Chapter-25

Coordination Chemistry (IUPAC Nomenclature)

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The first comprehensive system of nomenclature was suggested by the Alfred Werner. Later on (2005) this was modified by the International Union of Pure and Applied Chemistry (IUPAC).

In order to name coordination compounds certain rules have been framed by IUPAC.
(i) The **positive part** of a coordination compound is **named first** and is **followed** by the name of **negative part.**

(ii) The **ligands are named first followed by the central metal**. The **prefixes di-, tri-, tetra-** etc, are **used** to indicate the number of each kind of **monodentate ligand present**. The **prefixes bis (two ligands), tris (three ligands)**, etc. are **used** when the ligands are **polydentate (bidentate, tridentate etc.)** e.g. dipyridyl, diethylene diamine.

(iii) The **ligands are named in alphabetical order**. Names of the **anionic ligands end in 'O'**, **those of cationic in 'ium'**. **Neutral ligands** have their **regular names except** that **H_2O is named as aqua, NH_3 as ammine, NH_2 as amido, NO as nitrosyl and CO as carboxyl (Table 1 & 2).**

Table 1: IUPAC naming of *Neutral Ligands*

Ligand	IUPAC Name
H_2O	aqua
NH_2	amido
NH_3	ammine
C_6H_6	benzene
CO	carbonyl
NO	nitrosyl
C_5H_5N	Pyridine
$(C_5H_4N)_2$	2,2 ′-bipyridine
$H_2NCH_2CH_2NH_2$	ethylenediamine

Table 2: IUPAC naming of *Anionic Ligands*

Ligand	IUPAC Name
F^-	fluoro
Cl^-	chloro
Br^-	bromo
I^-	iodo
CO_3^{2-}	carbonato
CN^-	cyano
H^-	hydrido
O^{2-}	oxo
O_2^{2-}	peroxo
OH^-	hydroxo
O_2H^-	perhydroxo
NO_2^-	nitro
ONO^-	nitrito
NO_3^-	nitrato
$C_2O_4^{2-}$	oxalato (*ox*)
SO_4^{2-}	sulphato
SO_3^{2-}	sulphito
S^{2-}	sulphido or thio
SCN^-	thiocyanato
N_3^-	azido
$S_2O_3^{2-}$	thiosulfato
$NHOH^-$	hydroxylamido
$(CH_2COO)_2N(CH_2)_2N(CH_2COO)_2^{4-}$	ethylenediaminetetraacetato (EDTA)

(iv) When a **complex species has negative charge (anionic complexes)**, the name of the **central metal ends in 'ate'.** For some elements, the ion name is based on the Latin name of the metal (eg argentate for silver) **(Table-3)**. In case of **cationic and neutral complexes** simply **write the metal name without addition of suffix 'ate'.**

Table 3: IUPAC naming of *Metal atom in* anionic complexes

Fe	**Ferrate**	***Cu***	**Cuprate**	**Ni**	**Nicklate**	**Pt**	**Platinate**
Ag	**Argentate**	***Au***	**Aurate**	**Co**	**Cobaltate**	**Cr**	**Chromate**
Sn	**Stannate**	***Pb***	**Plumbate**	**Zn**	**Zincate**	**Ga**	**Gallate**

(v) The **oxidation number (state) of the central metal** is indicated in **roman numbers** in **parentheses after name of the metal.**

(vi) **In polynuclear complexes**, the **bridging group is indicated** in the formula of the complex **by separating it from the rest of the complex by hyphens** and **by adding the prefix *μ*** before its name. The Greek letter ***μ* should be repeated before the name of each different bridging group. Two or more bridging groups** of the same kind are **indicated by di-*μ*-, tri-*μ*-,….** etc.

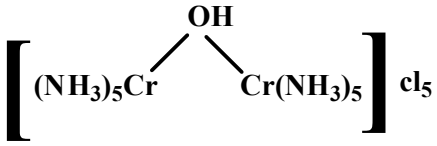
Examples based on above rules are given below:-

Complex Cations		**IUPAC Name**
i) $[Co(H_2O)_6]^{2+}$	→	Hexaaqua cobalt (II) ion
ii) $[Pt(NH_3)_2Cl_2]Cl_2$	→	Diamminedichloro platinum (IV) chloride.
iii) $[Ni(en)_3]^{+3}$	→	Tris (ethylenediammine) nickel (III) ion.
iv) $[Co(NH_3)_5Cl]^{+2}$	→	Pentaammine chloro cobalt (III) ion.
v) $[Co(NH_3)_6]Cl_3$	→	Hexaammine cobalt (III) chloride.
vi) $[Cr(NH_3)_4SO_4]ClO_4$	→	Tetra ammine sulphato chromium (III) per chlorate.

Complex Anions		
i) $K_4[Fe(CN)_6]$	→	Potassium hexacyano ferrate (II).
ii) $K_3[Fe(CN)_6]$	→	Potassium hexacyano ferrate (III).
iii) $[Au(CN)_4]^{2-}$	→	Tetracyano aurate (II) ion.
iv) $K[AgCl_2]$	→	Potassium dichloro argentite (I)
v) $[CrF_6]^{3-}$	→	Hexafluoro chromate (III)
vi) $Na[Al(OH)_4]$	→	Sodium tetra hydroxo aluminate (III)
vii) $[Pt(NH_3)_4Cl_2][PtCl_4]$	→	Tetraammine dichloro platinum (IV) tetra chloro palatinate (II)
viii) *cis*-$[PtBrCl(NO_2)_2]^{2-}$	→	*cis*-bromochlorodinitroplatinate (II) ion
ix) *trans*-$[Co(OH)Cl(en)_2]^{+}$	→	*trans*-chlorobis(ethylenediamine)hydroxo cobalt (III) ion

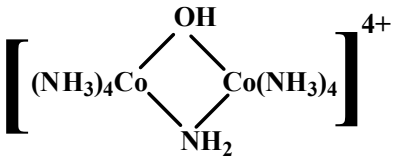
Neutral Complexes		
i) $[Co(NH_3)_3Cl_3]$	→	Triammine trichloro cobalt (III)
ii) $[Pt(NH_3)_2Cl_2]$	→	Diammine dichloro platinum (II)
iii) $[Ni(CO)_4]$	→	Tetra carbonyl nickel (0)

Bridged polynuclear complexes



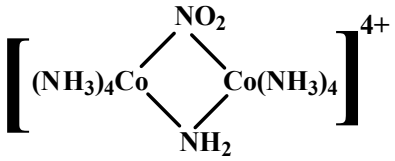
(i)

- μ-hydroxo-bis{pentaammine chromium (III)}chloride.



(ii)

- μ-amino-μ-hydroxo octaammine dicobalt (III) ion.



(iii)

- μ-amino-μ-nitro octaammine dicobalt (III) ion.

Related Questions

Q. 1. Name the following

a. $K_4[Ni(CN)_4]$
b. $(NH_4)_3[Fe(SCN)_6]$
c. $Na_2[Ni(CN)_4]$
d. $[Fe(ox)_3]^{3-}$
e. $[Co(NH_3)_5Cl]Br_2$
f. $[Cr(OH_2)_4Cl_2]Cl$
g. $[Pt(NH_3)_2]Cl_2$
h. $Na_2[MoOCl_4]$
i. $[Cr(OH_2)_6](NO_3)_3$
j. $[Fe(NH_3)_6]SO_4$
k. $(NH_4)_2[CoCl_4]$
l. $Cr(NH_3)_4Cl_2$
m. $[Co(P(CH_3)_3)_4]_2(SO_4)_3$
n. $[Ni(OH_2)_6]Cl_2$

Q.2. Write formulas for the following

a. ***potassium hexacyanoferrate(III)***
b. ***sodium hexafluoroaluminate(III)***
c. ***pentaaquabromomanganese(III) sulfate***
d. ***hexaamminechromium(III) nitrate***
e. ***sodium tetrahydroxochromate(III)***
f. ***hexaammineruthenium(III) tetrachloronickelate(II)***
g. ***tetraamminecopper(II) pentacyanohydroxoferrate(III)***
h. ***potassium diaquatetrabromovanadate(III)***

Reference Books:

1. Introduction to Coordination Chemistry, Geoffrey A. Lawrance

2. Coordination chemistry, Joan Ribas Gispert

3. Coordination Chemistry, 20: Invited Lectures Presented at the 20th International Conference on Coordination Chemistry, Calcutta, India, 10-14 December 1979, D. Banerjea

4. Comprehensive Coordination Chemistry III, Gerard Parkin, Edwin C Constable, Lawrence Que

5.https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Supplemental_Modules_and_Websites_(Inorganic_Chemistry)/Coordination_Chemistry/Complex_Ion_Equilibria/Stability_of_Metal_Complexes_and_Chelation

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