Nomenclature of Coordination Compounds

According to IUPAC (International Union of Pure and Applied chemistry) the coordination compounds are named according to the following rules:

(i) **Order of naming ions**: In ionic complexes, the cation is named first and then the anion (as in NaCl : Sodium chloride) Non-ionic complexes are given a one word name without any separation.

(ii) **Naming the coordination sphere**: In naming the coordination sphere, the ligands are named first and then the central metal ion. e.g. in the complex $[Co(NH_3)_3Cl_3]$, the ligands NH_3 and Cl^- will be named first and then the central metal ion, cobalt.

iii) **Names of ligands**: The names of negative ligands end in '-o' and of positive ligands (which are rare) end in '-ium' Neutral ligands are named as such like molecules. This rule is illustrated below:

(a) Negative ligands end in -o:

F^- → fluoro	CH_3COO^- → acetato	SO_4^{2-} - sulphato
Cl^- → chloro	SCN^- → thiocyanato	COO^- | COO^- - Oxalato
Br^- → bromo	NO_3^- → nitrato	
OH^- → hydroxo	NO_2^- → nitro	O^{2-} - oxo
CN^- → cyano	ONO^- → nitrito	O_2^{2-} - peroxo
CO_3^{2-} → carbanato	H^- → hydrido	N_3^- - azido
S^{2-} → thio	NH^{2-} → imido	
	NH_2^- → amido	

(b) Positive ligands end in '-ium'.

NO^+ nitrosonium NO_2^+ nitronium $NH_2NH_3^+$ hydrazinium

(c) Neutral ligands are named as such

$NH_2CH_2CH_2NH_2$ ethylenediamine

C_6H_5N pyridine

$(C_6H_5)_3$ triphenylphosphine

However, there are a few exceptions in naming neutral ligands. e.g.

H_2O → aquo NH_3 → ammine NO → nitrosyl CO → carbonyl

(iv) Order of naming ligands : The ligands should be named in alphabetical order irrespective of their being negative, neutral or positive. e.g. in the complex,

$[Co(NH_3)_4Cl(NO_2)]^+$, the ligands are named as ammine, chloro and nitro

(v) Numerical prefixes to indicate no. of ligands : When more than one ligands of particular kind are present in the complex the prefixes di, tri, tetra etc. are used to indicate their number two, three, four respectively. When the name of ligand, includes the numerical prefix (di, tri, tetra) then the prefixes, bis, tris, tetrakis are used for 2, 3, 4 ligands respectively. Such ligands are called complex ligands.

e.g. $[Co(en)_2Br_2]Cl$ Dibromobis(ethylenediamine) cobalt (III) Chloride

$[VO(acac)_2]$ Bis(acetylacetonato) oxovanadium (IV)

(vi) Ending of names : When the complex is anionic, the name of the central metal atom ends in -ate. For cationic and neutral complexes, the name of the metal is written without any characteristic ending.

e.g. Cationic complex $[Co(NH_3)_6]Cl_3$ Hexaamminecobalt (III) chloride

and anionic complex $K[Pt(NH_3)Cl_5]$ Potassium amminepentachloro platinate (IV)

It may be noted that for anion complexes the Latin names of certain metals are commonly used. e.g.

ferrate for Fe, cuperate for Cu, Argentate for Ag, aurate for Au etc.

(vii) Oxidation state of central metal ion : The oxidation state of central metal ion is designated by a Roman numeral (such as II, III, IV) in the brackets at the end of the name of the complex without a gap between the two.

e.g. $[Co(NH_3)_5Cl]Cl_2$

In this case, the ligands are chloro and ammine. The complex is cation and chloride is anion. The oxidation state of cobalt is III as

$$x + 5(0) - 1 - 2 = 0 \quad \text{or } x = +3$$

Its name is pentaamminechlorocobalt(III) chloride.

Similarly $K_4[Ni(CN)_4]$ Potassium tetracyanonickelate(0).

$Na[Co(CO)_4]$ Sodium tetracarbonylcobaltate(-I)

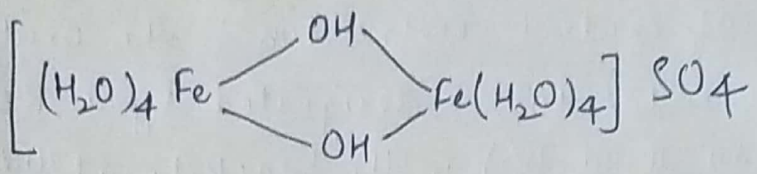
⇒ It may be noted that for zero oxidation state, the letter '0' is mentioned and for a negative oxidation state, the 'minus' sign is used before the roman numeral as in above examples.

(viii) Bridging group in bidentate ligands: For ligands which act as bridge between two metal atoms, the Greek letter 'μ' is written before the name of the ligand. The prefix 'μ' is repeated before the name of each kind of bridging ligand. Greek letter 'μ' is separate from the name by hyphens.

⇒ Two or more bridging groups of same kind are indicated by di-μ or bis-μ etc.

⇒ In a compound where the same ligand is present as a bridging ligand and as a non-bridging ligand, then the bridging ligand is written first.

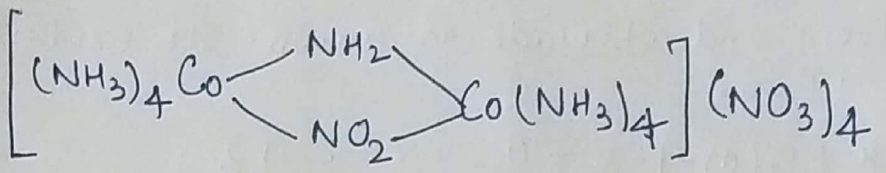
$[(NH_3)_5Cr - OH - Cr(NH_3)_5]Cl_5$ μ-hydroxobis[pentaammine chromium(III)]chloride



Tetraaquoiron(III) -μ- dihydroxo tetraaquoiron(III) sulphate

Or

Octaaquo-μ-dihydroxo diiron(III) sulphate



Tetraammine cobalt(III) -μ-amido-μ-nitrotetraammine cobalt(III) nitrate

OR

Octaammine-μ-amido-μ-nitrodicobalt(III) nitrate.

(IX) Point of attachment: When a ligand can coordinate through more than one atom, then the point of attachment of the ligand is indicated by putting the symbol (in italics) of the atom through which coordination occurs after the name of the ligand. e.g. nitro group can coordinate either through N (written as NO_2^-) or through O written as (ONO^-). In some cases, special names are given for alternative modes of linkages.

e.g. (i) $-NO_2^-$ (Through N) $M-NO_2$ nitro &

$-ONO^-$ (Through O) $M-ONO$ nitrito

(ii) Thiocyanate ion can coordinate through S or N.

$-SCN^-$ (Through S) $M-SCN$ thiocyanato-S or thiocyanato

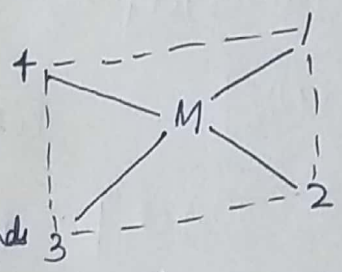
$-NCS$ (Through N) isothiocyanato or thiocyanato-N.

$K_3[Co(NO_2)_6]$ Potassium hexanitrocobaltate(III).

$[Co(NH_3)_5ONO]SO_4$ ~~Potassium~~ Pentaamminenitritocobalt(III) sulphate

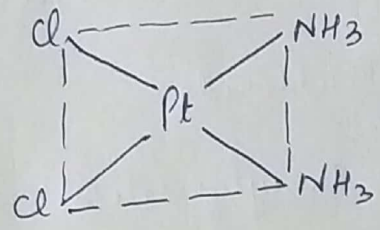
(X) Naming of geometrical isomers: Geometrical isomers are named by the use of the terms 'cis' to designate adjacent positions and 'trans' to designate opposite positions.

e.g. In square planar complexes,

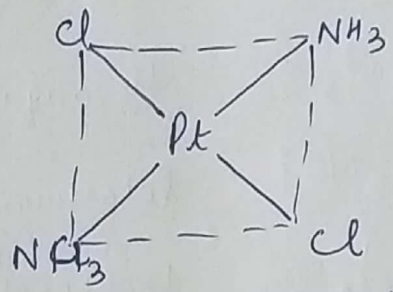


the positions 1,4; 1,2; 2,3 & 3,4 are cis while 1,3 & 2,4 are trans w.r.t each other. In naming these compounds cis or trans is written before the names of the compounds.

eg.



cis-diammine dichloroplatinum (II)



trans-diammine dichloroplatinum (II)

(XI) Naming of Optical isomers: Optically active compounds are designated by the symbols (+) or d for dextro rotatory and (-) or l for levo rotatory. e.g.

d-$K_3[Ir(C_2O_4)_3]$ Potassium (+) trioxalato iridate (III)

(XII) Abbreviations for complicated molecules: For complicated names of ligands, abbreviations are generally used. For example some common abbreviations are given below

Ethylenediamine	'en'
Pyridine	'py'
2,2-bipyridine	'bipy'
acetylacetonate	'acac'
oxalate	'ox'
diethylenetetraamine	'dien'
ethylenediaminetetraacetate	EDTA

Examples:

$K[Ag(CN)_2]$ Potassium dicyanoargentate (I)

$[Pt(NH_3)_4(NO_2)Cl]SO_4$ Tetraamminechloronitroplatinum (IV) sulphate

$K_4[Cu(CN)_6]$ Potassium hexacyanocuprate (II).

$[Co(NH_3)_3(NO_2)Cl_2]$ Triammine dichloronitrocobalt (III).

$[(C_6H_5)_3P_3Rh]Cl$ Tris (triphenyl phosphine) rhodium (I) chloride

$[Cr(H_2O)_6]Cl_3$ Hexaaquochromium (III) chloride

$K_2[Fe(CN)_5NO]$ Potassium pentacyanonitrosylferrate (III)

$[Co(en)_2Cl_2]_2SO_4$ Dichlorobis (ethylenediamine) cobalt (III) sulphate

$[Cr(NH_3)_6]^{3+}$ Hexaamminechromium (III) ion

$Mn_3(CO)_{12}$ Dodecacarbonyltrimanganese (0)

$Na[Au(CN)_2]$ Sodium dicyanoaurate (I)

$[Pt(NH_3)_6]Cl_4$ Hexaammineplatinum (IV) chloride.

$[Cr(PPh_3)(CO)_5]$ Pentacarbonyltriphenylphosphinechromium (0).

$[Pt(NH_3)_4][PtCl_4]$ Tetraammine platinum (II) tetrachloroplatinate (II)