Chemistry | Inorganic Chemistry

Test for Mercurous Radical

General Aim

Detection of the presence of the mercurous ion as a base radical in inorganic salts such as mercurous nitrate.

Method

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

Learning Objectives (ILOs)

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

Theoretical Background/Context

- Mercury is one of the few and rare elements that are abundant naturally in a liquid form. Mercury dissolves in oxidizing acids leading to the formation of either Hg2+ or Hg22+ according to the excess reagent. In addition, mercury element dissolves in aqua regia (a mixture of nitric and hydrochloric acids) forming $HgCl4^{2-}$.

Properties and Uses of Mercury

Mercury has a melting point of -38.87 °C and boiling point of 356.57 °C. Its density is 13.546 g/cm3. It has two common oxidation states which are +1 and +2. Mercury is used in the manufacture of thermometers and scientific instruments. In addition, it is used as an electrical conductive element. Mercury vapor is used in streetlight signs and fluorescent signs.

Mercurous Salts

Mercurous nitrate is a mercury salt whose chemical formula is HgNO3. Mercury in mercurous nitrate is present as $Hg2^{2+}$ where its oxidation state is +1. Mercury(I) compounds usually are subjected into disproportionation leading to the formation of black metallic mercury and mercury (II) compounds.

Preparation of Mercurous Nitrate

Mercurous nitrate can be prepared through the reaction of mercury metal and hot concentrated nitric acid as shown in the following reaction:

$$Hg + HNO3(conc) \rightarrow Hg2(NO3)2 + 2\ H2\uparrow$$

Mercurous nitrate could produce toxic nitrogen oxides gases if heated to complete decomposition.

Properties and Uses of Mercurous Nitrate

•Mercurous nitrate is a white crystalline salt that is soluble in water forming colorless aqueous solutions.
•Mercurous nitrate has no odor or slightly nitric acid odor.
•Mercurous nitrate is used along with alcohol in preparation of explosives.
•Mercurous nitrate is used in felt and textiles manufacturing.

Principle of Work

- In this experiment, mercurous ions in mercurous nitrate are detected through some identification and confirmatory tests. The mercurous radical is among the first group of basic radicals in which hydrochloric acid is used as group reagents.
- During the experiment, salt solubility in water will be tested. Then the behavior of the salt will be tested with hydrochloric acid followed by confirmatory tests which will be performed using sodium hydroxide, hydrogen sulfide, potassium iodide, ammonia and potassium chromate reagents to confirm the presence of mercurous radical in the salt.

First: Solubility Test

In this test, a sample of the mercury (I) salt is tested for its solubility in water.

Second: Dilute Hydrochloric Acid Test

It depends on the fact that dil. HCl can displace nitrate ions in mercurous nitrate salt forming mercurous chloride salt which is a white precipitate. The color of the precipitate is then changed into black through adding ammonium hydroxide solution. The reaction between mercurous nitrate and HCl is shown below.

$$Hg(NO_3)_2 + 2\,HCl \rightarrow 2\,HNO_3 + Hg_2Cl_2 \downarrow \text{(White ppt.)}$$

Third: Sodium Hydroxide Test

Sodium Hydroxide solution is added to aqueous mercurous nitrate leading to the precipitation of mercurous oxide as a black precipitate due to its low solubility product. The reaction of the test is:

$$Hg(NO_3)_2 + 2\,NaOH \rightarrow 2\,NaNO_3 + H_2O + Hg_2O \downarrow \text{(Black ppt.)}$$

The precipitate is not soluble in excess reagent.

Fourth: Hydrogen Sulfide Test

Hydrogen sulfide solution is added to an aqueous mercurous nitrate solution leading to the precipitation of mercurous sulfide as a black precipitate as well as mercury as an element as shown in the reaction below.

$$Hg_2(NO_3)_2 + H_2S \rightarrow 2HNO_3 + HgS \downarrow + Hg$$

Fifth: Potassium Iodide Test

Potassium iodide solution is added to mercurous nitrate aqueous solution resulting in precipitation of mercurous iodide as a yellowish green precipitate due to low solubility product as shown in the following chemical reaction:

$$Hg(NO_3)_2 + 2\,KI \rightarrow KNO_3 + Hg_2I_2\downarrow \text{(Yellowish green ppt.)}$$

Sixth: Ammonia Test

Ammonia solution is added to mercurous nitrate aqueous solution resulting in precipitation of mercurous ammonium nitrate as a black precipitate due to low solubility product as shown in the following chemical reaction:

$$Hg(NO_3)_2 + 2\,NH_3 \rightarrow NH_4NO_3 + Hg + HgNH_2^2NO_3\downarrow$$
$$\text{(Black ppt.)}$$

Seventh: Potassium Chromate Test

Potassium chromate test is considered as a specific test for detection of the presence of mercurous ions as the basic radical of a salt. The test depends on adding potassium chromate solution to aqueous mercurous nitrate solution leading to the formation of brown amorphous precipitate of mercurous chromate according to the following reaction:

$$K_2CrO_4 + Hg_2(NO_3)_2 \rightarrow 2\,KNO_3 + Hg_2CrO_4\downarrow$$