

10/10/2020

Unit - III

Magnetic Properties of Transition Metal Complexes

It is essential to know the following -

1) Magnetic Induction - When any magnetic substance is placed in magnetic field, the magnetism is produced in that substance. This phenomenon is called magnetic induction. The number of magnetic lines of force perpendicular to magnetic field passing through per unit area of magnetic substance is called magnetic flux density (B).

2) Magnetic permeability ( $\mu$ ) - On placing a substance in a magnetic field, number of lines of force passing through it may increase or decrease as compared to magnetic field. The characteristic of substance is called permeability.

It is the ratio of magnetic flux density (B) and external magnetic field strength (H) at any point in the substance.

$$\mu = \frac{B}{H}$$

Permeability of vacuum or air  $\mu_0 = 4\pi \times 10^{-7} \text{ N/amp}^2$

3) Intensity of Magnetization - The extent to which a magnetic substance gets magnetised in magnetic field is determined by magnetisation intensity. It is the magnetic moment per unit area.

$$I = \frac{M}{V}$$

I = Intensity of magnetisation, M = Magnetic Moment  
V = Volume

Magnetic moment is determined by the multiplication of distance between poles and pole strength.

4) Magnetic Susceptibility - The ratio of intensity of magnetisation (I) and magnetic field strength (H)

$$K = \frac{I}{H}$$

where  $K$  is magnetic susceptibility (Per unit volume)

If density of the substance is  $d$  gram, then

$$\%g = \frac{K}{d}$$

In the same way molar magnetic susceptibility,

$$\% = \%g \times M = \frac{KM}{d}$$

### Types of Magnetic Behaviour -

On placing the substances in external magnetic field, different behaviours shown by them are called magnetic behaviours. First of all, Faraday in 1846 studied various characteristics produced by these.

#### ① Diamagnetic substance (Diamagnetism) -

On placing the substance in a magnetic field, the magnetic field strength inside the substance gets decreased compared to the applied magnetic field strength. These substances gets repelled when brought near the pole of strong magnet.

For example - Bi, Zn, Cu, Ag, Au, C, Salt, water,  $N_2$ ,  $H_2$  etc. are diamagnetic substance.

#### ② Paramagnetic Substance (Paramagnetism) -

When any substance is placed in magnetic field the field strength of magnet inside the substance may be more than field strength of applied magnetic field. Paramagnetic substances attract magnetic lines of force towards them. If these substances are free to move in magnetic field they move from weak to strong field.

For example - Al, Na, Pt, Mn,  $CuCl_2$ ,  $O_2$  etc.

#### ③ Ferromagnetic Substance (Ferromagnetism) -

Some substances on placing in magnetic

field get strongly magnetised in the direction of field. These substances on bringing near the ends of the magnet get attracted by the ends rapidly.

For example - Fe, Ni, Co, Magnetite ( $Fe_3O_4$ ) etc.

This is similar to paramagnetic substances.

(4) Antiferromagnetic substance (Antiferromagnetism) -

Some magnetic substances though act as ferromagnetic or paramagnetic substance yet magnetic moment produced by interaction of paramagnetic ions or atoms of those substances which are very close to each other get aligned in opposite direction in each other Fig -

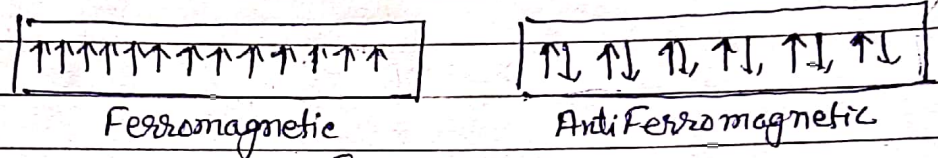


Fig -

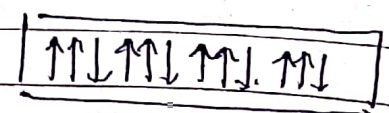
The magnetic moment is lower than free paramagnetic ions or atoms.

For example - Simple salts of  $Fe^{3+}$ ,  $Mn^{2+}$  and  $Gd^{3+}$

Ferromagnetism and Antiferromagnetism both depend on configuration of ions. Hence these properties are not found in the solution of these substance.

(5) Ferrimagnetic Substances (Ferrimagnetism) -

Substance whose properties are found between ferromagnetic and antiferromagnetic substances, in these substances magnetic moments produced by interaction of very close paramagnetic atoms or ions do not align in one direction but align in opposite directions similar to antiferromagnetic substances, then magnetic moment are less in these substances Fig -



Ferrimagnetic Fig -

These substances Fig -