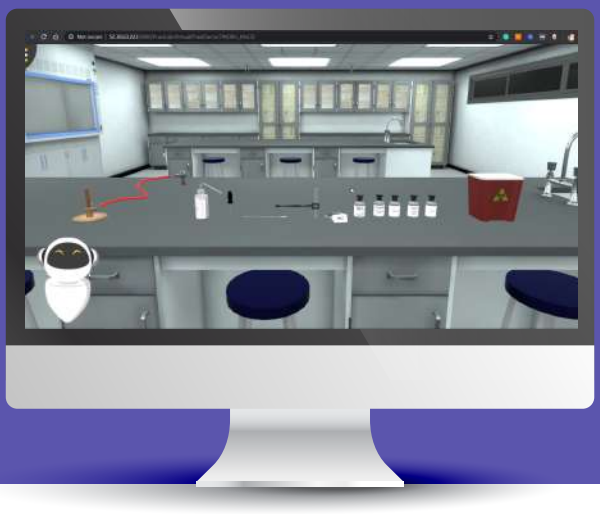
Chemistry | Inorganic Chemistry

Test for Manganous Radical



General Aim

Detection of the presence of manganese ions as a base radicals in inorganic salts such as manganese chloride.

Method

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

Learning Objectives (ILOs)

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

Theoretical Background/Context

Manganese is the 25th abundant element on earth. Its name comes from the Latin word 'magnes' which means a magnet owing to its magnetic properties. Manganese is one of the few elements that humans need daily. Manganese was first isolated from the reduction of manganese compounds such as manganese dioxide. Manganism which is manganese poisoning could result from exposure to manganese dust or fumes for a long duration.

Abundance of Manganese in Nature

Manganese is considered to be the 25th most abundant element in the earth crust. Manganese cannot be found easily in nature as a free metal. However, it is found as a mineral in the form of oxides, silicates or carbonates. Manganese could be extracted from those ores. It is also found in the ocean floor in the form of nodules that are considered to be large lumps of metallic ores.

Properties and Uses of Manganese

Manganese is a hard, brittle, gray-white metal when found in its pure form. It is commonly known by being used as an alloying agent in steel manufacturing. It enhances the resistance of steel to impact. Long ago, Romans have used manganese in manufacturing their weapons and strong equipment for war due to its hardness. Moreover, romans used manganese as a pigment.

Manganese Compounds

- Manganese is a highly reactive metal so it possesses high ability to react with different elements to produce various manganese containing compounds with various uses and functions. This is attributed to manganese's valence electron that allows diversity of reactions. In biological systems, manganese is a mandatory element in the composition of vitamin B1.
- Manganese, as many transition metals, has various oxidation states that could exceed 5 stable oxidation states. Each oxidation state possesses a distinctive color. Therefore, it is commonly used as a chemical reagent or indicator. For instance, it is commonly found in the laboratory as potassium permanganate KMnO4 that is used as a strong oxidizing agent. In addition, MnO2 catalyzes the decomposition of H2O2 as well as production of oxygen gas on a lab scale. Furthermore, manganese is incorporated in some inorganic salts such as manganese chloride whose molecular formula is MnCl2.

Preparation of Manganese Chloride

Manganese chloride could be prepared through the reaction of manganese (IV) oxide with concentrated hydrochloric acid. This reaction has been used also for the preparation of chlorine

$$MnO2 + 4\ HCl \rightarrow MnCl2 + 2H2O + Cl2 \uparrow$$

- Furthermore, on laboratory scale, manganese chloride can be prepared through the reaction of manganese metal or manganese carbonate with hydrochloric acid.

$$Mn + 2\ HCl + 4\ H2O \rightarrow MnCl2.4H2O + H2$$

$$MnCO3 + 2\ HCl + 3\ H2O \rightarrow MnCl2.4H2O + CO2$$

- Manganese chloride hydrates are water soluble forming acidic solutions of pH 4 containing the metal aqua complex $[Mn(H2O)6]2+$.

Properties and Uses of Manganese Chloride

- Manganese chloride is a white powdered salt when it is dehydrated. Its color turns into pink upon its hydration.
- Anhydrous manganese (II) chloride is used to initiate the synthesis of various manganese compounds. For instance, manganocene is prepared through reacting MnCl2 with sodium cyclopentadienide solution in THF.

$$MnCl2 + 2\ NaC5H5 \rightarrow Mn(C5H5)2 + 2\ NaCl$$

- Manganese chloride reacts with typical organic ligands, so that manganese (II) gets oxidized by air to give Mn (III) complexes such as [Mn(EDTA)]−, [Mn(CN)6]3−, and [Mn(acetylacetonate)3].
  For example, triphenylphosphine forms a liable 2:1 adduct as shown below.

$$MnCl2 + 2\ Ph3P \rightarrow [MnCl2(Ph3P)2]$$

- Manganese chloride is commonly used in dry cell batteries manufacturing. It is also used as precursor for the antiknock compound methylcyclopentadienyl manganese tricarbonyl.

Principle of Work

- In this experiment, manganese ion in manganese chloride is detected through some identification and confirmatory tests. The manganese radical is among the fourth group of basic radicals in which ammonium sulfide along with ammonium hydroxide and ammonium chloride are used as group reagents.
- During the experiment, salt solubility in water will be tested. Then the behavior of the salt will be tested with ammonium sulfide followed by confirmatory tests which will be performed using sodium hydroxide and ammonia to confirm the presence of manganese radical in the salt.

First: Physical Appearance Test

In this test, a sample of the manganese chloride salt is tested for its color, odor, texture, etc.

Second: Solubility Test

In this test, a sample of the manganese chloride salt is tested for its solubility in water.

Third: Ammonium Sulfide Test

It depends on the fact that sulfide anions can displace chloride ions in manganese chloride salt forming insoluble manganous sulfide as a pink precipitate as the following reactions:

$$(NH_4)_2S + MnCl_2 \rightarrow 2\,NH_4Cl + MnS \downarrow \text{(Pink ppt.)}$$

Fourth: Sodium Hydroxide Test

Sodium Hydroxide solution is added to aqueous manganese chloride leading to the precipitation of manganese hydroxide as a white precipitate that changes into brown with time due to its oxidation. Both precipitates are not soluble in excess reagent.

$$MnCl_2 + 2NaOH \rightarrow 2NaCl + Mn(OH)_2 \downarrow \text{(White ppt.)}$$

$$Mn(OH)_2 + 2H_2O + O_2 \rightarrow Mn(OH)_3 \downarrow \text{(Brown ppt.)}$$

Fifth: Ammonia Test

Ammonia solution is added to aqueous manganese chloride leading to the precipitation of the manganese hydroxide as a white precipitate due to its low solubility product. Then, upon being exposed to air, the white precipitate changes into brown:

$$MnCl_2 + 2NH_4OH \rightarrow NH_4Cl + Mn(OH)_2 \downarrow \text{(White ppt.)}$$