

What Will Be The Percentage Composition By Mass Of A Solution Made By Dissolving 22.5 G Of Sodium Hydroxide

What Will Be The Percentage Composition By Mass Of A Solution Made By Dissolving 22.5 G Of Sodium Hydroxide

Understanding the percentage composition by mass of a solution is fundamental in chemistry, especially when preparing solutions for laboratory experiments, industrial processes, or educational demonstrations. When dissolving a specific amount of solute—in this case, sodium hydroxide (NaOH)—in a solvent, typically water, determining the percentage composition by mass helps chemists evaluate concentration, purity, and suitability for various applications. This article explores how to calculate the percentage composition by mass of a solution created by dissolving 22.5 grams of sodium hydroxide, providing detailed explanations and practical insights.

Introduction to Percentage Composition by Mass

Before delving into the specific calculation involving sodium hydroxide, it is essential to understand what percentage composition by mass entails.

Definition

Percentage composition by mass, also known as mass percent, indicates the proportion of a particular component in a mixture relative to the total mass of the mixture. It is expressed as a percentage and calculated using the formula:

$$\text{Mass \% of component} = \left(\frac{\text{Mass of component}}{\text{Total mass of solution}} \right) \times 100$$

Importance in Chemistry

Knowing the percentage composition by mass allows chemists to:

- Determine the molarity and molality of solutions
- Assess purity levels of chemicals
- Design experiments with precise concentrations
- Ensure safety and compliance in industrial settings

Scenario Overview: Dissolving 22.5 g of Sodium Hydroxide

In our scenario, a chemist dissolves 22.5 grams of sodium hydroxide (NaOH) into a certain amount of water to prepare a solution. The key question is: What will be the percentage composition by mass of this solution? To answer this, we need to understand the total mass of the solution, which depends on the amount of water used.

Assumptions and Conditions

To simplify the calculation, we assume:

1. The sodium hydroxide is completely dissolved without any loss.
2. The solvent used is pure water.
3. The entire solution's mass is simply the sum of the solute and solvent masses.

Calculating the Total Mass of the Solution

The total mass of the solution is the sum of the mass of sodium hydroxide (solute) and the water (solvent).

Case 1: Known Solvent Mass

If the amount of water used is specified, calculation becomes straightforward.

Example:

Suppose 100 g of water is used to dissolve 22.5 g of NaOH.

Total mass of solution:

$$\begin{aligned} \text{Total mass} &= \text{Mass of NaOH} + \text{Mass of water} = 22.5\text{ g} + 100\text{ g} = 122.5\text{ g} \end{aligned}$$

Percentage composition by mass of NaOH:

$$\frac{22.5\text{ g}}{122.5\text{ g}} \times 100 \approx 18.37\%$$

Similarly, the water's percentage:

$$\frac{100\text{ g}}{122.5\text{ g}} \times 100 \approx 81.63\%$$

Conclusion:

In this case, the solution contains approximately 18.37% sodium hydroxide by mass.

Case 2: Variable Water Volume

If the volume of water is specified instead of mass, we need to convert volume to mass, assuming the density of water is approximately 1 g/mL.

Example:

Dissolving 22.5 g of NaOH in 200 mL of water:

Mass of water:

$$200\text{ mL} \times 1\text{ g/mL} = 200\text{ g}$$

Total mass:

$$22.5\text{ g} + 200\text{ g} = 222.5\text{ g}$$

Percentage NaOH:

$$\frac{22.5\text{ g}}{222.5\text{ g}} \times 100 \approx 10.11\%$$

Note: The percentage decreases as the amount of water increases.

Understanding the Role of Molarity and Molar Mass

While percentage by mass provides a mass-based concentration, chemists often work with molarity or molality for more precise solution descriptions. Understanding the molecular weight of NaOH is critical for these calculations.

Molecular Weight of Sodium Hydroxide

Calculate the molar mass of NaOH:

- Sodium (Na): approximately 23.0 g/mol
- Oxygen (O): approximately 16.0 g/mol

- Hydrogen (H): approximately 1.0 g/mol

$$\text{Molar mass of NaOH} = 23.0 + 16.0 + 1.0 = 40.0 \text{ g/mol}$$

Moles of NaOH in 22.5 g

Number of moles:

$$\frac{22.5 \text{ g}}{40.0 \text{ g/mol}} = 0.5625 \text{ mol}$$

This information helps in preparing solutions with specific molar concentrations.

Practical Applications of Percentage Composition Calculations

Understanding how to compute percentage composition by mass is crucial in various real-world scenarios:

1. Preparing Standard Solutions

- For titrations, calibration, or chemical reactions, precise concentration calculations are essential.
- Example: To prepare a 0.5 M NaOH solution, knowing the percentage helps in accurately weighing and dissolving the solute.

2. Quality Control in Industry

- Ensuring the concentration of sodium hydroxide in products aligns with specifications.
- Detecting impurities or deviations from desired concentrations.

3. Educational Demonstrations

- Visualizing concentration concepts in laboratory experiments.
- Demonstrating the relationship between mass, volume, and concentration.

4. Safety and Handling

- Knowing the concentration helps in assessing hazards and implementing safety measures when handling caustic substances like NaOH.

Factors Affecting the Percentage Composition in Practice

While calculations provide a theoretical value, real-world factors can influence the final percentage composition:

1. Purity of Sodium Hydroxide

- Commercial NaOH may contain impurities, affecting the actual concentration.

2. Completeness of Dissolution

- Incomplete dissolution can lead to inaccuracies in concentration measurements.

3. Temperature Effects

- Temperature variations can influence the density of water, slightly altering mass calculations.

4. Measurement Accuracy

- Precise weighing and volumetric measurements are vital for accurate calculations.

Conclusion

Calculating the percentage composition by mass of a solution made by dissolving 22.5 grams of sodium hydroxide involves understanding the total mass of the solution, which depends on the amount of solvent used. Whether the solvent's mass is known or its volume is specified, the fundamental formula remains the same:

$$\text{Mass \% of NaOH} = \left(\frac{\text{Mass of NaOH}}{\text{Total mass of solution}} \right) \times 100$$

This calculation is vital for preparing solutions with specific concentrations, ensuring quality control, and conducting accurate chemical analyses. By mastering this process, chemists and students alike can confidently determine solution compositions, optimize reactions, and uphold safety standards. Remember, always consider purity, measurement precision, and environmental factors to ensure your calculations reflect real-world conditions accurately.

Frequently Asked Questions

What is the percentage composition by mass of sodium hydroxide in a solution made by dissolving 22.5 g of NaOH in 100 g of solution?

The percentage composition by mass of NaOH is 22.5%. Since the solution's total mass is 100 g, and 22.5 g is NaOH, the percentage is $(22.5/100) \times 100\% = 22.5\%$.

How do you calculate the percentage by mass of NaOH in a solution if 22.5 g is dissolved?

Divide the mass of NaOH (22.5 g) by the total mass of the solution, then multiply by 100%. For example, if the total solution mass is 100 g, the percentage is $(22.5/100) \times 100\% = 22.5\%$.

What assumptions are made when calculating the percentage composition by mass of NaOH in this solution?

It is assumed that the total mass of the solution is the sum of the NaOH and solvent masses and that the solution is homogeneous, with no other substances affecting the calculation.

If the total solution weighs 50 g after dissolving 22.5 g of NaOH, what is the percentage composition by mass of NaOH?

The percentage is $(22.5 \text{ g} / 50 \text{ g}) \times 100\% = 45\%$.

Why is understanding the percentage composition by mass important in chemistry?

It helps in preparing solutions with precise concentrations, in stoichiometric calculations, and in understanding the properties and reactions of the solution.

How does dissolving 22.5 g of NaOH affect the molarity of the solution?

The molarity depends on the total volume of the solution, not just mass. To find molarity, divide moles of NaOH by the volume in liters. The percentage by mass provides concentration context but is not sufficient alone to determine molarity.

What is the significance of knowing the percentage composition by mass of NaOH in industrial applications?

It ensures proper formulation and safety standards, controls reaction stoichiometry, and maintains quality in manufacturing processes involving NaOH solutions.

Can the percentage composition by mass of NaOH be used to determine its concentration in molarity?

Not directly. Percentage by mass indicates mass ratio, while molarity depends on moles per liter of solution. To convert, you need the total volume of the solution and molar mass of NaOH.

How would the percentage composition change if more NaOH was added to the solution?

The percentage of NaOH by mass would increase, assuming the total solution mass increases proportionally with added NaOH, indicating a higher concentration.

Additional Resources

Percentage Composition By Mass Of A Solution Made By Dissolving 22.5 G Of Sodium Hydroxide

Understanding the percentage composition by mass of a solution is fundamental in chemistry, especially when preparing solutions for laboratory and industrial applications. When sodium hydroxide (NaOH) is dissolved in water, the resulting solution's composition depends on the mass of solute and solvent used. In this comprehensive review, we'll explore how to determine the percentage by mass of a solution made by dissolving 22.5 grams of sodium hydroxide, examining key concepts, calculations, and implications.

Introduction to Solution Composition and Percentage by Mass

Definition of Percentage Composition by Mass

The percentage by mass (or weight percent, w/w%) of a component in a solution is a way to express how much of that component is present relative to the total mass of the solution. It is calculated as:

$$\text{Percentage by mass} = \left(\frac{\text{Mass of component}}{\text{Total mass of solution}} \right) \times 100\%$$

Significance in Chemistry

- Ensures precise formulation of solutions for reactions.
- Critical for quality control in manufacturing.
- Helps in calculating molarity, molality, and normality.
- Aids in understanding solution properties such as concentration, reactivity, and safety.

Understanding Sodium Hydroxide (NaOH) and Its Dissolution

Properties of Sodium Hydroxide

- NaOH is a strong base, highly soluble in water.
- It is hygroscopic, readily absorbing moisture from the environment.
- Used in various applications: soap making, pH regulation, chemical manufacturing.

Dissolution Process

When 22.5 g of NaOH dissolves in water:

- The NaOH particles disperse uniformly.
- The process is exothermic, releasing heat.
- The solution's properties depend on the total mass of the final mixture.

Calculating the Total Mass of the Solution

Determining the Total Mass

The total mass of the solution is the sum of:

- The mass of sodium hydroxide (solute): 22.5 g
- The mass of water (solvent): unknown, variable

Example Scenarios

To understand the percentage composition, we consider different amounts of water added:

1. Dissolving NaOH in 100 g of water
2. Dissolving NaOH in 200 g of water
3. Dissolving NaOH in a specified volume of water (e.g., 1 liter), considering water density

Calculations

- Total mass = mass of NaOH + mass of water

For example, if 22.5 g NaOH is dissolved in 100 g water:

$$\text{Total mass} = 22.5\text{ g} + 100\text{ g} = 122.5\text{ g}$$

\]

Calculating Percentage Composition by Mass

General Formula

\[

$$\text{Mass \% of NaOH} = \left(\frac{22.5 \text{ g}}{\text{Total mass of solution}} \right) \times 100\%$$

\]

Applying to the example:

\[

$$\text{Mass \% of NaOH} = \left(\frac{22.5}{122.5} \right) \times 100\% \approx 18.37\%$$

\]

Implications of Different Concentrations

- Dilute solution: larger amount of water, lower percentage
- Concentrated solution: less water, higher percentage

Sample Calculations

Water added (g)	Total mass (g)	NaOH % by mass	Remarks
50	72.5	31.03%	More concentrated solution
100	122.5	18.37%	Common concentration for many applications
200	222.5	10.13%	Diluted solution

Practical Considerations in Preparing Solutions

Safety Precautions

- NaOH is caustic; handle with gloves and eye protection.
- Add NaOH to water slowly to prevent splashing.
- Use appropriate containers resistant to alkali.

Preparation Steps

1. Measure 22.5 g of NaOH accurately.
2. Choose the desired volume or mass of water for the solution.
3. Dissolve NaOH in water gradually, stirring continuously.

4. Record the total mass once dissolved to determine concentration.

Ensuring Homogeneity

- Use magnetic stirrers for uniform mixing.
- Allow the solution to cool if heat is generated during dissolution.

Theoretical and Practical Limitations

Purity of NaOH

- Commercial NaOH may contain impurities affecting concentration.
- Always use analytical grade for precise work.

Volume vs. Mass

- While mass-based calculations are precise, sometimes volume measurements are used.
- Water density at room temperature ($\sim 1 \text{ g/mL}$) allows conversion between volume and mass.

Temperature Effects

- Temperature influences solubility and density.
- For accurate calculations, consider temperature conditions.

Advanced Topics: Molarity and Molar Mass Considerations

Molar Mass of NaOH

- Na: 23.0 g/mol
- O: 16.0 g/mol
- H: 1.0 g/mol

$$\text{Molar mass of NaOH} = 23.0 + 16.0 + 1.0 = 40.0 \text{ g/mol}$$

Number of Moles in 22.5 g

$$\text{Moles of NaOH} = \frac{22.5 \text{ g}}{40.0 \text{ g/mol}} = 0.5625 \text{ mol}$$

Concentration in Molarity

- For a solution with total mass of 122.5 g (from previous example):

Water volume approximation:

$$\text{Volume of water} \approx 100\text{ mL}$$

Total volume:

$$\text{Total volume} \approx \text{volume of water} + \text{negligible volume change}$$

Molarity:

$$\text{Molarity} = \frac{\text{moles of solute}}{\text{volume of solution in liters}} \approx \frac{0.5625}{0.1225\text{ L}} \approx 4.6\text{ M}$$

This indicates a highly concentrated NaOH solution.

Real-World Applications and Significance

Industrial Uses

- Manufacturing soaps and detergents
- pH regulation in water treatment
- Chemical synthesis and processing

Laboratory Uses

- Titration experiments
- Standardization of acids
- pH adjustments

Educational Context

- Demonstrates solution preparation
- Reinforces concepts of concentration and solution chemistry

Conclusion and Key Takeaways

Preparing a solution by dissolving 22.5 g of sodium hydroxide involves understanding the relationship between the mass of solute, solvent, and the resulting concentration expressed as a percentage by mass. The calculation hinges on knowing:

- The mass of the solute (22.5 g NaOH)
- The mass of the solvent (water)
- The total mass of the solution

By manipulating the amount of water, various concentration levels are achievable, each with specific applications. The percentage by mass provides a straightforward measure of solution strength, essential for ensuring accuracy in chemical reactions, industrial processes, and educational demonstrations.

In summary:

- The percentage composition by mass depends on how much water is added.
- For a typical dilute solution with 100 g of water, NaOH makes up approximately 18.37% of the solution.
- Adjustments in water volume directly influence the concentration.
- Proper safety and preparation protocols are vital when handling NaOH.
- Understanding these principles enhances the ability to prepare solutions tailored to specific needs, ensuring precision and safety.

This comprehensive exploration underscores the importance of fundamental concepts in solution chemistry and their practical applications across scientific disciplines.

[What Will Be The Percentage Composition By Mass Of A Solution Made By Dissolving 22.5 G Of Sodium Hydroxide](#)

What Will Be The Percentage Composition By Mass Of A Solution Made By Dissolving 22.5 G Of Sodium Hydroxide

Related Articles

- [How Many Nitrogen Molecules Are Present In 2N₂?; How Do You Balance N₂ To O₂ To N₂O?; Which Of The Following](#)
- [What Compromises Did The Convention Delegates Reach When Planning For the Legislative And Executive Branches?](#)
- [Directions: Rewrite Each Of The Following Sentences To Correct Errors In Parallel Structure. 1. Ben Franklin](#)

[Back to Home](#)