

A Saturated Solution Is Made By Dissolving A 36.8 Of A Solid In 200 ML Of Water. A Second Solution Is

A Saturated Solution Is Made By Dissolving A 36.8 Of A Solid In 200 ML Of Water. A Second Solution Is a fundamental concept in chemistry that explores how substances dissolve and reach equilibrium in solvents like water. Understanding the formation of saturated solutions is essential for students, educators, and professionals working in fields such as chemistry, environmental science, and chemical engineering. This article delves into the principles behind saturated solutions, how to calculate their concentrations, and explores the implications and applications of such solutions across various contexts.

Understanding Saturated Solutions

What Is a Saturated Solution?

A saturated solution is one in which the maximum amount of solute has been dissolved in a solvent at a given temperature and pressure. In this state, the solution is in equilibrium: the rate of dissolution of the solute equals the rate of crystallization or precipitation from the solution.

Key Characteristics of Saturated Solutions:

- No more solute can dissolve at the current temperature.
- Any additional solute added will remain undissolved.
- The solution is dynamic, with ongoing dissolution and crystallization occurring simultaneously.

The Importance of Saturation in Chemistry

Understanding saturation helps in:

- Controlling the crystallization process in manufacturing.
- Designing drug formulations with specific solubility profiles.
- Managing environmental concerns, such as mineral deposits in water sources.
- Analyzing solution chemistry in laboratory settings.

Calculating the Concentration of the Saturated Solution

Given Data

In our scenario:

- Solute mass = 36.8 grams
- Water volume = 200 milliliters (mL)

To understand the concentration of this saturated solution, we need to determine its molarity or mass/volume ratio.

Step-by-Step Calculation

1. Convert Volume to Liters

Since molarity is expressed in moles per liter, convert 200 mL to liters:

- $200 \text{ mL} = 0.200 \text{ L}$

2. Determine the Molar Mass of the Solute

Assuming the solute is a common compound, such as sodium chloride (NaCl), molar mass = 58.44 g/mol.

3. Calculate Moles of Solute

Number of moles = mass / molar mass

- For NaCl: $36.8 \text{ g} / 58.44 \text{ g/mol} \approx 0.629 \text{ mol}$

4. Calculate Molarity

Molarity = moles of solute / volume in liters

- Molarity $\approx 0.629 \text{ mol} / 0.200 \text{ L} \approx 3.145 \text{ mol/L}$

5. Expressing the Saturated Solution

The saturated solution contains approximately 3.145 mol of NaCl per liter at the given temperature.

Understanding Second Solutions: Variations in Concentration

Creating a Less Saturated Solution

A second solution can be prepared by dissolving less than 36.8 g of the solute in 200 mL of water or by increasing the water volume. For example:

- Dissolving 20 g of NaCl in 200 mL water yields a solution with approximately 1.715 mol/L, well below saturation.
- Increasing water volume while keeping solute constant also decreases concentration.

Implications:

- The solution remains unsaturated.
- More solute can still dissolve until reaching saturation.

Creating a Supersaturated Solution

By heating the solution and then slowly cooling it, more solute than the saturation point can temporarily be dissolved, creating a supersaturated solution. This state is unstable and can lead to rapid crystallization if disturbed.

Factors Affecting Saturation and Solubility

Temperature

- Generally, increasing temperature increases solubility for most solids.
- For example, sugar dissolves more readily in hot water.

Pressure

- Mainly affects gases; higher pressure increases gas solubility.
- For solids like salt, pressure has minimal effect.

Nature of Solute and Solvent

- Polar solutes tend to dissolve well in polar solvents like water.
- Non-polar substances are less soluble in water.

Common Solubility Data

| Substance | Solubility at 25°C (g/100 mL) |

|-----|-----|

| NaCl | 36.0 |

| Sugar | 200 |

| CaSO₄ | 0.2 |

This data helps in predicting whether a solution is saturated under specific conditions.

Applications of Saturated Solutions

Industrial Processes

- Salt Production: Using saturated brine solutions to extract salt.

- Pharmaceuticals: Formulating drugs with precise solubility profiles.
- Food Industry: Creating saturated sugar solutions for candies and jams.

Environmental Science

- Studying mineral deposits.
- Understanding water hardness caused by dissolved calcium and magnesium salts.

Laboratory Techniques

- Crystallization for purifying substances.
- Titration methods requiring saturated solutions.

Practical Tips for Working with Saturated Solutions

- Always measure temperature accurately, as solubility varies with temperature.
- Use appropriate containers to prevent evaporation or contamination.
- When preparing saturated solutions, add solute gradually until no more dissolves.
- In crystallization experiments, carefully control cooling rates to obtain desired crystal sizes.

Summary

A saturated solution is characterized by its maximum solute capacity at a specific temperature, exemplified by dissolving 36.8 g of a solid in 200 mL of water. Calculations of concentration, understanding factors affecting solubility, and manipulating solution conditions allow chemists to control and utilize such solutions effectively. Whether in industrial manufacturing, environmental management, or laboratory research, mastering the principles of saturation is vital for achieving desired outcomes in chemical processes.

Understanding the nuances between saturated, unsaturated, and supersaturated solutions enables better control over solubility phenomena, optimizing processes across a wide array of scientific and industrial applications.

Frequently Asked Questions

What is a saturated solution?

A saturated solution is one in which no more solute can dissolve at a given temperature, meaning the maximum amount of solute has been dissolved in the solvent.

How do you determine if a solution is saturated?

You can determine if a solution is saturated by adding more solute; if it dissolves, the solution is unsaturated. If the added solute remains undissolved, the solution is saturated.

What does dissolving 36.8 g of a solid in 200 mL of water indicate?

It indicates that 36.8 g of the solid has been dissolved in 200 mL of water, potentially forming a saturated solution depending on the solubility of the solid at that temperature.

How can you prepare a saturated solution of a solid in water?

To prepare a saturated solution, add the solid to water gradually until no more dissolves at the given temperature, ensuring the solution is at equilibrium.

What is the significance of the solubility of a substance in solution chemistry?

Solubility determines how much of a substance can dissolve in a solvent at a specific temperature, affecting the formation of saturated or unsaturated solutions.

How does temperature affect the solubility of solids in water?

Generally, increasing temperature increases the solubility of solids in water, allowing more solute to dissolve and potentially changing the solution from saturated to supersaturated.

What are the units typically used to express solubility?

Solubility is commonly expressed in grams per 100 mL of solvent or grams per liter (g/L).

Why might the second solution be relevant in this context?

The second solution may be used to compare solubility under different conditions or to demonstrate the process of saturation at varying concentrations or temperatures.

How can you tell if a solution is unsaturated if 36.8 g of solid

dissolves in 200 mL water?

If additional solid can still dissolve in the solution without any undissolved residue, then the solution is unsaturated; otherwise, it is saturated.

Additional Resources

A Saturated Solution Is Made By Dissolving A 36.8 Of A Solid In 200 Ml Of Water: An In-Depth Exploration

Understanding the process of creating saturated solutions is fundamental in chemistry, with applications spanning from laboratory experiments to industrial processes. The phrase "A saturated solution is made by dissolving a 36.8 of a solid in 200 mL of water" encapsulates a specific case study that offers insight into solubility principles, solution chemistry, and practical considerations. This article aims to dissect this scenario thoroughly, exploring the concepts involved, the factors affecting saturation, and the broader implications in scientific and real-world contexts.

Understanding Saturated Solutions

What Is a Saturated Solution?

A saturated solution is a homogeneous mixture where the maximum amount of solute has been dissolved in a solvent at a given temperature. Any additional solute added beyond this point will not dissolve and will instead remain as a separate phase, usually as a precipitate.

Key features of saturated solutions:

- Dynamic equilibrium exists between dissolved solute and undissolved solute.
- The concentration of solute remains constant unless temperature changes.
- The solubility of a substance varies with temperature, pressure (for gases), and other conditions.

Significance of Saturation in Chemistry

Saturated solutions serve as critical benchmarks in understanding solubility limits, crystallization processes, and chemical equilibria. They are used in:

- Preparing standard solutions
- Crystallization and purification
- Industrial manufacturing of chemicals

Analyzing the Example: Dissolving 36.8 g of a Solid in 200 mL Water

Context and Assumptions

In the scenario presented, a solid is dissolved in water until the solution becomes saturated. The solute's mass is 36.8 grams, and the solvent volume is 200 mL. To understand whether the solution is saturated, we need to analyze the solubility of the solid at the given conditions.

Assumptions:

- The water temperature is standard room temperature (~25°C).
- The solid is a typical soluble compound (e.g., salt, sugar).
- The solution is prepared carefully to reach saturation without excess undissolved solid.

Calculating Concentration

The concentration of the solution can be expressed in grams per liter (g/L):

- Convert the volume of water to liters:

$$200 \text{ mL} = 0.2 \text{ L}$$

- Calculate the concentration:

$$\text{Concentration} = \frac{36.8 \text{ g}}{0.2 \text{ L}} = 184 \text{ g/L}$$

This value indicates the amount of solute per liter of solution, which can be compared to known solubility data to determine if the solution is saturated.

Understanding Solubility and Saturation Limits

Solubility Data

Solubility is typically expressed as the maximum grams of solute that can dissolve in 100 mL of solvent at a specific temperature. For example:

- Sodium chloride (NaCl): ~36 g per 100 mL at 25°C
- Sugar (sucrose): ~200 g per 100 mL at 25°C
- Potassium nitrate (KNO₃): ~32 g per 100 mL at 25°C

Based on these data, dissolving 36.8 g in 200 mL of water surpasses the solubility of NaCl but is well below that of sugar, indicating that if NaCl were the solute, the solution would be supersaturated, leading to crystallization.

Implications of Solubility Data

Knowing the solubility helps determine whether the solution is saturated:

- If the amount dissolved equals the maximum solubility, the solution is saturated.
- If less than the maximum is dissolved, the solution is unsaturated.
- If more than the maximum is dissolved (possible in some cases), it is supersaturated, which is unstable.

In our case, with 36.8 g in 200 mL, the solution likely approaches or exceeds the solubility limit of certain salts, indicating saturation or supersaturation.

Factors Affecting Saturation and Solubility

Temperature

Most solutes exhibit increased solubility with rising temperature, especially solids in liquids. For example:

- Sugar dissolves more readily at higher temperatures.
- Some salts, like KNO₃, have significant solubility increases with temperature.

Impact:

- Heating water can create a supersaturated solution if cooled carefully.
- Cooling a saturated hot solution can lead to crystallization.

Pressure (for Gases)

While pressure significantly affects gas solubility, it has minimal impact on solid-liquid solutions at standard conditions.

Nature of Solute and Solvent

- Polar solutes dissolve better in polar solvents like water.
- Ionic compounds tend to have higher solubility due to lattice energy considerations.

Presence of Other Substances

Impurities or other dissolved substances can alter solubility via common ion effects or complex formation.

Practical Applications and Considerations

Preparation of Saturated Solutions

- Usually involves adding solute gradually to the solvent until no more dissolves.
- Stirring and heating can help reach saturation faster.
- Precise measurements are necessary for reproducibility in lab settings.

Industrial and Laboratory Uses

- Crystallization: Saturated solutions are often used to grow crystals for purification or study.
- Buffer Solutions: Saturated solutions can maintain specific concentrations for reactions.
- Calibration Standards: Known saturated solutions serve as references.

Limitations and Challenges

- Achieving true saturation requires careful control of temperature and concentration.
- Supersaturation can lead to unpredictable crystallization.
- Solubility data are temperature-dependent; inaccuracies can lead to errors.

Second Solution Scenario: A Comparative Analysis

The initial statement introduces a second solution, but details are incomplete. Typically, such comparisons explore how different solutes, temperatures, or concentrations influence saturation.

Potential topics include:

- Dissolving a different amount of the same solid.
- Using a different solvent or temperature.
- Observing how solubility limits change with conditions.

Example:

Suppose the second solution involves dissolving 50 g of the same solid in 200 mL water at a higher temperature. If the solubility at that temperature is known to be 80 g per 100 mL, then:

- Max solute in 200 mL = 160 g
- Since 50 g < 160 g, the solution is unsaturated.

This comparison highlights how temperature and solubility data inform saturation status.

Conclusion and Broader Implications

The process of creating a saturated solution by dissolving a specific amount of solid in water is fundamental in understanding solution chemistry. The example of 36.8 g in 200 mL of water underscores the importance of solubility data, temperature control, and precise measurement.

Key takeaways:

- Saturated solutions are at the equilibrium point of dissolution.
- Solubility varies with temperature, pressure, and chemical nature.
- Proper understanding enables controlled crystallization, purification, and formulation in various industries.

Pros of mastering saturation principles:

- Facilitates accurate preparation of solutions.
- Enhances understanding of chemical equilibria.
- Supports industrial processes like recrystallization and formulation.

Cons or challenges:

- Dependence on temperature-sensitive data.
- Difficulty in maintaining true saturation in practical settings.
- Potential for supersaturation and unintended crystallization.

In essence, mastering the concepts surrounding saturated solutions empowers chemists and scientists to manipulate solution conditions effectively, leading to advancements in research, manufacturing, and education. Whether working with simple salts or complex compounds, understanding how to control and utilize saturation is a cornerstone of chemical science.

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