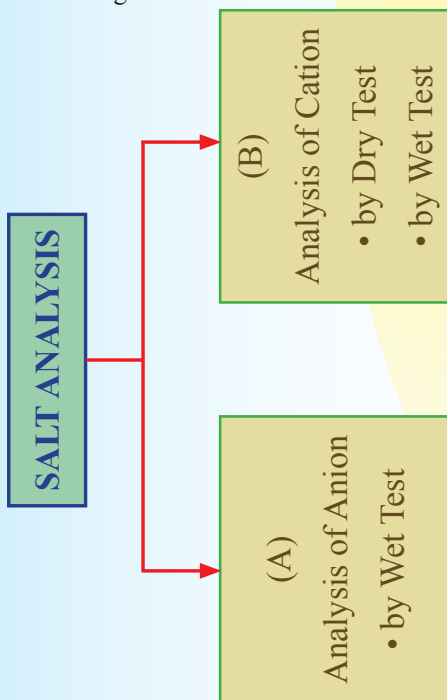


Salt Analysis

DEFINITION

The branch of chemical analysis which aims to find out the constituents of a mixture of compound is known as Qualitative Analysis.

The Identification of a substances usually involves its conversion into a new substance possessing characteristic properties with the help of one or more substance of known composition. The Substance which is used to bring about such change is called a Reagent.



ANALYSIS OF ACIDIC RADICAL

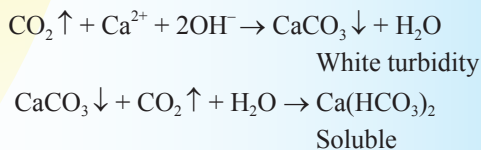
Classification of Acidic Radical

Class - A (Form volatile product with acid)	Class - B (Does not form volatile product with acid)
Sub group-I	Sub group-I
(Form volatile product with dil. HCl/ dil. H ₂ SO ₄) CO ₃ ²⁻ , HCO ₃ ⁻ , SO ₃ ²⁻ , HSO ₃ ⁻ , S ₂ O ₃ ²⁻ , S ²⁻ , CH ₃ COO ⁻ , NO ₂ ²⁻	(Detected by precipitation reaction) SO ₄ ²⁻ , PO ₄ ³⁻ , AsO ₃ ³⁻ , AsO ₄ ³⁻
Sub group-II	Sub group-II
(Form volatile product with conc. H ₂ SO ₄) F ⁻ , Cl ⁻ , Br ⁻ , I ⁻ , NO ₃ ⁻ , BO ₃ ³⁻ , C ₂ O ₄ ²⁻ + sub group-I	(Detected by redox reaction) CrO ₄ ²⁻ , Cr ₂ O ₇ ²⁻ , MnO ₄ ⁻ , MnO ₄ ²⁻

- CO₂ is colourless, odourless gas evolved with brisk effevescence, Detected by lime water test.
- SO₂ is colourless, Suffocating gas with burning sulphur odour. Detected by lime water test or by passing in Cr₂O₇²⁻/H⁺ solution.
- H₂S is a colourless gas having rotten egg odour.
- CH₃COOH has colourless fumes having vinegar odour.
- NO₂/Br₂ is brown gas.
- I₂ is violet gas.

LIME WATER / BARYTA WATER TEST

When CO₂ is passed in lime water or baryta water then white turbidity (milky appearance) is formed due to the formation of soluble carbonate but when excess of CO₂ is passed then white turbidity disappeared due to formation of soluble bicarbonate.



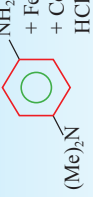
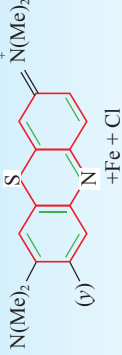
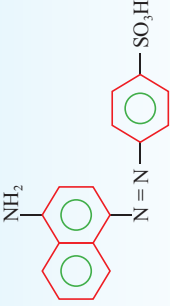
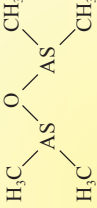
SO₂ also gives similar observation.


ACIDIC RADICAL TABLE

	dil. H_2SO_4	Conc. H_2SO_4	$CaCl_2$	$BaCl_2$	$HgCl_2$	$AgNO_3$	$Pb(OAc)_2$	MnO_4^-/H^+
CO_3^{2-}	$CO_2 \uparrow$	$CO_2 \uparrow$	$CaCO_3 \downarrow$ white	$BaCO_3 \downarrow$ white	$HgCO_3 \cdot 3HgO \downarrow$ Reddish brown	$Ag_2CO_3 \downarrow$	$PbCO_3 \cdot 2Pb(OH)_2 \downarrow$	–
$HCO_3^- + \Delta$	$CO_2 \uparrow$	$CO_2 \uparrow$	$CaCO_3 \downarrow$	$BaCO_3 \downarrow$	$HgCO_3 \cdot 3HgO \downarrow$ Reddish brown	$Ag_2CO_3 \downarrow$	$PbCO_3 \cdot 2Pb(OH)_2 \downarrow$	–
SO_3^{2-}	$SO_2 \uparrow$	$SO_2 \uparrow$	$CaSO_3 \downarrow$ white	$BaSO_3 \downarrow$ white	–	$Ag_2SO_3 \downarrow$ white	$PbSO_3 \downarrow$ white	SO_4^{2-}
$S_2O_3^{2-}$	$SO_2 \uparrow + S \downarrow$	$SO_2 \uparrow$	–	$BaS_2O_3 \downarrow$ white	$HgS_2O_2 \downarrow$ white	$Ag_2S_2O_3 \downarrow$ white	$PbS_2O_3 \downarrow$ white	$SO_4^{2-} + S \downarrow$
S^{2-}	$H_2S \uparrow$	$S \downarrow + SO_2 \uparrow$	–	$BaS \downarrow$ black	$HgS \downarrow$ black	$Ag_2S \downarrow$ black	$PbS \downarrow$ black	$S \downarrow$
NO_2^-	$NO_2 \uparrow$	$NO_2 \uparrow$	–	–	–	$AgNO_2 \downarrow$	–	NO_3^-
CH_3COO^-	$CH_3COOH \uparrow$	$CH_3COOH + SO_2 \uparrow$	–	–	–	–	–	–
I^-		$I_2 \uparrow$ violet	–	–	$HgI_2 \downarrow$ scarlet red	$AgI \downarrow$ yellow	$PbCl_2 \downarrow$ dark yellow	$I_2 \uparrow$

	dil. H_2SO_4	Conc. H_2SO_4	$CaCl_2$	$BaCl_2$	$HgCl_2$	$AgNO_3$	$Pb(OAc)_2$	MnO_4^-/H^+
Cl^-		$HCl \uparrow$	-	-	-	$AgCl \downarrow$ white	$PbCl_2 \downarrow$ white	$Cl_2 \uparrow$
Br^-		$Br_2 \uparrow$ brown	-	-	-	$AgBr \downarrow$ pale yellow	$PbBr_2 \downarrow$ white	$Br_2 \uparrow$
$C_2O_4^{2-}$	-	$CO_2 \uparrow + CO \uparrow$	$CaC_2O_4 \downarrow$ white	$BaC_2O_4 \downarrow$ white	-	$Ag_2C_2O_4 \downarrow$ white	-	$CO_2 \uparrow$
BO_2^-	-	$H_3BO_3 \uparrow$	$Ca(BO_2) \downarrow$ white	$Ba(BO_2) \downarrow$ white	-	$AgBO_2 \downarrow$ white	-	-
NO_3^-	-	$NO_2 \uparrow$	-	-	-	-	-	-
SO_4^{2-}	-	-	$CaSO_4 \downarrow$ white	$BaSO_4 \downarrow$ curdy white ppt	$HgSO_4 \cdot 2HgO \downarrow$ yellow	-	$PbSO_4 \downarrow$ white	-
PO_4^{3-}	-	-	$CaHPO_4 \downarrow$ white	$BaHPO_4 \downarrow$ white	-	$Ag_3PO_4 \downarrow$ yellow	-	-
CrO_4^{2-}	-	-	-	$BaCrO_4 \downarrow$ yellow	-	$Ag_2CrO_4 \downarrow$ brick red	$PbCrO_4 \downarrow$ yellow	-

SPECIFIC REACTION OF ACIDIC RADICAL

Anion	Reaction Nmae /with	Reagent	Product	Observation
S^{2-}	Sodium Nitro Prusside	$Na_2[Fe(CN)_5NO]$	$Na_4[Fe(CN)_5NOS]$	Purple Complex
S^{2-}	Methylene blue Test	 NH_2 + $FeCl_3$ + Conc. HCl $(Me)_2N$	 $N(Me)_2$ (v) + $Fe + Cl$	Methylene Blue
NO_2^-	Gries Illosaway Test	(i) Sulphamic acid (ii) 1, Methyl Amine		Red Azo dye
NO_2^-	Brown Ring Test	$FeSO_4 + \text{dil. } H_2SO_4$	$[Fe(H_2O)_4NO]SO_4$	Brown Ring
CH_3COO^-	Cacodyl Test	As_2O_3		Nauseating odour
CH_3COO^-	$FeCl_3$ Sol ⁿ	$FeCl_3 + H_2O \xrightarrow{\text{boil}}$	$[Fe_3(HO)_2(CH_3OO)_6]^+$	Blood Red solution ↓ Boiling Reddish Brown ppt.

Anion	Reaction Nmae /with	Reagent	Product	Observation
NO_3^-	Brown Ring test	$\text{FeSO}_4 + \text{Conc. H}_2\text{SO}_4$	$[\text{Fe}(\text{H}_2\text{O})_5\text{NO}]\text{SO}_4$	Brown Ring
$\text{C}_2\text{O}_4^{2-}$	$\text{Mn}^{+2} + \text{NaOH}$	$\text{NaOH} + \text{Mn}^{+2} \xrightarrow{\Delta}$	$[\text{Mn}(\text{C}_2\text{O}_4)_3]^{3-}$	Red Complex
Br^-	Layer Test	Cl_2 Water + CCl_4	$\text{Br}_2 + \text{CCl}_4$	Red layer
I^-	Layer Test	Cl_2 Water + CCl_4	$\text{I}_2 + \text{CCl}_4$	Violet Layer
I^-	HgCl_2	HgCl_2	HgI_2	Red/yellow
Cl^-	Chromyl Chloride Test	(i) $\text{K}_2\text{Cr}_2\text{O}_7(\text{s}) + \text{conc. H}_2\text{SO}_4$ (ii) NaOH (iii) $\text{Pb}(\text{CH}_3\text{COO})_2 + \text{CH}_3\text{COOH}$	CrO_2Cl_2 CrO_4^{2-} \downarrow PbCrO_4	Reddish brown Vapour \downarrow Yellow Solution \downarrow Yellow PPT.
BO_3^{3-}	Green Flame Test	$\text{Conc. H}_2\text{SO}_4 + \text{ROH} + \Delta$ (Flame)	$\text{B}(\text{OR})_3$	Green edge flame
BO_3^{3-}	Modified Green Flame Test	$\text{CaF}_2 + \text{Conc. H}_2\text{SO}_4$	$\text{BF}_3 \uparrow + \text{Ca}(\text{HSO}_4)_2 + \Delta$	Green flame
PO_4^{3-}	Ammonium molybdate	$(\text{NH}_4)_2\text{MoO}_4 + \text{dil HNO}_3 + 30 - 40^\circ\text{C}$	$\text{Na}_3\text{MoO}_4 \cdot 12\text{MoO}_3$	Canary yellow ppt.
$\text{CrO}_4^{2-} / \text{Cr}_2\text{O}_7$	Acidic Solution of H_2O_2 + pyridine	$\text{H}_2\text{O}_2 + \text{H}^+$ + 	CrO_5	Blue Solution

BASIC RADICAL ANALYSIS

Dry Text of Cation

Flame test : used for s-block cation (except Be^{+2} , Mg^{+2})

Cation:	Li^+	Na^+	K^+	Ca^{+2}	Sr^{+2}	Ba^{+2}	Cu^{+2}
Observation: (Naked eye)	Caramine red	Golden yellow	Lilac	Brick Red	Crimosn Red	Apple green	Green flame
Cobalt glass:		flame disappear	crimson red	Green	Purple	Bluish green	Green flame

Borax Bead Text

- Used for cloured cation (d-block cation)
- Given salt heated on borax bead than metal metaborate are form.
- Metal metaborate on heating show characteristic bead colour.

	Oxidizing flame		Reducing flame	
	Hot	Cold	Hot	Cold
Mn	Violet	Amethyst	Colourless	Colourless
Cr	Yellow	Yellow	Green	Green
Fe	Yellowish brown	Green	Green	Green
Co	Blue	Blue	Blue	Blue
Ni	Violet	Brown	Grey	Grey
Cu	Green	Blue	Colourless	Opaque red

Charcol Cavity Text

Heat salt with Na_2CO_3 in charcoal cavity

Zn^{+2} In hot yellow and in cold white residue.

Pb^{+2} Yellow residue in hot and grey metal in cold.

As^{+3} White residue with garlic odour.

Cd^{+2} Brown residue.

If white residue is obtain then add. $\text{Co}(\text{No}_3)_2$ and heat.

Zn^{+2}	$\text{ZnO} \cdot \text{CoO}$	Rinmann's Green
Al^{+3}	Al_2O_3	Thenard Blue
Mg^{+2}	$\text{MgO} \cdot \text{CoO}$	Pink residue
Sn^{+2}	$\text{SnO} \cdot \text{CoO}$	Bluish residue

CLASSIFICATION OF BASIC RADICAL

Group	Basic Radical	Reagent used	Precipitate form
Group-I	$\text{Pb}^{+2}, \text{Hg}_2^{+2}$	dil HCl	$\text{AgCl}, \text{PbCl}_2, \text{Hg}_2\text{Cl}_2$ white ppt.
Group-II	$\text{Cu}^{+2}, \text{Pb}^{+2}, \text{Hg}^{+2}, \text{Cd}^{+2}, \text{Bi}^{+3}$	$\text{H}_2\text{S} + \text{dil. HCl}$	$\text{Cu}_2\text{S}, \text{PbS}, \text{HgS}, \text{CdS}, \text{Bi}_2\text{S}_3$ Black yellow black
	$\text{Sn}^{+2}, \text{Sn}^{+4}, \text{As}^{+3}, \text{As}^{+5}, \text{Sb}^{+3}, \text{Sb}^{+5}$		$\text{SnS}, \text{SnS}_2, \text{As}_2\text{S}_3, \text{As}_2\text{S}_5, \text{Sb}_2\text{S}_3, \text{Sb}_2\text{S}_5$ Brown Brown yellow Gray
Group-III	$\text{Cr}^{+3}, \text{Al}^{+3}, \text{Fe}^{+3}$	$\text{NH}_4\text{OH} + \text{NH}_4\text{Cl}$	$\text{Al}(\text{OH})_3$ gelatinous white $\text{Fe}(\text{OH})_3$ reddish brown $\text{Cr}(\text{OH})_3$ green
Group-IV	$\text{Zn}^{+2}, \text{Mn}^{+2}, \text{Ni}^{+2}, \text{Co}^{+2}$	$\text{H}_2\text{S} + \text{NH}_4\text{OH}$	ZnS white MnS buff NiS, CoS black
Group-V	$\text{Ca}^{+2}, \text{Sr}^{+2}, \text{Ba}^{+2}$	$(\text{NH}_4)_2\text{CO}_3 + \text{NH}_4\text{OH}$	$\text{CaCO}_3, \text{SrCO}_3, \text{BaCO}_3$ white

TEST OF BASIC RADICAL

	Ag ⁺	Hg ₂ ²⁺	Pb ²⁺	Cu ²⁺	Hg ²⁺	Cd ²⁺	Al ³⁺
KI	AgI Yellow	Hg ₂ I ₂ Green	PbI ₂ Yellow	CuI + I ₂ ⁻ White solution	HgI ₂ Scarlet Red	—	—
ex KI	—	Hg + [HgI ₄] ²⁻ Black	[PbI ₄] ²⁻ soluble complex	—	[HgI ₄] ²⁻ Red solution	—	—
KCN	AgCN White	Hg + Hg(CN) ₂	Pb(CN) ₂ white	CuCN + [CN] ₂ ↑	—	Cd(CN) ₂ White	—
ex KCN	[Ag(CN) ₂] ⁻	—	—	K ₃ [Cu(CN) ₄] soluble complex	—	[Cd(CN) ₄] ²⁻	—
NaOH	Ag ₂ O Brown	Hg ₂ O Black	Pb(OH) ₂ White	Cu(OH) ₂ Pale Blue	HgO yellow	Cd(OH) ₂ White	Al(OH) ₃ Gelatinous white
ex NaOH	—	—	Na ₂ [Pb(OH) ₄] soluble complex	—	—	—	Na[Al(OH) ₄] soluble complex

	Ag ⁺	Hg ₂ ²⁺	Pb ²⁺	Cu ²⁺	Hg ²⁺	Cd ²⁺	Al ³⁺
NH ₄ OH	Ag ₂ O Brown	Hg + HgO, HgNH ₂ ⁺ NO ₃	Pb(OH) ₂ White	Cu(OH) ₂ Pale Blue	HgO, HgNH ₂ Cl White	Cd(OH) ₂ White	Al(OH) ₃ Gelatinous white
ex NH ₄ OH	[Ag(NH ₃) ₂] ⁺	—	—	[Cu(NH ₃) ₄] ²⁺ Deep blue	—	[Cd(NH ₃) ₄] ²⁺	—
H ₂ S/(NH ₄) ₂ S	Ag ₂ S Black	$\underbrace{\text{Hg} + \text{HgS}}_{\text{black}}$	PbS Black	CuS Black	HgS Black	CdS Yellow	Al(OH) ₃ Gelatinous white
K ₂ CrO ₄	Ag ₂ CrO ₄ Red	Hg ₂ CrO ₄ Red	PbCrO ₄ Yellow	—	—	—	—
NH ₄ S ₂ O ₈	Ag ₂ S ₂ O ₈ White	—	PbS ₂ O ₃ White	Cu ₂ S ₂ O ₃ White	HgS ₂ O ₃ White	—	—
K ₄ [Fe(CN) ₆]	Ag ₄ [Fe(CN) ₆] White	—	—	Cu ₂ [Fe(CN) ₆] Brown	—	—	—
K ₃ [Fe(CN) ₆]	—	—	—	Cu ₃ [Fe(CN) ₆] Green	—	—	—

TEST OF BASIC RADICAL

	Cr^{+3}	Fe^{+3}	Fe^{+2}	Zn^{+2}	Mn^{+2}	Ni^{+2}	Co^{+2}
KI	—	$\text{FeI}_2 + \text{I}_2$ yellowish brown sol.	—	—	—	—	—
ex KI	—	—	—	$\text{Zn}(\text{CN})_2$ White	—	—	—
KCN	—	$\text{Fe}(\text{CN})_3$ Brown	$\text{Fe}(\text{CN})_2$ yellowish brown	—	$\text{Mn}(\text{CN})_2, \text{Mn}(\text{OH})_2$ Pink	$\text{Ni}(\text{CN})_2$ green	$\text{Co}(\text{CN})_2$ Reddish Brown
ex KCN	—	$\text{K}_4[\text{Fe}(\text{CN})_6]$ Yellow	$\text{K}_4[\text{Fe}(\text{CN})_6]$ Pale yellow	—	—	$\text{K}_2[\text{Ni}(\text{CN})_4]$ Soluble Complex	$[\text{Co}(\text{CN})_6]^{4-}$ Brown Solution
NaOH	$\text{Cr}(\text{OH})_3$ Green	$\text{Fe}(\text{OH})_3$ Reddish Brown ppt	$\text{Fe}(\text{OH})_2$ Dirty Green	$\text{Zn}(\text{OH})_2$ White	$\text{Mn}(\text{OH})_2$ Pink	$\text{Ni}(\text{OH})_2$ Green	$\text{Co}(\text{OH})\text{Cl}$ Blue
ex NaOH	$\text{Na}[(\text{AlOH})_4]$ Yellow	—	—	$\text{Na}_2[\text{Zn}(\text{OH})_4]$	—	—	$(\text{CoOH})_2$ pink
NH_4OH	$\text{Cr}(\text{OH})_3$ Green	$\text{Fe}(\text{OH})_3$ Reddish Brown ppt	$\text{Fe}(\text{OH})_2$ Dirty Green	$\text{Zn}(\text{OH})_2$	—	$\text{Ni}(\text{OH})_2$ Green	$\text{Co}(\text{OH})\text{Cl}$

	Cr^{+3}	Fe^{+3}	Fe^{+2}	Zn^{+2}	Mn^{+2}	Ni^{+2}	Co^{+2}
ex NH_4OH	$[\text{Cr}(\text{NH}_3)_6]^{3+}$ Pink/violet	—	—	$[\text{Zn}(\text{NH}_3)_4]^{2+}$	—	$\text{Ni}[(\text{NH}_3)_6]^{2+}$ Deep blue	$[\text{Co}(\text{NH}_3)_6]^{2+}$ Yellow
$\text{H}_2\text{S}/^*(\text{NH}_4)_2\text{S}$	$\text{Cr}(\text{OH})_3$ Green	$\text{FeS} + \text{S}$ Black yellow	FeS Black	ZnS White	MnS Pink	NiS Black	CoS Black
K_2CrO_4	—	—	—	—	—	—	—
$\text{Na}_2\text{S}_2\text{O}_3$	—	Fe^{+2} Green solution	—	—	—	—	—
$\text{K}_4[\text{Fe}(\text{CN})_6]$	—	$\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$ Prussian blue	$\text{K}_3\text{Fe}[\text{Fe}(\text{CN})_6]$	$\text{K}_2\text{Zn}_3[\text{Fe}(\text{CN})_6]$ White	$\text{Mn}_2[\text{Fe}(\text{CN})_6]$ White	$\text{Ni}_2[\text{Fe}(\text{CN})_6]$ Light green	$\text{Co}_3[\text{Fe}(\text{CN})_6]$ Green
$\text{K}_3[\text{Fe}(\text{CN})_6]$	—	$\text{Fe}[\text{Fe}(\text{CN})_6]$ Brown	$\text{Fe}_3[\text{Fe}(\text{CN})_6]_2$ Turnbull's blue	—	—	—	—

OTHER IMPORTANT REACTION OF BASIC RADICAL

Basic radical	Reagent	Product	Observation
Fe^{+3}	SCN^-	$\text{Fe}(\text{SCN})_3$	Blood red colouration
Ni^{+2}	$\text{dmg} / \text{NH}_4^+$	$[\text{Ni}(\text{dmg})_2]$	Rosy red complex
Co^{+2}	KNO_2	$\text{K}_3[\text{Co}(\text{NO}_2)_6]$	Yellow ppt
Hg^{+2}	$\text{SnCl}_2(\text{ex})$	Hg	Grey / black
K^+	HClO_4	KClO_4	White ppt

