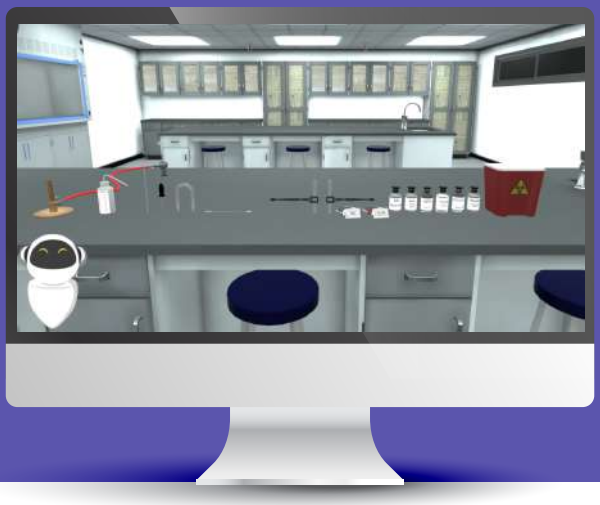
Chemistry | Inorganic Chemistry

Test for Chloride Radical



General Aim

To test for the chloride radical in inorganic salts.

Method

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

Learning Objectives (ILOs)

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

Theoretical Background/Context

- Chloride is the chlorine anion that forms the acid radical (negative portion) of some inorganic salts such as sodium chloride, potassium chloride, calcium chloride, etc. Chlorine gas exists in nature as a diatomic molecule. Chlorine in its gaseous state is a highly toxic gas that possesses a strong smell. However, chlorine is mostly abundant in nature in the form of chloride ions in salts, which is more safe and usable in different applications including food industries, pharmaceutical and biomedical applications.
- For instance, chloride is the acid radical of sodium chloride salt that is used as the table salt. In addition, it is an essential anion that exists inside our body to be utilized in many biochemical processes. It is responsible for maintaining the acid-base balance in our bodies, where its concentration is controlled by the kidneys.
- The chloride ion is classified as a member of acidic radicals of the second group in which concentrated sulphuric acid is used as a group reagent. Sulphuric acid displaces chloride ions in its salts leading to liberation of HCl gas that could be detected using ammonium hydroxide solution.
- In addition, soluble chloride salts such as sodium chloride could be detected through some confirmatory tests using silver nitrate solutions or lead acetate solutions since they react together forming silver chloride or lead chloride as a white precipitate. This returns back to the low solubility product of silver and lead chloride salts so they precipitates very easily at very low concentrations.
- Finally, a chromyl chloride test is carried out as a specific test for detection of chloride ion, where the results gives red vapors and yellow solution upon using chromyl reagents.

Principle of Work

- In this experiment, chloride ion in sodium chloride 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: Solubility Test

In this test, a sample of the chloride salt is tested for its solubility in distilled water on cold. Most chloride salts such as sodium chloride are water soluble without heating.

Second: Concentrated Sulphuric Acid Test

It depends on the fact that conc. sulphuric acid can displace chloride ions in its sodium salt forming sodium bisulphate salt and hydrochloric acid gas. The evolved gas can react with ammonium hydroxide solution to liberate detectable ammonium chloride white fumes. The two steps of the reactions are:

Step 1: Reaction of Sodium Chloride with Sulphuric Acid:

$$NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl\uparrow$$

Step 2: Reaction of HCl gas with Ammonium Hydroxide:

$$HCl + NH_4OH \rightarrow NH_4Cl\uparrow + H_2O$$

Third: Silver Nitrate Test

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

$$NaCl + AgNO_3 \rightarrow NaNO_3 + AgCl\downarrow$$

Forth: Lead Acetate Test

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

$$2\ NaCl + (CH_3COO)_2Pb \rightarrow 2\ CH_3COONa + PbCl_2\downarrow$$

Fifth: Chromyl Chloride Test

Chromyl chloride test is considered as a specific test for detection of the presence of chloride ion as the acid radical of a salt. The test depends on that when heating a chloride containing salt in the presence of acidified potassium dichromate salt, evaluation of orange chromyl chloride gas is clearly noticed according to the following reaction:

$$K_2Cr_2O_7 + 4\ NaCl + 6\ H_2SO_4 \rightarrow 2\ KHSO_4 + 4\ NaHSO_4 + CrO_2Cl_2\uparrow$$ **Orange red vapors**