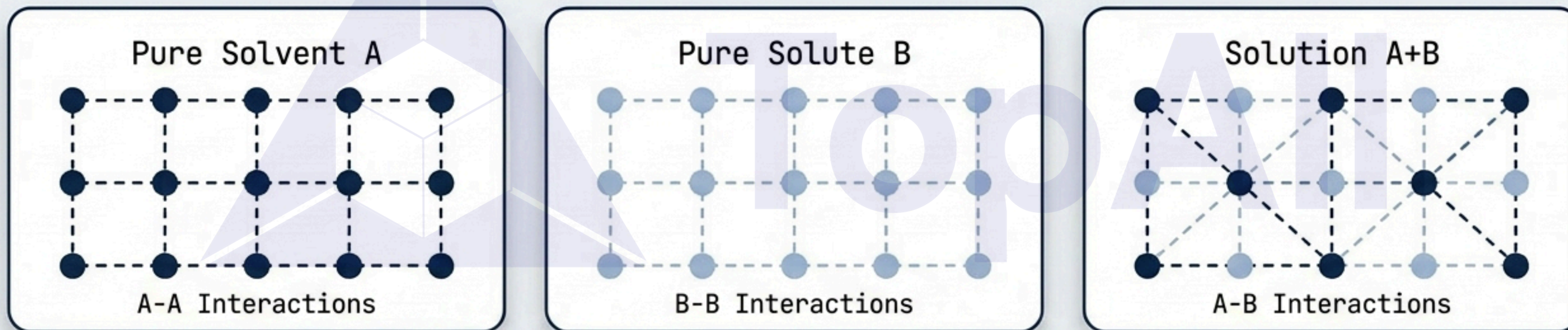
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The Equality of Molecular Interactions

At the molecular level, ideal behavior occurs because the attractive forces between unlike molecules (**A-B**) are **nearly identical** to the attractive forces between **like** molecules (**A-A** and **B-B**).



Intermolecular Forces: $A-A \approx B-B \approx A-B$

Key Takeaway: Molecules of A and B find it exactly as easy to escape the mixture as they did their pure states.

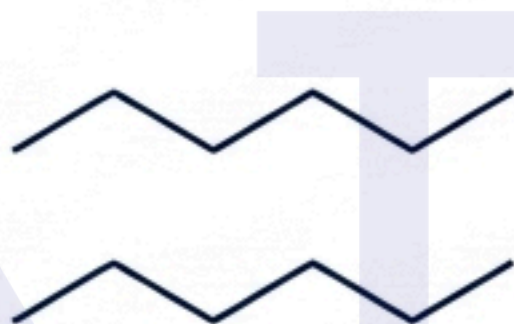
Near-Ideal Binary Solutions



Notice a pattern?

A perfectly ideal solution is rare. Near-ideal solutions are formed by liquids with highly similar molecular structures, sizes, and chemical polarities.

n-hexane &
n-heptane



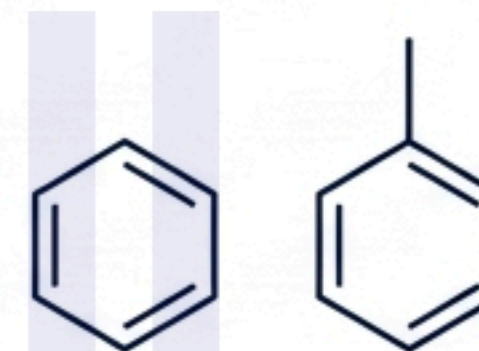
Similar non-polar
aliphatic chains.

bromoethane &
chloroethane



Similar haloalkane
structures and
polarities.

benzene &
toluene



Similar aromatic
ring structures.

Key Takeaway: Structural similarity is the prerequisite for molecular interaction equality.

Ideality = No Major Disturbance on Mixing

A perfectly ideal solution is a theoretical construct where the act of mixing two liquids creates absolutely no disturbance—chemically, energetically, or spatially.

Macroscopic	Raoult's Law	$p_i = x_i p_i^0$	Vapour pressure changes linearly without deviation.
Thermodynamic	Enthalpy & Volume	$\Delta_{\text{mix}} H = 0 ; \Delta_{\text{mix}} V = 0$	No heat exchange; perfect volume additivity.
Microscopic	Interactions	$A-A \approx B-B \approx A-B$	Solute and solvent behave identically to pure states.



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