UNIT - VI - ENGINEERING MATERIALS

Dielectric Materials:

→ The dielectric material is an insulating material in which all the electrons are tightly bound to the nucleus of the atom. There is no free e^- available for the conduction of current, Therefore, the electrical conductivity of such materials is very low. The E.C of ideal Dielectric is 0.

On the basis of band theory the forbidden gap (Eg) is very large. materials such as glass, Polymers are dielectric in nature.

The basic diff. b/w dielectric & insulators is that dielectric can store charge.

When the E.F is applied the +ve & -ve charge separating and polarisation occurs, c2 of internal E.F, such materials opposes the applied E.F.

Dielectric constant:

The dielectric constant of a material is the ratio of the capacitence of a given capacitor filled with dielectric material to the capacitence of same capacitor in free space of Vaccum.

In other words it is the ratio of permitivity of a medium to Permitivity of free space.

Denoted by symbol k

$$k = \frac{\varepsilon}{\varepsilon_0} = \varepsilon_r.$$

where ε is the permitt. of medium.
ε_0 " " " of free space
ε_r " " relative permitivity.

In basic terms the dielectric constant is the measure of the ability of any mate. that how easily it will get polarized.

Magnetic Materials.

→ The M.M are the substance that exhibits magnetic properties either naturally or in the presense of applied magnetic field. such materials get magnetised in the presence of applied magnetic field.

Such materials have domains, that are the regions where, the magnetic moments of individuals atoms or group of atoms allign in a particular dir., resulting in net Magnetic field.

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Important Parameters of Magnetic materials.

- Magnetic susceptibility (χ_m), it is the measure of how much a material will get magnetise in the presense of applied M.F. It is given as

$$\chi_m = \frac{I}{H}.$$

I = Intensity of Magnetisation
H = Intensity of applied field.

- Permiability. The permiability of a material is the capability of magnetic lines of force to penetrate the materials, it is denoted by symbol (μ), & it is given as $B = \mu H$
or $\mu = \frac{B}{H}$.

B = Magnetic flux density.

The relative permiability is given as $\mu_r = \frac{\mu}{\mu_0}$

μ = Permiability of medium
μ_0 = Per " of free space.

Relationship between Magnetic susceptibility & Relative permiability

$$\mu_r = 1 + \chi_m$$

Classification of Magnetic materials.

On the basis of magnetic properties diff. materials are classified as

1. Diamagnetic materials.
2. Paramagnetic materials.
3. Ferromagnetic materials.

1. Diamagnetic materials

→ Diamagnetism occurs in those materials in which individuals atoms do not have any net magnetic moment, as their orbital & spin moment add vectorily to become zero.

→ On placing such materials in external magnetic field, the will get repelled.

→ Such properties are found in the materials whose outermost shells has even no. of electrons.

→ Since, the e^- have spins opposite to each other, the net magnetic moment will be zero.

→ Such types of materials are Type I super-conductors as they exhibit perfect conductivity & perfect diamagnetism when cooled at very low temp.

for ex, Zinc - copper - bismuth.

* Magnetisation is independent on temperature

2. Paramagnetic materials

→ Paramagnetism occurs in those materials in which the outermost orbit has an odd no. of electrons such materials are highly attracted by the magnets, initially the dipole moments are randomly oriented. When such materials are kept in M.F, the magnetic moments get alligned in the direction of applied field. such materials have +ve sussecipitibility & the permiability greater than 1.

*** The Magnetisation decreases with increase in temperature because of thermal motion which disturbs the magnetic moment. For ex. Aluminium chromium etc.

3. Ferromagnetic materials

→ " occurs in such materials in which the atoms have permanent dipole moments.*** The strong interaction b/w neighbouring atomic dipole moments keep them allign even in the absense of magnetic field.

→ The magnetic sussepi... is always +ve & the value of permiability is of few thousands.

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The magnetisation varies inversly with temp.
For example : Iron.

Super conductive Materials

→ When certain materials are cooled below a particular temperature then there electrical Resistivity suddenly drops to zero, & also act as pure diamagnetic materials, such materials are known as super-conductive materials.

Properties :-

(i) $\rho = 0$ (Electrical ~~conductivity~~ Resistivity)

(ii) $\chi_m = -1$

(iii) $\mu_r = 0$

(iv) $B = 0$

Meissner Effect

→ When super-conductors are ~~coated~~ cooled below it's critical temperature in the presensce of applied M.F then it expelled out, the Magnetic flux, then act like a pure diamagnetic material, this is known as Meissner effect.

TYPE - I SUPER CONDUCTORS

Such materials strictly follow Meissner effect which means, the transition of normal state to super conductive state will be sudden

TYPE - II SUPERCONDUCTORS

→ such materials do not follow Mei. eff strictly which means it will take some time to shift from normal state to super - conductive state.