Chapter 23

Principles Related to Practical Chemistry

ANALYSIS OF ACIDIC RADICALS

Acidic radicals are categorised into three groups. There is no such scheme which permits the separation of the common anions into major groups. The classification may be studied in two parts :

1. Those involving the identification by volatile products obtained on treatment with acids, and
2. Those dependent upon reactions in solution.

The part (1) is subdivided into

(i) Gases evolved with dilute HCl or dil H_2SO_4 and

(ii) Gases or vapours evolved with conc. H_2SO_4.

The part (2) is subdivided into

(i) Precipitation reactions and

(ii) Oxidation and reduction in solution

Group Category of Acid Radicals

Group I :

Radicals which are detected by dilute H_2SO_4 or dilute HCl, by liberating a gas/volatile material

(i) Carbonate

(ii) Sulphite

(iii) Sulphide

(iv) Nitrite

(v) Acetate

Group II :

Radicals which are detected by concentrated H_2SO_4

(i) Chloride

(ii) Bromide

(iii) Iodide

(iv) Nitrate

(v) Oxalate

Group III :

Radicals which do not give any characteristic gas with dilute and concentrated H_2SO_4

(i) Sulphate

(ii) Phosphate

(iii) Borate

(iv) Fluoride

Group	Group reagent	Group radicals	Colour & Observation
1.	Dil. H_2SO_4 or dil HCl	(i) CO_3^{2-}	Brisk effervescence in cold with evolution of colourless and odourless gas i.e. CO_2
		(ii) SO_3^{2-}	Colourless gas with suffocating odour (smell of burning sulphur) i.e. SO_2
		(iii) S^{-2}	A colourless gas with smell of rotten eggs i.e. H_2S
		(iv) NO_2^-	A light brown gas i.e. NO_2
		(v) CH_3COO^-	Colourless vapours with smell of vinegar.
2.	Conc. H_2SO_4	(i) Cl^-	Colourless gas with pungent smell which fumes in air.
		(ii) Br^-	Reddish brown fumes which intensify on addition of MnO_2.
		(iii) I^-	Violet pungent fumes evolved which intensify on addition of MnO_2 and condense as black.
		(iv) NO_3^-	Light brown vapours with pungent smell and intensify on addition of Cu turnings.
		(v) $C_2O_4^{2-}$	Colourless, odourless gas burns with blue flame at the mouth of test tube and turns lime water milky.
3.	$BaCl_2$	SO_4^{2-}	White precipitate of $BaSO_4$, insoluble in conc. HNO_3.
	C_2H_5OH and conc. H_2SO_4	BO_3^{3-}	Green edged blue flame of $(C_2H_5)_3BO_3$.
	Conc. HNO_3 and $(NH_4)_2MoO_4$	PO_4^{3-}	A canary yellow precipitate of $(NH_4)_3PO_4.12MoO_3$.
	Sand and conc. H_2SO_4	F^-	Waxy white deposit of silicic acid *i.e.* H_4SiO_4 or $Si(OH)_4$.

Identification of Acid Radicals

Group : I

Group acidic radicals : CO_3^{2-}, SO_3^{2-}, S^{-2}, NO_2^-

Group reagent : dil. HCl or dil. H_2SO_4

ANALYSIS OF BASIC RADICALS

Group - II :

Group - II is categorised as group-IIA and Group-IIB. The ions of this group do not react with HCl but precipitate with H_2S in dilute mineral acidic medium.

The Group-IIA sulphides of these cations are insoluble in ammonium polysulphide. The Group-IIB sulphides of these cations are soluble in ammonium polysulphide.

Group-IIA	**Group-IIB**
(i) Mercury (II) ion	(i) Arsenic (III) ion
(ii) Bismuth (III) ion	(ii) Antimony (III) ion
(iii) Copper (II) ion	(iii) Tin (II) ion
(iv) Cadmium (II) ion	(iv) Tin (IV) ion

Group-III :

Group-III cations do not react with dil. HCl or with H_2S in dilute acidic medium.

Group-III cations precipitate with ammonium hydroxide

(i) Iron (III) ion

(ii) Aluminium (III) ion

(iii) Chromium (III) ion

Group-IV :

Group-IV cations form sulphides with H_2S in presence of NH_4OH, these sulphides are insoluble in NH_4OH.

(i) Zinc (II) ion

(ii) Manganese (II) ion

(iii) Cobalt (II) ion

(iv) Nickel (II) ion

Group-V :

Group-V cations give precipitate with ammonium carbonate in presence of NH_4Cl in neutral or slightly alkaline medium.

(i) Barium (II) ion

(ii) Strontium (II) ion

(iii) Calcium (II) ion

Group-VI :

Group-VI cation reacts with Na_2HPO_4 to form precipitate

(i) Magnesium (II) ion

(ii) Sodium (I) ion

(iii) Potassium (I) ion

(iv) Lithium (I) ion

Group Zero :

Group zero cation *i.e.* NH_4^+ reacts with NaOH to give NH_3 gas

Group	Group Reagent	Basic Radicals	Colour and Composition of Precipitate
1.	Dil. HCl	Ag^{+} Pb^{+2} Hg_2^{2+}	AgCl — White $PbCl_2$ — White Hg_2Cl_2 — White
2.	H_2S in presence of dil. HCl	Hg^{+2} Pb^{+2} Bi^{+3} Cu^{+2} Cd^{+2} As^{+3} Sb^{+3} Sn^{+2} Sn^{+4}	HgS — Black PbS — Black Bi_2S_3 — Black CuS — Black CdS — Yellow As_2S_3 — Yellow Sb_2S_3 — Orange SnS — Brown SnS_2 — Yellow
3.	NH_4OH in presence of NH_4Cl	Fe^{+3} Cr^{+3} Al^{+3}	$Fe(OH)_3$ — Reddish Brown $Cr(OH)_3$ — Green $Al(OH)_3$ — White
4.	H_2S in presence of NH_4OH	Mn^{+2} Co^{+2} Ni^{+2}	MnS — Buff CoS — Black NiS — Black
5.	$(NH_4)_2CO_3$ in presence of NH_4OH	Ba^{+2} Sr^{+2} Ca^{+2}	$BaCO_3$ — White $SrCO_3$ — White $CaCO_3$ — White
6.	Na_2HPO_4	Mg^{+2}	$Mg(NH_4)PO_4$ — White
Zero	NaOH	NH_4^{+}	NH_3 gas

❑ ❑ ❑