B.Sc. (Honours) Part-I

Paper-IB

Topic: **Elementary Magnetochemistry: Diamagnetism**

UG

Subject-Chemistry

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Elementary Magnetochemistry: Diamagnetism

CLASSIFICATION OF MAGNETIC MATERIALS:

Various properties of magnetic materials in terms of the magnetic properties of the atomic dipoles and the interaction between them. The first distinction is based on whether the atoms carry permanent magnetic dipoles or not. Materials which lack permanent dipoles are called diamagnetic. If the atoms of the materials carry permanent magnetic dipoles such a material may be paramagnetic, ferromagnetic, anti ferromagnetic, and ferrimagnetic depending on the interaction between the individual dipoles. If the permanent dipoles do not interact among themselves the material is called paramagnetic. If the interaction among permanent dipoles is strong such that all dipoles line up in parallel, the material is ferromagnetic. If permanent dipoles line up in anti parallel direction, then the material can be anti ferromagnetic or ferrimagnetic. In anti ferromagnetic material the magnitudes of permanent dipoles aligned parallel and anti parallel are equal and hence the magnetisation vanishes. In case of ferrimagnetic materials, magnitudes of permanent dipoles aligned anti parallel are not equal thus exhibiting magnetization.

Diamagnetic Materials:

Diamagnetism is a fundamental property of all matter. Diamagnetism is a very weak form of magnetism. Diamagnetism persists only in presence of an external magnetic field. It is induced by a change in the orbital motion of electrons due to an applied magnetic field. Diamagnetic material does not possess permanent dipoles. Dipoles are induced only in presence of external magnetic field. The magnitude of the induced magnetic moment is extremely small, and in a direction opposite to that of the applied field and hence tends to decrease the magnetic induction present in the material. Thus diamagnetism is the phenomenon by which the induced magnetic moment is always in the opposite direction of the applied field. Thus, the relative permeability is less than unity (however, only very slightly), and the magnetic susceptibility is negative; that is, the magnitude of the *B* field

within a diamagnetic solid is less than that in a vacuum. The volume susceptibility for diamagnetic solid materials is on the order of -10^{-5}. When placed between the poles of a strong electromagnet, diamagnetic materials are attracted toward regions where the field is weak. Though diamagnetism is present in all materials but it is masked by other types of magnetism because it is very weak. It can be observed only when other types of magnetism are absent.

Fig. 1 shows that there is a repulsion of magnetic flux from the centre of the material indicating the diamagnetic behavior of the magnetic material. Fig. 2 shows the atomic magnetic dipole configuration for a diamagnetic material both with and without external magnetic field. When no field is applied the atoms does not contain atomic dipoles where as ones the external magnetic field is applied the dipoles are induced and they are aligned in a direction opposite to the applied field.

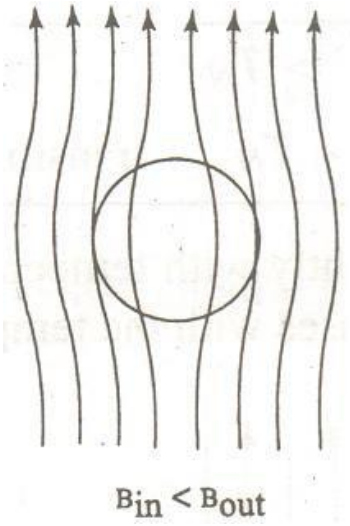

Fig. 1: Behaviour of diamagnetic material in presence of magnetic field

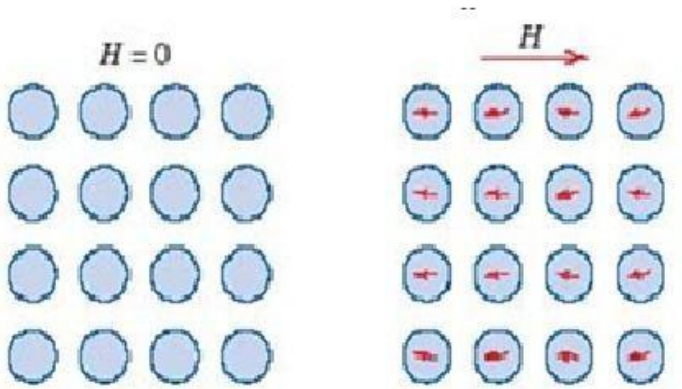

Fig. 2: Atomic dipole configuration with and without magnetic field

Examples of diamagnetic materials: Bismuth (Bi), Zinc (Zn), copper (Cu), Silver (Ag), Gold (Au), Salt (NaCl), Water (H_2O), Mercury (Hg), Hydrogen (H_2), Ge, Si.

Properties of diamagnetic materials

1. An atom of this material does not contain permanent dipoles.
2. An atom of this material has no magnetic dipole moment.
3. The effect is weak and often masked by other kinds of magnetism.
4. A Dia-magnet is weakly repelled by a normal magnet.
5. Relative permeability is less than 1 but only slightly less than unity.
6. Magnetic susceptibility is negative but only slightly less than unity.
7. Magnetic susceptibility is independent of temperature.