

What Is The Molar Solubility Of Silver Carbonate (Ag_2CO_3) In Water? The K_{sp} For Ag_2CO_3 Is 8.1×10^{-12}

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When investigating the solubility of a salt like silver carbonate (Ag_2CO_3) in water, a fundamental question arises: what is its molar solubility? The molar solubility refers to the number of moles of the compound that dissolve in a liter of water to form a saturated solution. This quantity is directly related to the solubility product constant, or K_{sp} , which quantifies the equilibrium between the solid salt and its dissolved ions in solution. Given that the K_{sp} for Ag_2CO_3 is 8.1×10^{-12} , understanding how to compute the molar solubility from this value involves analyzing the dissociation equilibrium of the salt and applying principles of equilibrium chemistry. This article offers an in-depth exploration of the concepts, calculations, and factors involved in determining the molar solubility of silver carbonate in water.

Understanding Solubility and the Solubility Product Constant (K_{sp})

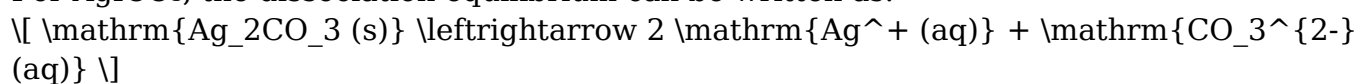
What Is Solubility?

Solubility is a measure of how much of a substance can dissolve in a solvent at a given temperature to form a saturated solution. It is often expressed in grams per liter (g/L) or molarity (mol/L). For ionic compounds like Ag_2CO_3 , solubility is typically expressed as molar solubility, indicating moles of compound per liter of solution.

What Is the K_{sp} ?

The solubility product constant (K_{sp}) is an equilibrium constant that describes the dissolution of an ionic compound in water. It is specific to a particular temperature and represents the product of the molar concentrations of the ions, each raised to the power of their coefficients in the balanced dissociation equation.

For Ag_2CO_3 , the dissociation equilibrium can be written as:



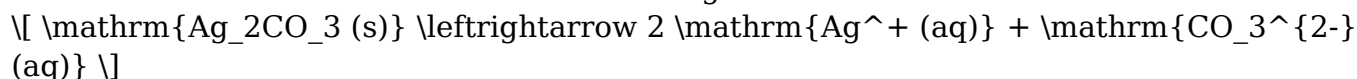
The corresponding K_{sp} expression is:

$$K_{sp} = [\text{Ag}^+]^2 [\text{CO}_3^{2-}]$$

Dissociation of Silver Carbonate in Water

Balanced Dissociation Equation

Silver carbonate dissociates in water according to:



This indicates that for every mole of $\mathrm{Ag_2CO_3}$ that dissolves, 2 moles of $\mathrm{Ag^+}$ ions and 1 mole of $\mathrm{CO_3^{2-}}$ ions are produced.

Relating Molar Solubility to Ion Concentrations

Let the molar solubility of $\mathrm{Ag_2CO_3}$ be denoted as (s) mol/L. Then:

- The concentration of $(\mathrm{Ag^+})$ ions in solution will be $(2s)$.
- The concentration of $(\mathrm{CO_3^{2-}})$ ions will be (s) .

Using these, the K_{sp} expression becomes:

$$K_{sp} = (2s)^2 \times s = 4s^3$$

Calculating the Molar Solubility of $\mathrm{Ag_2CO_3}$

Using the K_{sp} Expression

Given:

$$K_{sp} = 8.1 \times 10^{-12}$$

and

$$K_{sp} = 4s^3$$

we can solve for (s) :

$$4s^3 = 8.1 \times 10^{-12}$$

$$s^3 = \frac{8.1 \times 10^{-12}}{4} = 2.025 \times 10^{-12}$$

Solving for (s)

Taking the cube root:

$$s = \sqrt[3]{2.025 \times 10^{-12}}$$

Calculating:

$$s \approx \sqrt[3]{2.025} \times 10^{-\frac{12}{3}}$$

$s \approx 1.27 \times 10^{-4}$

Thus, the molar solubility of Ag_2CO_3 in water is approximately:

$s \approx 1.27 \times 10^{-4} \text{ mol/L}$

This means that at equilibrium, about (1.27×10^{-4}) moles of silver carbonate dissolve per liter of water to produce a saturated solution.

Implications of the Molar Solubility of Silver Carbonate

Low Solubility and Its Significance

The calculated molar solubility indicates that silver carbonate is only sparingly soluble in water. This is typical for salts with low K_{sp} values, which tend to precipitate out of solution readily.

Applications and Considerations

Understanding the molar solubility has practical applications:

- In Analytical Chemistry: It helps determine how much silver carbonate can be used without precipitating.
- In Environmental Chemistry: Silver compounds' solubility influences their bioavailability and toxicity.
- In Industrial Processes: Knowledge of solubility guides the design of processes involving silver salts.

Factors Affecting the Solubility of Silver Carbonate

Temperature

While the K_{sp} is typically measured at a standard temperature (usually 25°C), temperature variations can affect solubility:

- For many salts, increased temperature increases solubility.
- For silver carbonate, specific data would be needed to determine the exact temperature dependence.

Common Ion Effect

Presence of common ions in solution can suppress the solubility:

- Additional Ag^+ or CO_3^{2-} ions decrease the solubility due to Le Châtelier's principle.
- This is crucial in controlling precipitation in industrial and laboratory settings.

pH of the Solution

The solubility can be affected by the pH:

- Acidic conditions might increase solubility by converting carbonate ions into bicarbonate or carbon dioxide.
- Basic conditions tend to decrease solubility.

Summary and Final Remarks

The molar solubility of silver carbonate (Ag_2CO_3) in water, given its K_{sp} of 8.1×10^{-12} , can be approximated as roughly (1.27×10^{-4}) mol/L. This value underscores the sparing solubility of Ag_2CO_3 , characteristic of many silver salts, which tend to form precipitates readily. Calculating molar solubility from K_{sp} involves understanding the dissociation equilibrium, relating ion concentrations to the solubility, and solving the resulting algebraic equations. The solubility is influenced by various factors including temperature, ionic strength, pH, and the presence of common ions. Recognizing these principles is essential in fields ranging from analytical chemistry to environmental science and industrial processes, where controlling or predicting solubility is crucial.

References:

- Atkins, P., & de Paula, J. (2010). Physical Chemistry. Oxford University Press.
- Zumdahl, S. S., & Zumdahl, S. A. (2014). Chemistry: An Atoms First Approach. Cengage Learning.
- Lide, D. R. (Ed.). (2004). Handbook of Chemistry and Physics. CRC Press.

Frequently Asked Questions

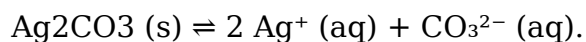
What is the molar solubility of silver carbonate (Ag_2CO_3) in water?

The molar solubility of Ag_2CO_3 in water is approximately 3.2×10^{-4} mol/L.

How is the molar solubility of Ag_2CO_3 calculated from its K_{sp} ?

By expressing the solubility as 's' for Ag_2CO_3 , where $2s$ is the concentration of Ag^+ and s is the concentration of CO_3^{2-} , the $K_{\text{sp}} = (2s)^2 \times s = 4s^3$. Solving for s gives the molar solubility.

What is the dissociation equation for silver carbonate in water?



What is the value of the solubility product constant (K_{sp}) for Ag_2CO_3 ?

The K_{sp} for Ag_2CO_3 is 8.1×10^{-12} .

How do you derive the molar solubility from the K_{sp} value?

Set the molar solubility as 's'; then, $K_{\text{sp}} = 4s^3$. Rearranged, $s = (K_{\text{sp}}/4)^{1/3}$. Plugging in the value of K_{sp} yields the molar solubility.

Is silver carbonate considered highly soluble or sparingly soluble in water?

Silver carbonate is sparingly soluble in water due to its very low K_{sp} value.

What factors influence the molar solubility of Ag_2CO_3 in water?

Temperature, presence of common ions, and pH can influence the solubility of Ag_2CO_3 .

How does the molar solubility of Ag_2CO_3 compare to other silver salts?

Ag_2CO_3 has a lower molar solubility compared to some other silver salts, reflecting its lower K_{sp} value and lower solubility.

Can the molar solubility of Ag_2CO_3 be used to determine its saturation point in water?

Yes, the molar solubility indicates the maximum amount of Ag_2CO_3 that can dissolve in water at equilibrium, representing its saturation point.

Why is understanding the molar solubility of Ag_2CO_3 important in chemistry?

Knowing the molar solubility helps in predicting precipitation, designing separation processes, and understanding the behavior of silver compounds in aqueous solutions.

Additional Resources

What Is The Molar Solubility Of Silver Carbonate (Ag_2CO_3) In Water? The K_{sp} For Ag_2CO_3 Is 8.1×10^{-12}

Understanding the molar solubility of silver carbonate (Ag_2CO_3) in water is a fundamental topic in chemistry, especially in the context of solubility equilibria and the application of solubility product constants (K_{sp}). Silver carbonate is an inorganic salt with interesting properties due to its low solubility, which makes it a classic example used in teaching solubility equilibria and the calculation of molar solubility from the K_{sp} . This article aims to explore the concept in depth, providing a comprehensive analysis of what molar solubility entails, how it relates to the K_{sp} , and the practical implications of these values.

Understanding Molar Solubility and K_{sp}

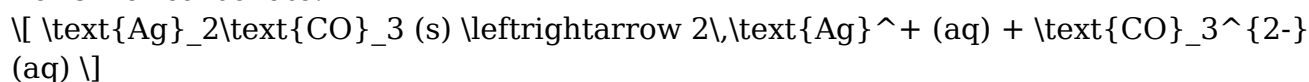
What Is Molar Solubility?

Molar solubility refers to the maximum amount of a substance (in moles) that can dissolve in a liter of water at a given temperature to form a saturated solution. It is expressed in mol/L. For salts like silver carbonate, molar solubility indicates how much of the compound can be dissolved before the solution becomes saturated and excess undissolved solid remains.

What Is the Solubility Product Constant (K_{sp})?

The K_{sp} is an equilibrium constant that describes the solubility of a sparingly soluble compound. It represents the product of the concentrations of the ions each raised to the power of their coefficients in the dissociation equation, at equilibrium, in a saturated solution.

For silver carbonate:



The solubility equilibrium expression is:

$$K_{sp} = [\text{Ag}^+]^2 [\text{CO}_3^{2-}]$$

Given the K_{sp} value of 8.1×10^{-12} , we can determine the molar solubility of Ag_2CO_3 in water.

Calculating the Molar Solubility of Ag_2CO_3

Step-by-Step Calculation

Let's denote the molar solubility of Ag_2CO_3 as 's' mol/L.

From the dissociation:

- For every 1 mole of Ag_2CO_3 that dissolves:
- 2 moles of Ag^+ ions are produced.
- 1 mole of CO_3^{2-} ions is produced.

Therefore:

- $[\text{Ag}^+] = 2s$
- $[\text{CO}_3^{2-}] = s$

Plugging into the K_{sp} expression:

$$K_{sp} = (2s)^2 \times s = 4s^3$$

Substitute the known K_{sp} value:

$$8.1 \times 10^{-12} = 4s^3$$

Solve for s:

$$s^3 = \frac{8.1 \times 10^{-12}}{4} = 2.025 \times 10^{-12}$$

$$s = \sqrt[3]{2.025 \times 10^{-12}}$$

Calculating the cube root:

$$s \approx \sqrt[3]{2.025} \times 10^{-4}$$

Since $\sqrt[3]{2.025} \approx 1.26$,
we get:

$$s \approx 1.26 \times 10^{-4} \text{ mol/L}$$

Therefore, the molar solubility of Ag_2CO_3 in water is approximately 1.26×10^{-4} mol/L.

Implications and Features of Silver Carbonate's Solubility

Features of Silver Carbonate Solubility

- Very Low Solubility: With a molar solubility of around 1.26×10^{-4} mol/L, silver carbonate is classified as a sparingly soluble salt.
- Precipitation Tendency: Due to its low solubility, Ag_2CO_3 readily precipitates out of solution when its ion concentrations exceed the solubility limit.
- Application in Chemistry: Its low solubility makes Ag_2CO_3 useful in qualitative analysis to

precipitate silver ions or to control reactions where insoluble silver salts are advantageous.

Pros and Cons of Silver Carbonate's Solubility

Pros:

- Controlled Precipitation: Useful in analytical chemistry for qualitative analysis.
- Low Solubility: Minimizes undesired dissolution in applications requiring insoluble silver compounds.
- Stable in Certain Conditions: Remains insoluble unless deliberately dissolved under specific conditions.

Cons:

- Limited Solubility: Not suitable for applications requiring high solubility or rapid dissolution.
- Handling and Storage: Its low solubility can pose challenges in preparing solutions with precise concentrations.
- Environmental Concerns: Silver ions can be toxic; thus, disposal of silver salts must be managed carefully.

Factors Affecting the Solubility of Ag_2CO_3

Temperature

As with most salts, increasing temperature can influence solubility, although for Ag_2CO_3 , the change may be minimal given its low solubility. Typically, solubility can increase slightly with temperature, but specific data should be checked for precise applications.

Presence of Common Ions

The solubility of Ag_2CO_3 can decrease in solutions containing common ions like Ag^+ or CO_3^{2-} due to the common ion effect, further suppressing dissolution.

pH of the Solution

Since carbonate ions can react with acids, lowering the pH, the solubility of Ag_2CO_3 can increase in acidic conditions, as carbonate ions convert into bicarbonates or carbonic acid, shifting the equilibrium.

Practical Applications and Real-World Relevance

Analytical Chemistry

Silver carbonate's low solubility makes it important in qualitative analysis for defining specific ions in a mixture, especially in gravimetric analysis where precipitation is used to isolate and quantify metals.

Photographic Industry

Silver compounds, including silver carbonate, have applications in photographic processes, although silver halides are more common.

Industrial and Environmental Considerations

Handling silver salts requires care due to silver's toxicity. The low solubility of Ag_2CO_3 reduces environmental risk but doesn't eliminate it, necessitating proper disposal methods.

Conclusion

The molar solubility of silver carbonate in water, given its K_{sp} of 8.1×10^{-12} , is approximately 1.26×10^{-4} mol/L. This remarkably low value underscores its classification as a sparingly soluble salt, with significant implications in analytical and industrial chemistry. Understanding this solubility helps chemists manipulate conditions to control dissolution, precipitation, and applications involving silver carbonate. While its low solubility limits some uses, it offers advantages in processes that benefit from insoluble or sparingly soluble compounds, especially in qualitative analysis and material synthesis.

In summary:

- The molar solubility is around 1.26×10^{-4} mol/L.
- It is derived from the K_{sp} value using equilibrium principles.
- Its features make it both useful and challenging, depending on the context.
- Factors such as temperature, pH, and common ions influence its solubility.

This comprehensive understanding of silver carbonate's solubility provides a foundation for further explorations into inorganic salts, solubility equilibria, and their practical applications in various scientific fields.

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