Chemistry | Inorganic Chemistry

Test for Zinc Radical

General Aim

Detection of the presence of zinc ion as a base radical in inorganic salts such as zinc sulfate.

Method

Detection of the presence of zinc as a base radical using specific chemical reagents.

Learning Objectives (ILOs)

- Define and differentiate between members of the third group cations and those of other cation groups.
- Classify inorganic salts according to their base radicals.
- Compare between zinc containing salts and other members of the same group in terms of chemical structures, properties and reactions.
- Identify zinc radicals containing salts experimentally.
- Select the appropriate reagents to detect the presence of zinc radical.
- Balance the chemical equations of chemical reactions.

Theoretical Background/Context

- **Zinc (Zn)**, is a metal whose atomic number is 30 and it is the first element located in group 12 in the periodic table. Its name is derived from the German word zink. Zinc is similar to magnesium in size and both of them possess only one oxidation state which is +2.

Abundance of Zinc in Nature

In the Earth's crust, zinc is the 24th most abundant element in the earth crust and possesses five isotopes. The most widely abundant zinc ore is sphalerite which is a zinc sulfide based ore. It is also commonly known as zinc blende. The largest workable zinc ores lodes are located in the United States of America, Australia and Asia. Zinc metal is obtained through the refinement of its ores through their froth flotation, roasting, then final extraction using electricity (electrowinning).

Properties and Uses of Zinc

- Zinc is a slightly brittle and ductile metal at room temperature possessing a blue silvery appearance. It is characterized by possessing low melting and boiling points. Zinc is considered as one of the most commonly abundant elements in its pure form and it is commonly obtained through electrolysis of zinc sulfate on a laboratory scale.
- Zinc is commonly used in the manufacture of dry cell batteries and galvanized nails. In addition, due to its low melting point, zinc could easily form with iron and steel leading to formation of a coat on the metal surfaces protecting them from corrosion.

Zinc Salts

Zinc reacts very slowly with weak acids. However, it reacts vigorously with sulfur forming zinc sulfide and halogens forming zinc halides. Since electronegativity of halogens decreases gradually along the halogen group, the reactivity with zinc decreases. Therefore, fluorine reacts with zinc violently, while iodine is the least reactive halogen producing very minute amount of heating.

Theoretical Background/Context (Cont')

Preparation of Zinc Salts

Zinc salts can be obtained through reacting with some elements such as sulfur and halogens to produce zinc sulfide and zinc halides, respectively. In addition, zinc or zinc containing compounds react with some strong acids such as sulfuric acid to produce zinc sulfate as shown in the following reaction.

$$Zn + H_2SO_4 + 7\ H_2O \rightarrow ZnSO_4.7\ H_2O + H_2 \uparrow$$

Properties and Uses of Zinc Sulfate

- Zinc sulfate is a white crystalline salt.
- Zinc sulfate is used in various medical preparations as a dietary supplement for treatment and prevention of zinc deficiency. It is also used in treatment of diarrhea.
- Overdoses of zinc sulfate may cause nausea and vomiting. In addition, it is an eye irritant.

Principle of Work

- In this experiment, zinc ion in zinc sulfate is detected through some identification and confirmatory tests. The zinc radical is among the third group of basic radicals in which ammonium sulfide is used as group reagents.
- During the experiment, salt solubility in water will be tested. Then the behavior of the salt will be tested through confirmatory tests which will be performed using sodium hydroxide, ammonia, and potassium ferrocyanide reagents to confirm the presence of zinc radical in the salt.

First: Solubility Test

In this test, a sample of the zinc salt is tested for its solubility in water on cold and hot if needed.

Second: Ammonium Sulfide Test

It depends on the fact that sulfide in the presence of ammonium chloride and ammonia can displace sulfate ions in zinc sulfate salt forming white precipitate of zinc sulfide according to the following reaction.

$$ZnSO_4 + (NH_4)_2S \rightarrow (NH_4)_2SO_4 + ZnS \downarrow \text{(White ppt.)}$$

Third: Sodium Hydroxide Test

Sodium Hydroxide solution is added to aqueous zinc sulfate leading to the precipitation of zinc hydroxide as a gelatinous white precipitate which is soluble in excess sodium hydroxide due to formation of sodium zincate $Na_2[ZnO_2]$. The reaction of the test is:

$$ZnSO_4 + 2\ NaOH \rightarrow Na_2SO_4 + Zn(OH)_2 \downarrow \text{(Gel. White ppt.)}$$

$$Zn(OH)_2 + 2\ NaOH \rightarrow 2\ H_2O + Na_2[ZnO_2]$$

Fourth: Ammonia Test

It depends on the fact that ammonia can displace sulfate ions in zinc sulfate salt forming white precipitate of zinc hydroxide which is soluble in excess ammonia.

$$ZnSO_4 + 2\ NH_4OH \rightarrow (NH_4)_2SO_4 + Zn(OH)_2 \downarrow \text{(White ppt.)}$$

Fifth: Potassium Ferrocyanide Test

Potassium ferrocyanide solution is added to zinc sulfate aqueous solution resulting in precipitation of zinc ferrocyanide as a white precipitate due to low solubility product as shown in the following chemical reaction:

$$2\ ZnSO_4 + K_4[Fe(CN)_6] \rightarrow 2\ K_2SO_4 + Zn_2[Fe(CN)_6] \downarrow \text{(White ppt.)}$$