

Solubility and Distribution Phenomena

ASST. LECT. FATIMAH HASAN

Solubility of Strong Electrolytes

- The temperature has an important affect on solubility of strong electrolytes.
- Solids are affected by heat differently depending on their chemical properties.
- Some of solid are dissolved and absorbed heat (endothermic) and the other released heat (exothermic).

Dissolution and heat

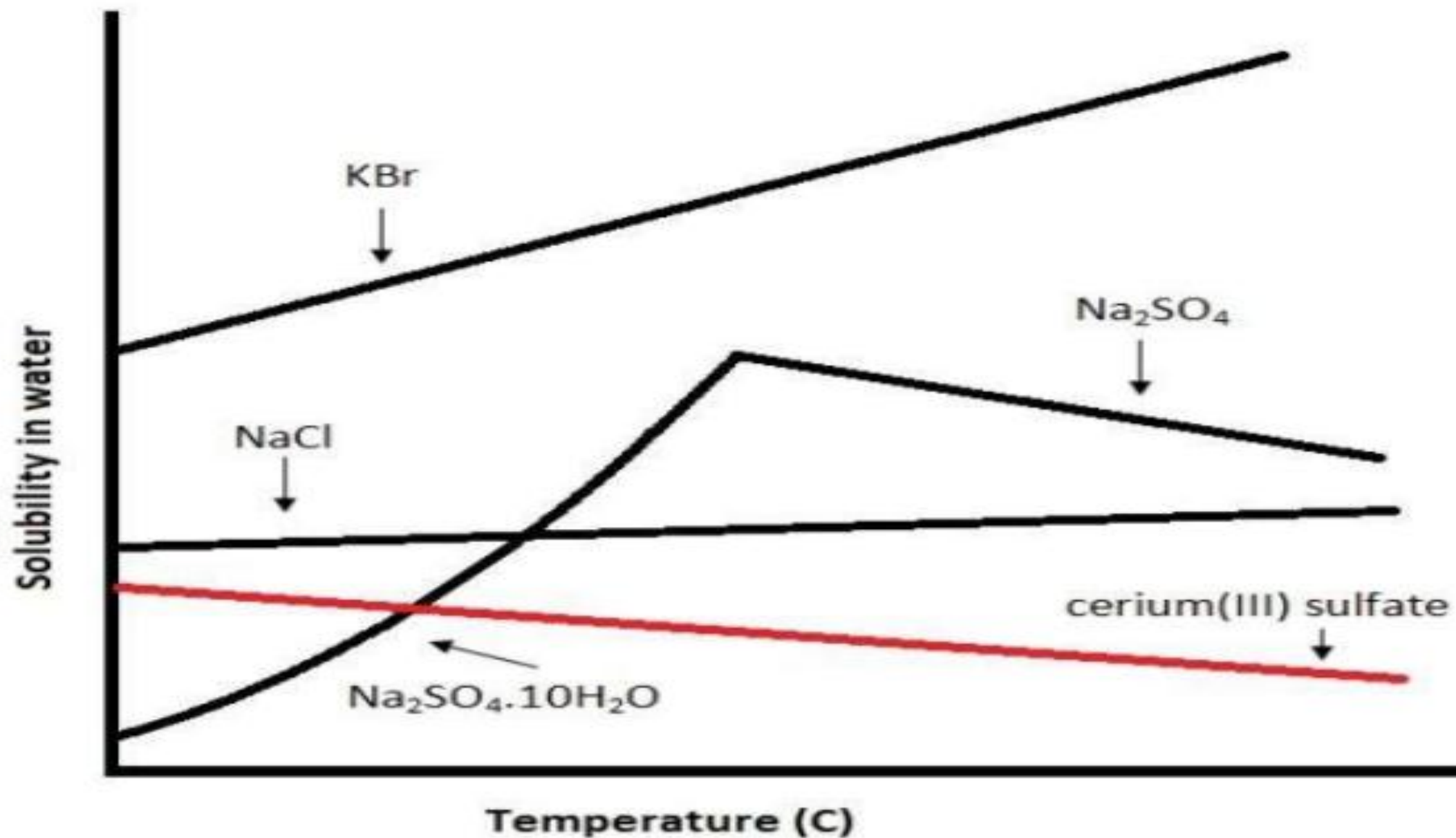
- KBr solution processes is endothermic, therefore the rising in temperature will increase solubility (positive relationship).
- cerium(III) sulfate solution processes is exothermic, therefore the rising in temperature will decrease solubility (negative relationship).

Dissolution and heat

- The dissolution of hydrated form of Sodium sulfate is endothermic up to 32°C, therefore, the solubility increase with temperature.
- Above this point, the compound exists as the anhydrous salt, Na_2SO_4 , the dissolution is exothermic, and solubility decreases with an increase of temperature.

Sodium chloride does not absorb or evolve an appreciable amount of heat when it dissolves in water; thus, its solubility is not altered

much by a change of temperature (isothermic reaction), and the heat of solution is approximately zero.



Solubility of Weak Electrolytes

- Most drugs belong to the class of weak acids and bases.
- Weak acids react with dilute alkalis to form watersoluble salts, but when the level of pH decreased by adding stronger acidic substances they can be precipitated.
- For example, a 1% solution of phenobarbital sodium is soluble at pH values high in the alkaline range. The soluble ionic form is converted into molecular phenobarbital as the pH is lowered, and below 9.3, the drug begins to precipitate from solution.

Solubility of Weak Electrolytes

- Weak bases react with dilute acids (low pH) to form water-soluble salts, but they can be precipitated as the free bases if stronger basic substances (increase the pH) are added to the solution.
- For example, alkaloid salts such as atropine sulfate begin to precipitate as the pH is elevated. To ensure a clear homogeneous solution and maximum therapeutic effectiveness, the preparations should be adjusted to an optimum pH.

Calculating the Solubility of Weak

- Electrolytes as Influenced by pH according to the Henderson-Hasselbalch equation, the relationship between pH, pKa, and relative concentrations of an acid and its salt is as follows:

$$\text{pH} = \text{pKa} + \log \frac{[\text{A}^-]}{[\text{HA}]}$$

- where $[\text{A}^-]$ is the molar concentration of the salt (dissociated species) ,

$[\text{HA}]$ is the concentration of the undissociated acid. When the concentrations of salt and acid are equal, the pH of the system equals the pKa of the acid. As the pH decreases, the concentration of the molecular acid

increases and that of the salt decreases.

Calculating the Solubility of Weak

Electrolytes solubility is Influenced by changing in pH according to the Henderson-Hasselbach equation The relationship between pH, pKa, and relative concentrations of an acid and its salt is as follows:

$$\text{pH} = \text{pKa} + \log \frac{[\text{A}^-]}{[\text{HA}]}$$

Where:

- $[\text{A}^-]$ is the molar concentration of the salt (dissociated species)
- $[\text{HA}]$ is the concentration of the undissociated acid.

The Influence of Solvents on the Solubility of Drugs

Weak electrolytes can behave like strong electrolytes or like nonelectrolytes in solution.

- When the solution is of such a pH that the drug is entirely in the ionic form, it behaves as a solution of a strong electrolyte-----> no problem.
- However, when the pH is adjusted to a value at which un-ionized molecules are produced in sufficient concentration to exceed the solubility of this form,
precipitation occurs. -----> (Problem)
- To solve this problem, a solute is more soluble in a mixture of solvents than in one solvent alone (co-solvency)

Distribution of Solutes between Immiscible Solvents

When the substance added to mixture of two immiscible liquids, it will be distributed between the two phases until becomes saturated.

- If the substance is added below the saturation level, it will be distributed between the two layers in a definite concentration ratio.

$$K = C_1/C_2$$

K, is known as the distribution ratio

C1 and C2 are the equilibrium concentrations of the substance in Solvent1 and Solvent2

- This constant is known as the partition coefficient (or distribution coefficient)

Partition coefficient

- Partition law holds true

1-at constant temperature

2-when the solute exists in the same form in both solvents (the species are common to both phases)

Extraction

Liquid-liquid extraction is a useful method to separate components of a mixture.

- Liquid-liquid extraction is based on the transfer of a solute substance from one liquid phase into another liquid phase according to the solubility.
- To separate the sugar from the oil we add water to the mixture with shaking. Sugar is much more soluble in water than in vegetable oil, and water is immiscible (=not soluble) with oil. By shaking the sugar will move to the phase in which it is most soluble

Experimental work

Extraction of sucrose from olive oil :

Material and equipment:

- Sucrose
- Olive oil
- Distilled water

Equipment:

- Conical flask
- Electrical balance

Experimental work

Practical work:

1. Weight 100 mg sucrose
2. Add its to 10 ml olive oil
3. Add 10 ml distilled water and shake well
4. Leave the system to separate to two phase
5. The water layer was analyzed to check the concentration of sucrose.