(14) FERRITES

Ferrites are a class of compounds of Ferrimagnetic substances. These are represented by general formula $Me^{++}\ Fe_2^{+++}\ O_4$, where Me^{++} stands for a suitable divalent ion such as Co^{++}, Mn^{++}, Ni^{++}, Fe^{++}, Mg^{++} etc. Fe_2^{+++} is trivalent ferric ion. If we inseret Co^{++} for Me^{++}, then the Ferrite $Co^{++}\ Fe_2^{+++}\ O_4$ is called Cobalt Ferrite etc. If two different Ferrites are mixed to form a solid solution (alloy), then it is called composite ferrite. *e.g.* Ni–Zn Ferrite is an example of composite Ferrite. The electrical resistance of Ferrites is 10^5 to 10^{15} times the resistance of metallic Ferromagnets (these are ceramic materials) hence materials are good insulators. Thus Ferrites possess electric properties of dielectrics combined with magnetic properties of Ferromagnetic materials. Hence these materials can be used for applications at high frequencies without loss of energy due to Eddy currents.

Ferrites can also be classified as Soft and Hard Ferrites. The area of Hysteresis loop of soft Ferrites is small. These are used for low. voltage signal, memory care, audio visual and recording applications. These are also used for low energy inductors and convergence coils for television receivers. Ferrites having nearly square shaped Hysteresis loop were earlier used as memory devices or logic operation devices in computers, as switching devices and in information storage.

The area of Hysteresis loop of Hard Ferrites is large. These are used to make permanent magnets. These are also widely used in generators, relays, loud speakers, telephone ringers, toys etc. where high energy product is not required. Hard ferrite powders mixed with plastic material to form flexible magnets are used as door closers of refrigerator doors.

(15) MAGNETOSTRICTION

When a ferromagnetic material is magnetised, its length either expands or contracts in the direction of magnetisation. This effect is called Magnetostriction or Joule Effect. The longitudinal

(16) MAGNETIC ANISOTROPY

In certain single crystals, such as iron, the magnetic properties depend upon the direction in which these are measured. This phenomenon is called magnetic anisotropy. *e.g.* when external magnetic field is absent, then spontaneous magnetisation takes up certain specific direction with respect to crystal axis instead of any arbitrary direction. In case of iron, there are six preferred directions of spontaneous magnetisation. In case of polycrystalline solids, the various crystals in a polycrystal are randomly oriented, so that properties are same in all directions. However if specific treatment such as cold rolling is given to certain polycrystalline substances, then magnetic properties become different in different directions. This anisotropy produced in the material is called Induced Anitropy. This property is of considerable practical importance. *e.g.* thin films of Ni-Fe alloy deposited on to a substrate by evaporation in vacuum with magnetic field applied in the plane of the substrate show spontaneous magnetisation in the direction of applied field. These magnetic films are used as storage devices in computers.

Example 1. ***The area of Hysteresis curve for 15 kg iron piece is equivalent to 300 J/m³. What will be the energy loss per minute in magnetising this piece at a frequency of 50 Hz. Give density of iron is 7.5 g cm⁻³.***

Solution. $\rho = 7.5 \text{ g cm}^{-3} = 7.5 \times 10^3 \text{ kg m}^{-3}$

Volume of specimen $= V = \dfrac{m}{\rho} = \dfrac{15}{7.5 \times 10^3} = 2 \times 10^{-3} \text{ m}^3$

Number of cycles completed in one minute $= 60 \times 50 = 3000$

Now energy lost per B-H cycle $= 300 \text{ J} \times 3000 = 9 \times 10^5 \text{ J m}^{-3}$

$\therefore$ total energy lost in specimen $= 9 \times 10^5 \text{ J m}^{-3} \times 2 \times 10^{-3} \text{ m}^3 = 1800 \text{ J}$