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Diploma in Pharmacy 1st Year
Pharmaceutical Chemistry
Experiment
To perform the identification test of Cations

Aim:

To perform the identification test of Cations

Reference :

‘ Dr. Gupta G.D. , Dr. Sharma Shailish , Kaur Baljeet ’ “Practical Manual of Pharmaceutical Chemistry” Published by Nirali Prakashan, Page no 16 - 20

Requirements:

Apparatus Required: Test tube, test tube holder, spatula, mouth blowpipe, bunsen burner, watch glass,

Chemicals Required: borax, distilled water, sodium carbonate, platinum wire, and cone HCL

Theory:

Qualitative analysis is a method of systematically removing cations from mixture via a precipitation reaction. The way cations react to a series of common test reagents varies from one cation to another, and this provides the basis for their separation.

Before performing a qualitative analysis on an inorganic mixture, various preliminary tests must be completed. The following are the preliminary cation tests:

1) Physical Examination:

a. **Blue or Bluish Green:** Copper or nickel salts
b. **Light Green:** Ferrous salts
c. **Dark Green:** Chromium salts
d. **Dark Brown:** Femme salts
e. **Light Pink or Flesh Colour:** Manganese salts
f. **White:** Absence of Cu, Ni. Fe, Mn and Co salts

2) **Charcoal Cavity Test:** In this test, cations are converted into metal carbonate in a charcoal cavity, which then decomposes to metal oxide of even metallic state when heated.

The cation present can be determined by the colour of the bead, residue left in the cavity or incrustation (a deposit created outside the cavity.

$\mathbf{ZnSO_4} + \mathbf{Na_2CO_3} \longrightarrow ZnCO_3 + Na_2SO_4$

$\mathbf{ZnCO_3} \rightarrow ZnO$ (yellow when hot) $+ CO_2$

$\mathbf{CuSO_4} + \mathbf{Na_2CO_3} \rightarrow CuCO_3 + Na_2SO_4$

$\mathbf{CuCO_4} \rightarrow CuO + CO_2$

$\mathbf{CuO + C} \rightarrow Cu$ (reddish) $+ CO$

$\mathbf{CdCl_2} + \mathbf{Na^2CO_3} \rightarrow CdCO_3 + 2NaCl$

$\mathbf{CdCO_3} \rightarrow$ Cdo (reddish brown) $+ CO_2$

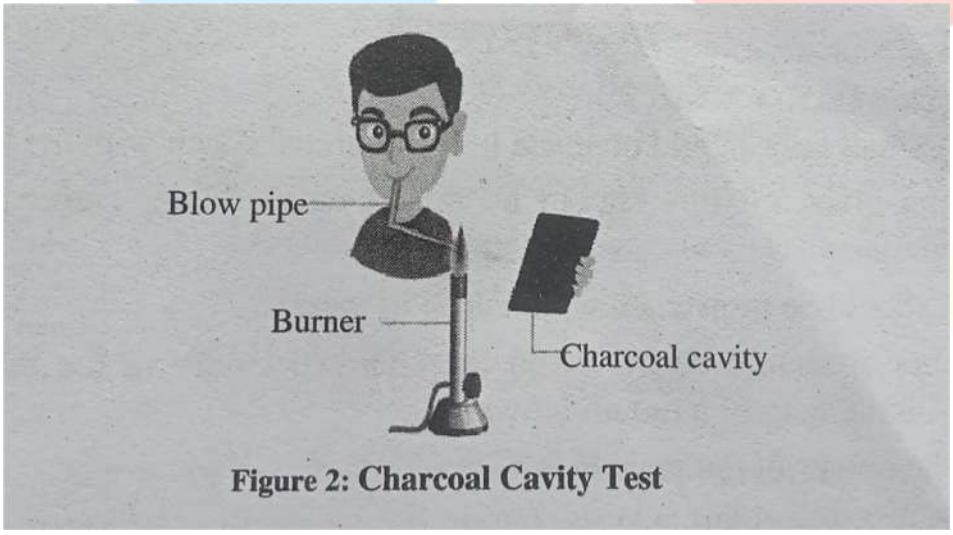

Figure 2: Charcoal Cavity Test

3) **Borax Bead Test:** This test is used to detect cations in coloured mixtures that may contain copper, nickel, iron, or manganese. Metavorates are formed when the metal oxides react with the borax bead, which has a distinct colour. When heated in a reducing flame, some metaborates form lesser metaborates or even metals thus causing change in the colour of the bead.

$Na_2B_4O_7.10H_2O \rightarrow Na_2B_4O_7$ (White porous mass) $NaBO_2 + B_2O_3$

$B_2O_3 + CuSO_4 \rightarrow Cu(BO)$ (blue green cupric metaborate) $+ SO_3\uparrow$

$2Cu(BO_2)_2 + C \rightarrow 2CuBO_2$ (colourless coprous metaborate) $+ B_2O_2 + CO\uparrow$

$2CuBO_2 + C \rightarrow 2Cu$ (red) $+ B_2O_3 + Co\uparrow$

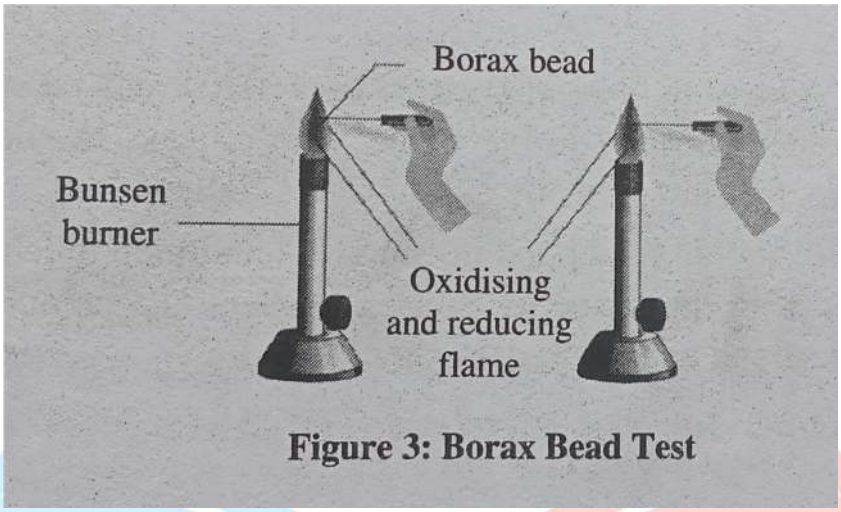

Figure 3: Borax Bead Test

4) **Flame Test:** Certain cations, such as the fifth group radicals Ba^{2+}, Sr^{2+} and Ca^{2+} in the form of their chlorides, give the non-luminous flame distinct colours. The chlorides of these cations are thermally ionised. The ions that are generated as a result of this process absorb heat energy and get excited.

In the visible part of the spectrum, the excess energy is emitted as light of a specific colour. Because different metal ions release light energy of different wavelengths, the colour imparted to the flame by the various cations varies.

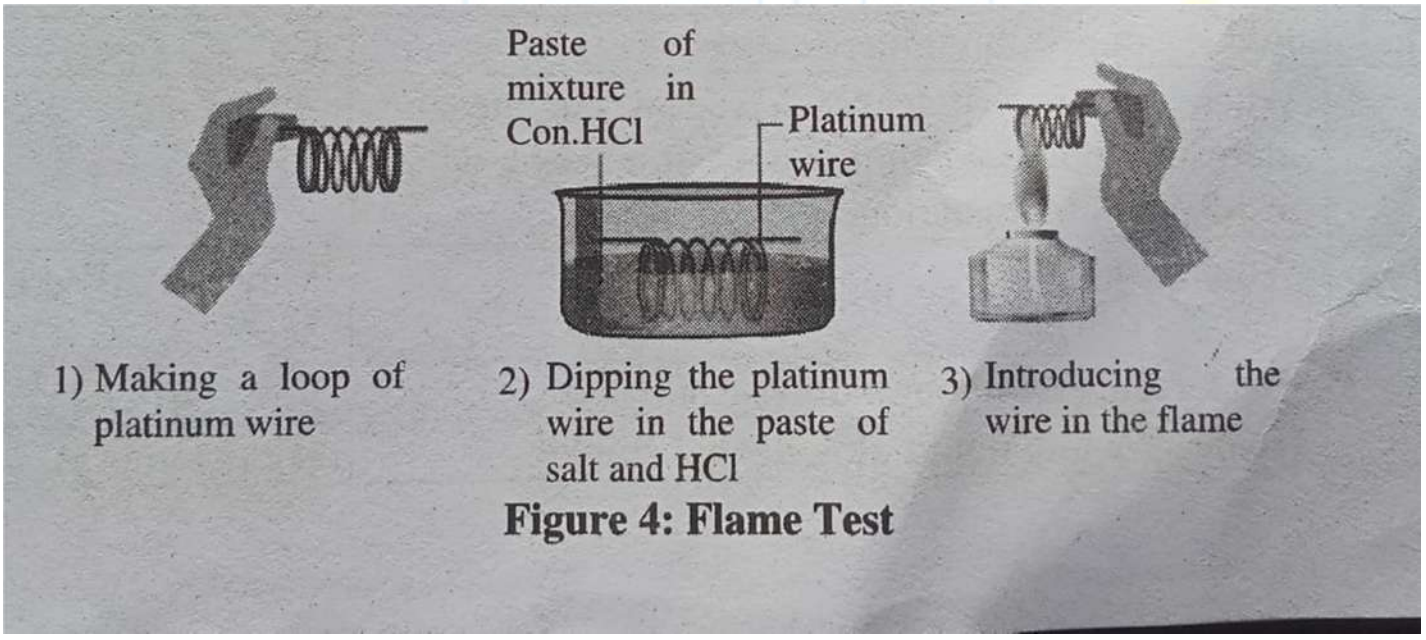

Figure 4: Flame Test

Procedure

1. **Charcoal Cavity Test:**
   i. A small hole should be made in the charcoal block with the help of borer.
   ii. The given mixture should be mixed with sodium carbonate or fusion
   iii. Mixture.
   iv. It should be moistened with a drop of water.
   v. Then it should be heated in the charcoal cavity in the reducing flame
   vi. with the help of a mouth blowpipe.
   vii. The colour of the residue left should be observed.

2. **Borax Bead Test:**
   i) A small loop should be made at the end of the platinum wire
   ii) The loop should be heated in a Bunsen flame until it is red hot.
   iii) It should be dipped into the powdered borax placed on a watch glass and heat again.
   iv) The hot bead should be touched with conc HCl and given mixture of salt. It should be heated in an oxidising (non-luminous) and reducing (luminous) flame. The colour of the bead should be observed and inferences should be drawn.

3. **Flame Test:**
   i) A platinum wire should be dipped in conc. HCI and taken on a watch glass and heated strongly in the flame. The process should be repeated until the wire does not give any colour to the flame.
   ii) Platinum wire should be dipped in conc.HCI and then touch it with given salt and heat it in the flame of Bunsen burner. The colour of the flame should be observed and inferences should be drawn.

Table 1: Charcoal Cavity Test

S.No	Observations	Inferences (Presence of)
1)	Metallic bead with yellow incrustation that is soft and leaves a mark on paper.	Pb^{2+}(Lead)
2)	The shining metallic bead does not leave a mark on the paper.	Ag^{+}(Silver)
3)	Yellow or brown incrustation on brittle bead.	Bi^{3+}(Bismuth)
4)	White incrustation with garlic-fumes white vapours	As^{3+}(Arsenic)
5)	Brown incrustation and brown residue.	Cd^{2+}(Cadmium)
6)	Red residue without incrustation.	Cu^{2+}(Copper)
7)	When it is hot, it leaves a yellow residue and incrustation and when it is cool, it leaves a white residue and incrustation.	Zn^{2+}(Zinc)
8)	White residue	May be Al^{3+}, Ca^{2+}, Ba^{2+} or Mg^{2+}
9)	Black residue without incrustation.	Fe^{3+}, Ni^{3+}, Mn^{2+}
10)	No bead, white liquid globule and smoke.	Hg (Mercury)

Table 2: Borax Bead Test

S.No	Colour of the Bead in Oxidising Flame		Colour of the Bead in Reducing Flame		Inferences (Presence of)
	Hot	Cold	Hot	Cold	
1)	Green	Blue	Reddish or Colourless	Reddish or Colourless	Copper
2)	Yellow	Yellow	Green	Green	Iron
3)	Brown	Brown	Grey or Black	Grey or Black	Nickel
4)	Pink	Pink	Colourless	Colourless	Manganese

Table 3: Flame Test

S.No	Colour of the Flame		Inferences (Presence of)
	With Naked Eye	Through Blue Glass	
1)	Golden Yellow	Nil	Sodium (Na^+)
2)	Violet	Pink	Potassium (K^+)
3)	Crimson red	Purple or crimson	Strontium (Sr^{2+})
4)	Brick red	Light yellow	Calcium (Ca^{2+})
5)	Light green	Bluish green	Barium (Ba^{2+})
6)	Bluish green or blue	Bluish green or blue	Copper (Cu^{2+})
7)	Flashes of green	Not characteristic	Zinc (Zn^{2+}) or Manganese (Mn^{2+})

Result: The given salt contains _____(NH_4^+, K^+, Ag^+, Hg_2^{2+}, Pb^{2+}, Hg^{2+}, Cu^{2+}, Bi^{3+}, Cd^{2+}. As^{3+}, Sb^{3+}, Sn^{4+}, Al^{3+}, Fe^{3+}, Co^{2+}, Ni^{2+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Ca^{2+}, Sr^{2+}. Ba^{2+}, Mg^{2+}, Na^+) cation.