The Concentration Of Hg 2 In A Saturated Solution Of Hg2br2 At 25c Is Found To Be 2/44x10 -8m. What Is

Understanding the Concentration of Hg_2^{2+} in Saturated Hg_2Br_2 Solution at 25°C

The Concentration Of Hg_2^{2+} In A Saturated Solution Of Hg_2Br_2 At 25°C Is Found To Be 2/44×10^{-8} M. What Is — this intriguing statement leads us into the fascinating world of solubility equilibria, complex ions, and chemical calculations. In this article, we will explore what this concentration signifies, how to interpret it, and the broader implications for chemistry students and professionals alike.

Introduction to Mercury(I) Bromide (Hg_2Br_2)

Mercury(I) bromide, also known as mercurous bromide, is an inorganic compound with the chemical formula Hg_2Br_2. It forms a white crystalline solid and is characterized by the presence of the diatomic mercury cation (Hg_2^{2+}), which is unique in its chemistry.

Structure and Nature of Hg_2Br_2

- Contains the diatomic cation Hg_2^{2+}
- Contains bromide anions (Br^-)
- Exhibits low solubility in water, leading to its classification as a sparingly soluble salt
- The solubility equilibrium involves the dissociation of Hg_2Br_2 into ions in aqueous solution

Solubility Equilibrium of Hg_2Br_2

Understanding the solubility equilibrium is essential to analyze the concentration data provided. The dissolution of mercury(I) bromide can be expressed as:

\[\text{Hg}_2\text{Br}_2 (s) \leftrightarrow \text{Hg}_2^{2+} (aq) + 2 \text{Br}^- (aq) \]

Key points:

- For every mole of Hg_2Br_2 dissolving, one mole of Hg_2^{2+} and two moles of Br^- are produced
- The solubility product constant, K_{sp}, describes the equilibrium

Calculating the Solubility Product K_{sp}

Given the concentration of Hg_2^{2+} ions in the saturated solution, we can determine the solubility product K_{sp}. The provided concentration is:

$$ [\text{Hg}_2^{2+}] = \frac{2}{44} \times 10^{-8} \, \text{M} $$

Let's simplify this expression:

- Numerator: 2
- Denominator: 44
- So,

$$ [\text{Hg}_2^{2+}] = \frac{2}{44} \times 10^{-8} = \frac{1}{22} \times 10^{-8} \approx 4.545 \times 10^{-10} \, \text{M} $$

Because the dissociation of Hg_2Br_2 produces 1 mol of Hg_2^{2+} and 2 mol of Br^- per mole of solid, the concentrations of other ions are:

$$ [\text{Br}^-] = 2 \times [\text{Hg}_2^{2+}] \approx 2 \times 4.545 \times 10^{-10} = 9.09 \times 10^{-10} \, \text{M} $$

Now, the solubility product K_{sp} is:

$$ K_{sp} = [\text{Hg}_2^{2+}] \times [\text{Br}^-]^2 $$

Plugging in the values:

$$ K_{sp} = (4.545 \times 10^{-10}) \times (9.09 \times 10^{-10})^2 $$

Calculating:

$$ (9.09 \times 10^{-10})^2 = 8.264 \times 10^{-19} $$

Therefore,

$$ K_{sp} \approx 4.545 \times 10^{-10} \times 8.264 \times 10^{-19} \approx 3.757 \times 10^{-28} $$

This extremely low K_{sp} confirms the low solubility of Hg_2Br_2 in water.

Implications of the Concentration Data

The given concentration of Hg_2^{2+} ions provides insights into:

- The solubility of Hg_2Br_2 at 25°C
- The stability of mercury(I) compounds in aqueous solutions
- The potential for complex formation or precipitation

What does this concentration tell us?

- The solubility of Hg_2Br_2 is very limited, with only about 4.545×10^{-10} mol per liter dissolving
- The solution is saturated, meaning no more solid can dissolve under current conditions
- The equilibrium favors the solid form due to low solubility

Significance in Analytical Chemistry

Understanding such concentrations is vital in various areas:

- Quantitative Analysis: Determining mercury levels in environmental samples
- Pharmacology: Ensuring safe levels of mercury compounds
- Environmental Chemistry: Assessing mercury pollution and its behavior in water bodies

Detecting Mercury Ions in Solutions

- Techniques like atomic absorption spectroscopy (AAS) or inductively coupled plasma mass spectrometry (ICP-MS) rely on such concentration data
- Recognizing the low solubility limits helps in designing detection protocols

Applications and Safety Considerations

Mercury compounds, including Hg_2Br_2, pose significant health risks due to their toxicity. Understanding their solubility and ion concentrations helps:

- Develop safe handling procedures
- Design remediation strategies for mercury-contaminated environments
- Establish regulatory standards for mercury levels in water

Environmental Impact of Mercury(I) Bromide

- Mercury compounds can bioaccumulate in aquatic life
- Their low solubility affects how mercury deposits and persists in water systems
- Proper disposal and containment are critical

Summary of Key Points

- The given concentration of Hg_2^{2+} in saturated Hg_2Br_2 solution at 25°C is approximately 4.545×10^{-10} M
- The solubility product K_{sp} is approximately 3.76×10^{-28}, indicating very low solubility
- The dissolution involves the formation of Hg_2^{2+} and Br^- ions in a 1:2 ratio
- Understanding these parameters aids in environmental monitoring, analytical chemistry, and safety protocols

Conclusion

The detailed analysis of the concentration of Hg_2^{2+} ions in a saturated solution of Hg_2Br_2 at 25°C not only illuminates the fundamental principles of solubility and equilibrium but also underscores the importance of precise calculations in chemistry. Recognizing how to interpret such data empowers chemists, environmental scientists, and health professionals to assess risks, devise detection methods, and implement safety measures concerning mercury compounds.

Remember: Precise understanding of solubility equilibria is crucial for tackling real-world problems involving heavy metals and ensuring both environmental safety and scientific accuracy.

Frequently Asked Questions

What is the concentration of Hg_2^{2+} ions in a saturated solution of Hg_2Br_2 at 25°C?

The concentration of Hg_2^{2+} ions is $2/44 \times 10^{-8}$ M, which simplifies to approximately 4.55×10^{-9} M.

How is the solubility product (Ksp) of Hg_2Br_2

related to the concentration of Hg_2^{2+} in a saturated solution?

The Ksp of Hg_2Br_2 is equal to the square of the concentration of Hg_2^{2+} ions, assuming the concentration of Br^- ions is proportional, so Ksp = $[Hg_2^{2+}]^2$.

Given the concentration of Hg_2^{2+} ions, how can we calculate the solubility product (Ksp) of Hg_2Br_2 at 25°C?

Using the given concentration $2/44 \times 10^{-8}$ M, Ksp = $([Hg_2^{2+}])^2 = (2/44 \times 10^{-8})^2$.

What does a low concentration of Hg_2^{2+} ions indicate about the solubility of Hg_2Br_2 at 25°C?

A low concentration of Hg_2^{2+} ions indicates that Hg_2Br_2 is sparingly soluble in water at 25°C.

Why is it important to know the concentration of Hg_2^{2+} ions in a saturated solution of Hg_2Br_2?

Knowing the concentration helps determine the solubility product (Ksp), which indicates the solubility and stability of the compound in solution.

What are the units of the given concentration $2/44 \times 10^{-8}$ M, and what do they represent?

The units are molarity (M), representing moles of Hg_2^{2+} ions per liter of solution.

Additional Resources

The Concentration of Hg_2^{2+} in a Saturated Solution of Hg_2Br_2 at 25°C Is Found to Be $2/44\times10^{-8}$ M. What Is

Understanding the behavior of mercury compounds in aqueous solutions is fundamental in inorganic chemistry, environmental science, and materials engineering. When dealing with compounds like mercury(I) bromide (Hg_2Br_2), quantifying the concentration of ions in saturated solutions provides insights into solubility, equilibrium dynamics, and potential applications or hazards. In this article, we will explore how to determine the concentration of Hg_2^{2+} ions in a saturated solution of Hg_2Br_2 at 25°C, given that this concentration is found to be $2/44\times10^{-8}$ M. We'll dissect the problem step by step, providing a comprehensive understanding of the underlying principles, calculations, and implications.

Understanding the Context: Mercury(I) Bromide and Its Dissolution

Before diving into calculations, it’s essential to understand the chemical nature of mercury(I) bromide (Hg_2Br_2), its solubility characteristics, and the relevance of the ions involved.

Structure and Dissociation of Hg_2Br_2

- Chemical formula: Hg_2Br_2
- Description: Mercury(I) bromide is a dark, crystalline solid composed of diatomic mercury ions (Hg_2^{2+}) and bromide ions (Br^-).
- Dissociation in water: When Hg_2Br_2 dissolves, it dissociates into its constituent ions:

$$Hg_2Br_2\ (s) \rightleftharpoons Hg_2^{2+}\ (aq) + 2\ Br^-\ (aq)$$

- The dissociation process involves the release of one Hg_2^{2+} ion and two Br^- ions per formula unit.
- The solubility equilibrium is characterized by the solubility product constant, Ksp.

The Significance of the Given Concentration

- The concentration $2/44 \times 10^{-8}$ M is provided as the concentration of Hg_2^{2+} ions in the saturated solution at 25°C.
- This value implies a very low solubility, typical for salts of heavy metals with low solubility products.
- Our goal is to interpret this data, understand its derivation, and determine the corresponding solubility parameters.

Deciphering the Given Concentration: $2/44 \times 10^{-8}$ M

At first glance, the concentration $2/44 \times 10^{-8}$ M may seem unusual. Let’s clarify what this notation means.

Expressing the Concentration Clearly

- The notation $2/44 \times 10^{-8}$ M can be interpreted as a fraction:

$$
\text{Concentration of } \mathrm{Hg}_2^{2+} = \frac{2}{44} \times 10^{-8} \text{ M}
$$

- Simplify the fraction:

$$
\frac{2}{44} = \frac{1}{22}
$$

- So, the concentration is:

$$
\frac{1}{22} \times 10^{-8} \text{ M} \approx 4.545 \times 10^{-10} \text{ M}
$$

Therefore, the Hg_2^{2+} ion concentration in the saturated solution is approximately 4.55×10^{-10} M.

Note: It's important to verify whether the original notation intended the fractional form or a different interpretation, but based on the standard reading, this is the most reasonable understanding.

Calculating the Solubility Product Constant (Ksp)

Given the concentration of Hg_2^{2+} ions, we can find the Ksp of Hg_2Br_2. This constant indicates the solubility equilibrium's extent and is crucial for understanding solubility behavior.

Step 1: Write the Dissolution Equation

$$
\mathrm{Hg_2Br_2 (s)} \leftrightarrow \mathrm{Hg_2^{2+} (aq)} + 2 \mathrm{Br^- (aq)}
$$

- Stoichiometry: For each mole of Hg_2Br_2 that dissolves, 1 mole of Hg_2^{2+} and

2 moles of Br^- are produced.

Step 2: Express the Equilibrium Concentrations

- Let the molar solubility of Hg_2Br_2 be s (mol/L).
- Then:

$$
[\mathrm{Hg_2^{2+}}] = s
$$

$$
[\mathrm{Br^-}] = 2s
$$

- From the given data, $[Hg_2^{2+}] = 4.55\times10^{-10}$ M.

- Hence:

$$
s = 4.55 \times 10^{-10}
$$

$$
[\mathrm{Br^-}] = 2 \times 4.55 \times 10^{-10} = 9.09 \times 10^{-10} \text{ M}
$$

Step 3: Write the Expression for Ksp

$$
K_{sp} = [\mathrm{Hg_2^{2+}}] \times [\mathrm{Br^-}]^2
$$

Substituting the values:

$$
K_{sp} = (4.55 \times 10^{-10}) \times (9.09 \times 10^{-10})^2
$$

Calculating the square:

$$
(9.09 \times 10^{-10})^2 = 82.6 \times 10^{-20} = 8.26 \times 10^{-19}
$$

Multiplying:

$$
K_{sp} = 4.55 \times 10^{-10} \times 8.26 \times 10^{-19} \approx 37.6 \times 10^{-29} = 3.76 \times 10^{-28}
$$

Thus, the approximate solubility product constant (Ksp) of Hg_2Br_2 at 25°C is:

$$
\boxed{
K_{sp} \approx 3.76 \times 10^{-28}
}
$$

Implications and Applications

Understanding the Ksp and ion concentrations of Hg_2Br_2 has significant implications:

- Environmental Impact: Mercury compounds are toxic; knowing their solubility helps assess environmental risks.
- Material Synthesis: Precise solubility data aids in designing processes involving mercury compounds.
- Chemical Analysis: Ion concentration measurements validate theoretical calculations and experimental methods.

Additional Considerations

- Temperature Dependence: Solubility constants vary with temperature; 25°C is standard for such calculations.
- Complex Formation: Presence of other ions could alter solubility due to complexation.
- Safety Precautions: Mercury compounds require careful handling due to toxicity.

Summary of Key Steps

1. Interpret the given concentration: Recognize that $2/44 \times 10^{-8}$ M simplifies to approximately 4.55×10^{-10} M.

2. Determine molar solubility (s): Since this is the concentration of Hg_2^{2+} ions, $s = 4.55 \times 10^{-10}$ M.

3. Calculate the concentration of Br^- ions: $2s = 9.09 \times 10^{-10}$ M.

4. Compute Ksp: Using the expression $K_{sp} = [\mathrm{Hg}_2^{2+}] \times [\mathrm{Br}^-]^2$, insert the values to find $K_{sp} \approx 3.76 \times 10^{-28}$.

Conclusion

By analyzing the provided ion concentration in a saturated solution of Hg_2Br_2 at 25°C, we've demonstrated how to derive the solubility product constant and interpret the solubility behavior of this mercury compound. Such calculations are foundational in inorganic chemistry, environmental monitoring, and industrial applications involving heavy metal salts. Always remember to approach such problems systematically: clarify data, interpret stoichiometry, write equilibrium expressions, and perform precise calculations. Understanding these principles enhances our ability to analyze complex chemical systems effectively.

The Concentration Of Hg 2 In A Saturated Solution Of Hg2br2 At 25c Is Found To Be 2 44x10 8m What Is

The Concentration Of Hg 2 In A Saturated Solution Of Hg2br2 At 25c Is Found To Be 2 44x10 8m What Is

Related Articles

- The Research On Illusory Correlations Shows That One Reason We Seem To Have Negative Stereotypes About
- To Compare The Effectiveness Of Two Treatments, Researchers Conducted A Well-designed Experiment Using
- There Are 56 Boys And 72 Girls In An After-school Club. The Club Is Splitting Thestudents In Groups So

Back to Home