MAGNETIC PROPERTIES

Introduction

- Magnetism arises from the Magnetic Moment or Magnetic dipole of Magnetic Materials.
- When the electrons revolves around the nucleus Orbital magnetic moment arises, similarly when the electron spins, spin Magnetic moment arises.
- The permanent Magnetic Moments can arise due to the

  1.The orbital magnetic moment of the electrons

  2.The spin magnetic moment of the electrons

Magnetic Induction or Magnetic flux Density

The Magnetic induction in any material is the number of lines of magnetic force passing through unit area perpendicularly. Units: wb/m^2 or Tesla.

Magnetic field intensity (H)

The Magnetic field intensity at any point in the magnetic field is the force experienced by an unit north pole placed at that point.

Units : A/m

Permeability: (μ)

The Magnetic induction B is proportional to the applied Magnetic field intensity H.

$$B \alpha H$$

$$B = \mu H$$

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

Where μ permeability of a medium

Relative permeability μ_r

The ratio of permeability of medium to the permeability of free space is called relative permeability μ_r of the solid.

$$\mu_r = \frac{\mu}{\mu_0}$$

$$\mu_r = \frac{\frac{B}{H}}{\frac{B_0}{H}} = \frac{B}{B_0}$$

Magnetization

- Magnetization refers to the process of converting a non-magnetic material into a Magnetic material.
- The intensity of Magnetization is directly related to the applied field H.

$$M \alpha H$$

$$M = \chi_m H$$

magnetic susceptibility $\chi_m = \frac{M}{H}$

$$B \alpha H$$

$$B = \mu H$$

$$B = \mu_0 \mu_r H$$

$$B = \mu_0 \mu_r H + \mu_0 H - \mu_0 H$$

$$B = \mu_0 H + \mu_0 H(\mu_r - 1)$$

$$B = \mu_0 H + \mu_0 M$$

Where M is the magnetization

$$B = \mu_0 (H + M)$$

$$\mu_0 = \frac{B}{(H + M)}$$

$$\text{relative permeability } \mu_r = \frac{\mu}{\mu_0} \rightarrow \frac{B/H}{B/(H + M)}$$

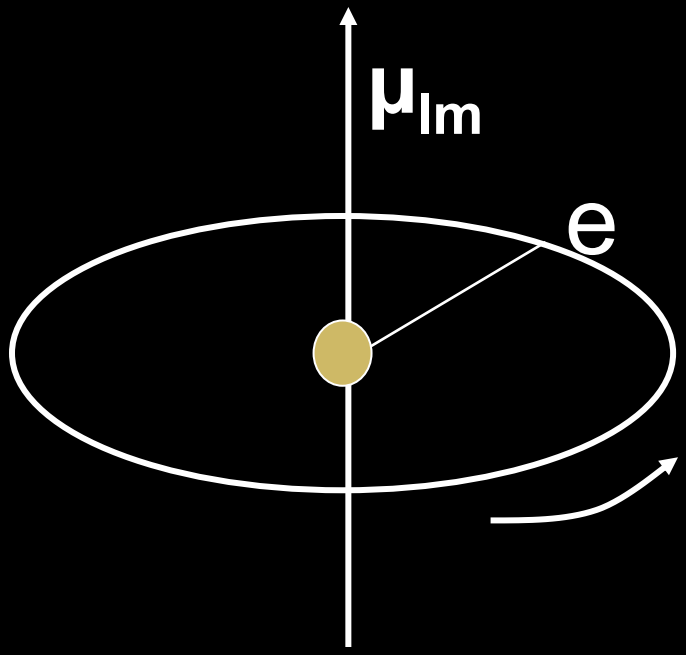
$$\mu_r = \frac{H + M}{H}$$

$$\mu_r = 1 + \frac{M}{H}$$

$$\mu_r = 1 + \chi_m$$

Origin of Magnetic Moment

The Magnetic moment in a material originates from the orbital motion and spinning motion of electrons in an atom.



Consider an atom & each electron in that, orbiting around the nucleus produces a loop current

$$i = q / t$$

$$i = q f$$

Where f is a frequency of electron..

If L is the angular momentum of electron, the Magnetic moment of the electron

μ_{lm} = (Area of loop) x (Current)

$$\mu_{lm} = (\pi r^2)(\frac{q}{t})$$

$$\mu_{lm} = (\pi r^2)(qf)$$

$$\mu_{lm} = (\pi r^2)(\frac{q}{2\pi} \times 2\pi f)$$

$$\mu_{lm} = (\pi r^2)(\frac{q}{2\pi} \times \omega)$$

$$\mu_{lm} = (\pi r^2)(\frac{q}{2\pi} \times \frac{v}{r})$$

$$\mu_{lm} = \frac{qvr}{2}$$

$$\mu_{lm} = \frac{q}{2m}.mvr$$

$$\mu_{lm} = \frac{q}{2m}.L$$

Where L is a Angular Momentum of electr

$$L = mvr = \frac{lh}{2\pi}$$

$$L = mvr = \sqrt{l(l+1)}\,\frac{h}{2\pi}$$

$$\mu_{lm} = \frac{q}{2m}.L$$

$$\mu_{lm} = \frac{q}{2m}.\sqrt{l(l+1)}\,\frac{h}{2\pi}$$

$$\mu_{lm} = \frac{qh}{4\pi m}.\sqrt{l(l+1)}$$

$$\mu_{lm} = \mu_B.\sqrt{l(l+1)}$$

$$where., \mu_B(Bhor,.magnaton) = \frac{qh}{4\pi m} \rightarrow 9.27408\times10^{-24} A-m^2$$

Classification of Magnetic Materials

1. Dia
2. Para
3. Ferro
4. Anti Ferro
5. Ferri Magnetic materials.

Dia Magnetic Materials

Diamagnetism is the phenomenon by which the induced Magnetic moment is always in the opposite direction of the applied Magnetic field.

Properties

1. These materials having negative susceptibility value.
2. No permanent Magnetic Moment.
3. Dia Magnetic materials repel magnetic lines of force.
4. The value of Diamagnetic susceptibility is independent of temperature and applied Magnetic field.

Examples: Organic materials, Alkali earth