E-Content Study Material

B. Sc. Chemistry (H)

2nd Year

Paper II B

Inorganic Chemistry

Chapter IV: Coordination Compounds

Topic: Effective Atomic Number (EAN)

Prepared By

Dr. Satyendra Gupta

Assistant Professor (Guest Faculty)

Department of Chemistry

Patna Science College, Patna

Email: satyendgupta@gmail.com

Mob. No. 9794346892

Effective Atomic Number (EAN)

It was proposed by Sidwick. In the formation of a complex, each ligand is considered to be donating one electron pair to the central metal atom/ion. The total number of electrons which the central metal atom/ion appears to possess in the complex including those gained by it in bonding, is called the effective atomic number (EAN) of the central metal atom/ion.

It was found that in many cases ligands are added until the central metal atom/ion gets the same number of electrons as are present in the next noble gas. Accordingly, the effective atomic number in a complex should be equal to 36 (electrons in krypton), 54 (electrons in xenon) or 86 (electrons ion radon) then it is said that EAN rule is obeyed and the compound is found to be stable. In this concept metal atom/ion is consider to be Lewis acid and ligand is considered to be Lewis base.

For example, consider the complex ion, $[Co(NH_3)_6]^{3+}$. The atomic number of cobalt is 27. The number of electrons in Co3+ ion is 24. Each of the six ammonia molecules donates a pair of electrons so that EAN becomes 24 + 2*6 = 24 + 12 = 36. This is the same as the atomic number of krypton. Some other examples of complexes obeying the above rule are listed in Table 1.

Table 1. Complexes obeying effective atomic number rule.

Complex molecule/ ion	Central metal atom/ion	Atomic number of central metal atom/ion	Number of electrons in metal atom/ion	Electrons gained from ligands	EAN
$[Pt(NH_3)_6]^{4+}$	Pt^{4+}	78	74	12	86
$[Pt(NH_3)_5Cl]^{3+}$	Pt^{4+}	78	74	12	86
$[Pt(NH_3)_3Cl_3]^{+}$	Pt^{4+}	78	74	12	86
$[PtCl_6]^{2-}$	Pt^{4+}	78	74	12	86
$[Fe(CN)_6]^{4-}$	Fe^{2+}	26	24	12	36
$[Co(NH_3)_6]^{3+}$	Co^{3+}	27	24	12	36
$[Ni(CO)_4]$	Ni	28	28	8	36
$[Cu(CN)_4]^{3-}$	Cu^{+}	29	28	8	36

However, many stable complexes are known in which the EAN is a few units above or below the number of electrons in the next noble gas. This is shown in Table 2.

Table 2. Complexes not obeying effective atomic number rule.

Complex molecule/ ion	Central metal atom/ ion	Atomic number of central metal atom/ion	Number of electrons in metal atom/ion	Electrons gained from ligands	EAN
$[Pt(NH_3)_4]^{2+}$	Pt^{2+}	78	76	8	84
$[Ni(NH_3)_6]^{2+}$	Ni^{2+}	28	26	12	38
$[Fe(CN)_6]^{3-}$	Fe^{3+}	26	23	12	35
$[Cr(NH_3)_6]^{3+}$	Cr^{3+}	24	21	12	33

Q. Calculate effective atomic number (EAN) of central metal atom/ion in the following complex molecule/ion.

(I) $K_4[Fe(CN)_6]$
(II) $[CoCl_2(en)_2]SO_4$
(III) $[Cu(NH_3)_4]^{2+}$
(IV) $[CoCl(ONO)(en)_2]^{+}$