Chemistry | Inorganic Chemistry

Test for Bromide Radical

General Aim

Detection of the presence of bromide ion as an acid radical in inorganic salts such as sodium bromide.

Method

Detection of the presence of bromide as acid radical using specific chemical reagents.

Learning Objectives (ILOs)

- Define and differentiate between bromide ions and other acid radicals through their chemical formulas.
- Classify inorganic salts according to their acid radicals.
- Compare between bromide and other halide members in terms of chemical structures, properties and reactions.
- Identify bromide radicals containing salts experimentally.
- Select the appropriate reagents to detect the presence of bromide radical.
- Balance the chemical equations of chemical reactions.

Theoretical Background/Context

- Bromide is the anion of bromine anion that possesses -1 charge. Bromide forms the acid radical (negative portion) of some inorganic salts such as sodium bromide, potassium bromide, calcium bromide, etc.

Abundance of bromide in nature

Bromide is present in nature in seawater with a concentration of 65 mg/L. This is considered to be around 0.2% of all dissolved salts in seawater. High levels of bromide salts are found in seafoods and deep sea plants. Crystalline silver bromide, commonly known as bromargyrite, is one of the most commonly known bromide salts although it is very rare. Another commonly known bromide salt is sodium bromide.

Preparation of Sodium Bromide

Sodium bromide (NaBr) can be prepared through the reaction of sodium hydroxide and hydrogen bromide as the following reaction:

$$NaOH + HBr \rightarrow NaBr + H2O$$

Chemical Properties of Sodium Bromide

Sodium bromide is a white crystalline inorganic salt that dissolves in water producing colorless aqueous solution. It is both chemically and thermally stable. Sodium bromide is used as a bromine source and a brominating agent in organic synthesis.

Theoretical Background/Context (Cont')

Uses of Sodium Bromide:

- Sodium bromide is used as a disinfectant for swimming pools and as hypnotic in sedatives preparation. It is also used in preparation of dense fluids in oil wells. In addition, it has been used in photography, films, dyes and other industries.
- Bromide ion is classified as a member of acidic radicals of the second group in which concentrated sulphuric acid is used as the group reagent. Sulphuric acid displaces bromide ions in its salts leading to liberation of reddish brown HBr gas. In addition, potassium permanganate is used as a reagent for detecting the presence of the bromide ion.
- Furthermore, bromide could be detected through some confirmatory tests using silver nitrate solution or lead acetate solution since they react together forming silver chloride or lead chloride as a pale yellow or sugary white precipitates, respectively. This returns back to the low solubility product of silver and lead chloride salts so they precipitate very easily at very low concentrations.
- Finally, cyclohexane test is carried out as a specific test for detection of bromide ion, where the result gives orange color in the cyclohexane layer.

Principle of Work

- In this experiment, bromide ion in sodium bromide is detected through some identification and confirmatory tests. In addition, these tests can be used to differentiate between halide class and other acid radical classes. Moreover, confirmatory and specific tests are used to differentiate between the presence of different halides.

First: Dry Heat Test

In this test, a sample of the bromide salt is heated to be tested for its ability to decompose into bromine gas.

Second: Concentrated Sulphuric Acid Test

It depends on the fact that conc. sulphuric acid can displace bromide ions in its sodium salt forming sodium bisulphate salt and reddish brown hydrogen bromide gas.

Reaction of Sodium bromide with Sulphuric Acid: $NaBr + H2SO4 \rightarrow NaHSO4 + HBr\uparrow$

Third: Potassium Permanganate Test

It depends on the fact that permanganate oxidizes bromide in an acidified medium into bromine gas, while permanganate gets reduced and discolored.

Fourth: Silver Nitrate Test

Silver nitrate solution is added to a solution of sodium bromide leading to the precipitation of silver bromide salt as a yellow precipitate due to its low solubility product. The reaction of the test is:

$$NaBr + AgNO3 \rightarrow NaNO3 + AgBr\downarrow$$

Fifth: Lead Acetate Test

Lead acetate solution is added to sodium bromide solution resulting in precipitation of lead bromide as a sugary white precipitate due to low solubility product as shown in the following chemical reaction:

$$2\ NaBr + (CH3COO)2Pb \rightarrow 2\ CH3COONa + PbBr2\downarrow$$

Sixth: Cyclohexane Test

Cyclohexane test is considered as a specific test for detection of the presence of bromide ion as the acid radical of a salt. The test depends on adding cyclohexane on a sodium bromide solution which results in formation of a separate cyclohexane layer above the salt aqueous solution. Afterwards, adding drops of chlorine water will displace bromide in its salt leading to liberation of bromine gas that imparts an orange color to the cyclohexane layer.

$$NaBr + Cl2 \rightarrow NaCl + Br2 \uparrow \text{Reddish brown vapors}$$