

p₄s₇ compound name chemistry

p₄s₇ compound name chemistry represents an intriguing subject within the realm of inorganic chemistry, focusing on the molecular structure and nomenclature of phosphorus-sulfur compounds. This particular compound, often referred to as tetraphosphorus heptasulfide, exhibits unique chemical and physical properties that make it notable in both academic research and industrial applications. Understanding the p₄s₇ compound name chemistry involves exploring its molecular geometry, bonding characteristics, synthesis methods, and its role in various chemical reactions. This article delves into the detailed chemical nomenclature, structural attributes, and practical significance of the p₄s₇ compound. Additionally, it addresses the compound's classification within phosphorus sulfides and discusses its reactivity and stability under different conditions. The following sections provide a comprehensive overview of p₄s₇ compound name chemistry, facilitating a deeper understanding of this important chemical entity.

- Chemical Nomenclature and Molecular Structure of P₄S₇
- Synthesis and Preparation Methods
- Chemical Properties and Reactivity
- Applications and Industrial Significance
- Safety and Handling Considerations

Chemical Nomenclature and Molecular Structure of P₄S₇

The p₄s₇ compound name chemistry is rooted in the systematic naming conventions established by the International Union of Pure and Applied Chemistry (IUPAC). The empirical formula P₄S₇ corresponds to a compound consisting of four phosphorus atoms and seven sulfur atoms. The most widely accepted name for this compound is tetraphosphorus heptasulfide. In chemical nomenclature, the prefix "tetra-" denotes four phosphorus atoms, while "hepta-" signifies the presence of seven sulfur atoms.

Molecular Geometry and Bonding

The molecular structure of P₄S₇ is characterized by a cage-like arrangement where phosphorus atoms are bonded to sulfur atoms forming a polyhedral geometry. The compound belongs to the family of phosphorus

sulfides, which display a variety of structural motifs due to the versatile bonding capabilities of phosphorus and sulfur.

In P₄S₇, each phosphorus atom typically exhibits three covalent bonds, involving both phosphorus-phosphorus (P–P) and phosphorus-sulfur (P–S) interactions. The sulfur atoms act as bridging ligands, connecting the phosphorus atoms and stabilizing the overall molecular framework. This structure imparts unique electronic and steric properties to the compound.

Isomerism and Structural Variants

Within the chemistry of phosphorus sulfides, P₄S₇ exhibits isomeric forms that differ in the arrangement of sulfur atoms around the phosphorus core. These isomers can influence the compound's reactivity and physical properties such as melting point and solubility. Understanding these structural variants is essential for manipulating the compound in synthetic applications.

Synthesis and Preparation Methods

The preparation of P₄S₇ involves controlled reactions between elemental phosphorus and sulfur under specific conditions. The synthesis process requires careful adjustment of temperature, stoichiometry, and reaction environment to favor the formation of the tetraphosphorus heptasulfide phase over other phosphorus sulfide compounds.

Direct Combination of Elements

A common synthesis route for P₄S₇ is the direct combination of white phosphorus (P₄) with sulfur in a sealed vessel. The reaction is typically conducted at elevated temperatures ranging from 250°C to 400°C to facilitate the formation of the P₄S₇ compound. The precise temperature and reaction time influence the purity and yield of the product.

Alternative Synthetic Methods

Besides direct combination, P₄S₇ can also be synthesized through the controlled decomposition of higher phosphorus sulfides or by sulfurization of phosphorus-containing precursors. These methods may offer advantages in selectivity or scalability depending on the intended application.

1. Mix elemental phosphorus and sulfur in the correct molar ratio.
2. Seal the mixture in an inert atmosphere or vacuum to prevent oxidation.
3. Heat gradually to the desired temperature and maintain for several hours.
4. Cool the product slowly to obtain crystalline P₄S₇.

Chemical Properties and Reactivity

Understanding the chemical characteristics of P₄S₇ is crucial for its application in various fields. The compound exhibits distinct reactivity profiles due to the presence of multiple P–S bonds and its cage-like structure.

Thermal Stability

P₄S₇ demonstrates moderate thermal stability, decomposing at temperatures above 400°C. Its stability is less than that of some other phosphorus sulfides like P₄S₁₀ but sufficient for many practical uses. Thermal decomposition typically leads to the release of sulfur vapors and formation of lower phosphorus sulfides.

Reactivity with Other Chemicals

The compound reacts with strong acids and bases, undergoing hydrolysis to yield phosphoric and sulfur-containing acids. It also participates in redox reactions where phosphorus atoms change oxidation states. P₄S₇'s reactivity with metals and organic compounds is exploited in the synthesis of various organophosphorus derivatives.

- Hydrolysis under acidic or basic conditions
- Oxidation and reduction reactions
- Formation of coordination complexes with transition metals
- Use as a reagent in organic synthesis

Applications and Industrial Significance

The P_4S_7 compound name chemistry is not only academically significant but also industrially relevant. Tetraphosphorus heptasulfide is employed in several applications that leverage its unique chemical properties.

Use in Lubricant and Additive Formulations

P_4S_7 serves as an additive in lubricant formulations due to its ability to form protective films on metal surfaces, reducing wear and friction. Its sulfur content contributes to anti-wear properties, making it valuable in mechanical and automotive industries.

Role in Chemical Synthesis

In chemical manufacturing, P_4S_7 acts as a precursor for producing other phosphorus-sulfur compounds and organophosphorus chemicals. It is used in the synthesis of pesticides, flame retardants, and vulcanization agents for rubber.

Research and Development

Ongoing research explores the potential of P_4S_7 in materials science, particularly in the development of novel catalysts and advanced materials with unique electronic properties. Its structural versatility makes it a candidate for future technological innovations.

Safety and Handling Considerations

Handling P_4S_7 requires adherence to safety protocols due to its chemical reactivity and potential hazards. Proper measures ensure safe use in laboratory and industrial environments.

Toxicity and Exposure Risks

P₄S₇ can release toxic sulfur-containing gases upon decomposition or exposure to moisture. Inhalation or skin contact may cause irritation or adverse health effects. Therefore, using protective equipment such as gloves, goggles, and adequate ventilation is essential.

Storage and Disposal

The compound should be stored in airtight containers away from heat sources and incompatible substances such as strong oxidizers. Disposal must conform to environmental regulations to prevent contamination and exposure risks.

- Store in cool, dry, well-ventilated areas
- Avoid contact with moisture and oxidizing agents
- Use appropriate personal protective equipment (PPE)
- Follow local regulations for chemical waste disposal

Frequently Asked Questions

What is the chemical formula of the compound P₄S₇?

The chemical formula P₄S₇ represents a compound consisting of 4 phosphorus atoms and 7 sulfur atoms.

What is the IUPAC name of P₄S₇?

The IUPAC name of P₄S₇ is tetraphosphorus heptasulfide.

What type of compound is P₄S₇ in chemistry?

P₄S₇ is a binary compound made up of phosphorus and sulfur, classified as a phosphorus sulfide.

How is P₄S₇ synthesized in the laboratory?

P₄S₇ is typically synthesized by heating white phosphorus with sulfur in a controlled environment, allowing them to react and form the compound.

What are the physical properties of P₄S₇?

P₄S₇ usually appears as a yellow to orange solid, with a characteristic smell, and is insoluble in water but soluble in organic solvents.

What are the applications of P₄S₇ in industry or research?

P₄S₇ is used in the synthesis of other phosphorus-sulfur compounds and can serve as a reagent in organic synthesis and materials science.

How does the structure of P₄S₇ influence its chemical properties?

The molecular structure of P₄S₇, featuring phosphorus atoms bonded to sulfur atoms, affects its stability, reactivity, and ability to form various allotropes and compounds with unique chemical behaviors.

Additional Resources

1. *Phosphorus-Sulfur Chemistry: Fundamentals and Applications*

This book explores the fundamental chemistry of phosphorus-sulfur compounds, including synthesis, structure, and reactivity. It covers a range of compounds such as P₄S₇, discussing their properties and roles in various chemical processes. The text is ideal for both students and researchers aiming to deepen their understanding of these unique compounds.

2. *Synthesis and Characterization of Phosphorus-Sulfur Compounds*

Focusing on laboratory techniques, this book provides detailed methodologies for synthesizing phosphorus-sulfur compounds like P₄S₇. It includes analytical procedures for characterizing these substances using modern instrumentation. The book serves as a practical guide for chemists working in inorganic and materials chemistry.

3. *Advanced Inorganic Chemistry: Phosphorus and Sulfur Compounds*

This comprehensive volume covers the chemistry of phosphorus and sulfur elements, emphasizing their combined compounds such as P₄S₇. It discusses bonding theories, structural aspects, and industrial applications. The book is suitable for advanced undergraduate and graduate students.

4. *The Chemistry of Phosphorus Sulfides*

Dedicated entirely to phosphorus sulfides, this book reviews their preparation, physical and chemical properties, and uses. It provides historical context and recent developments in the field, including the

significance of P4S7 in various chemical reactions. Researchers will find valuable insights into the molecular behavior of these compounds.

5. Phosphorus-Sulfur Heterocycles: Structure and Reactivity

This text delves into the heterocyclic compounds formed between phosphorus and sulfur atoms, with P4S7 as a key example. It examines their unique ring structures, electronic characteristics, and potential applications in organic synthesis. The book combines theoretical and experimental perspectives.

6. Industrial Applications of Phosphorus Sulfides

Highlighting the practical uses of phosphorus sulfides, this book covers their roles in lubricants, flame retardants, and chemical intermediates. It discusses the synthesis and handling of compounds like P4S7 within industrial settings. The book is a resource for chemical engineers and applied chemists.

7. Phosphorus-Sulfur Compounds in Materials Science

This book investigates how phosphorus-sulfur compounds contribute to the development of new materials with desirable properties such as conductivity and stability. It includes case studies involving P4S7 and related substances. Researchers interested in materials chemistry will find this text valuable.

8. Reactivity and Mechanisms of Phosphorus-Sulfur Compounds

Focusing on the reaction pathways and mechanisms, this book details how compounds like P4S7 interact with other chemicals. It explains catalytic processes and transformation reactions important in both laboratory and industrial contexts. Advanced chemists will benefit from its in-depth analysis.

9. Phosphorus Sulfide Compounds: Environmental and Safety Aspects

Addressing the environmental impact and safety considerations, this book discusses the handling, storage, and disposal of phosphorus-sulfur compounds such as P4S7. It highlights regulatory issues and best practices to minimize risks associated with these chemicals. The book is essential for professionals managing chemical safety.

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