

MAGNETISM AND MATTER

MAGNETIC PROPERTIES OF MATERIALS

Magnetic Properties of Materials

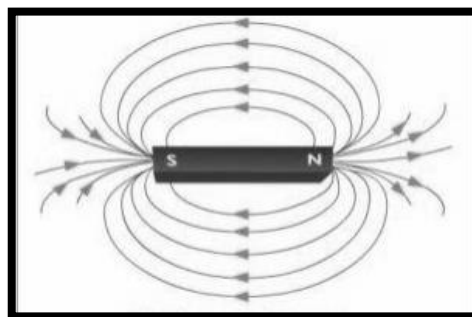
As kids, we loved playing with magnets. It seemed fascinating to watch the magnets get attracted to each other. But, today we know that magnets have so much more to them. Not only this, now we, also learn about the magnetic properties of various materials. Did you know even the Earth has a magnetic field? Let us learn about all these interesting concepts in this chapter.

Magnet

A magnet is a material or object that can produce a magnetic field. This magnetic field is invisible. However, it is mainly responsible for the most notable property of a magnet. According to these magnetic properties, a magnet possesses a force that pulls on other ferromagnetic materials, such as iron, and attracts or repels other magnets.

Magnetic Field

A magnetic field is the magnetic effect of electric currents and magnetic materials. Hence, the magnetic field at any given point is specified by both a direction and a magnitude (or strength). Therefore, it is clear that it is a vector field. You can produce magnetic fields by moving electric charges and the intrinsic magnetic moments of elementary particles associated with a fundamental quantum property, their spin.



Magnetic Field Intensity

The magnetic field intensity at a point is defined as the force experienced by a unit of the North Pole at that point. The tangent is drawn on the line of forces usually gives the direction of magnetic field intensity. It is measured in Telsa (T) or Gauss.

1. **Magnetic Pole Strength:** This (symbol: p) is a physical quantity that measures the strength of the pole of a bar magnet (or a hypothetical magnetic monopole).
2. **Magnetic Moment:** The magnetic moment of a magnet is a quantity that determines the torque that it experiences in an external magnetic field. Hence, we can find magnetic moments in a loop of electric current, a bar magnet, an electron (revolving around, a molecule).

Is the Magnetic Moment Scalar or Vector? The magnetic moment is a vector quantity, having a magnitude and direction. Therefore, the direction of the magnetic moment points from the South to the North Pole of the magnet. Hence, the magnetic field produced by the magnet is proportional to its magnetic moment. Therefore, depending on the above magnetic properties, magnets can be broadly classified:

1. Diamagnetic
2. Para-magnetic
3. Ferro-magnetic
4. Ferri-magnetic
5. Anti-Ferro Magnetic

Diamagnetic Substance

Diamagnetic substances are those that are repelled by magnets. This is because they produce negative magnetization. Hence, the net magnetic moment is zero in diamagnetic substance. Every element in the periodic table possesses the property of diamagnetism. However, elements like Cu, Al_2O_3 , Si, Zn have stronger diamagnetic property.

Paramagnetic Substance

Paramagnetic substances have a little magnetic moment. This is because the magnetic moment does not cancel out completely. The magnetic moments in the paramagnetic material are randomly aligned. Example of paramagnetic materials includes Al, Cr, Mo, Ti, Zr.

Ferromagnetic Substance

Unlike diamagnets or paramagnets, you can magnetize

Ferromagnetic substances, even when you remove the magnetic field. This phenomenon is called Hysteresis. However, at one point or temperature, the ferromagnetic materials lose their magnetic properties. This temperature is the Curie point or Curie temperature.

Ferri-Magnetic Substance The main difference between a ferromagnetic material and ferri-magnetic material is based on the alignment of the magnetic domains. While some magnetic domains in ferri-magnetic material points in the same direction, some point in the opposite direction. In the case of ferromagnetic material, all the magnetic domains point in the same direction.

Anti-Ferromagnetic Substance

In Anti-Ferromagnetic substances, the magnetic moments of atoms or molecules are usually related to the spin of the electrons. Therefore, they align in a regular pattern with neighboring spins in opposite directions. MnO or Manganese Oxide is an example of an anti-ferromagnetic substance.

Q. What is a magnetic material?

Ans: A magnetic material is a material which can attract or repel other substances, under the influence of its magnetic field. Therefore, the actions of attracting or repelling a substance depend on the arrangement of electrons. Here, this is the Magnetic Moment of the substance. Therefore, when you bring it under the influence of the external magnetic field, you produce this moment.

Q. What are the properties of Magnet?

Ans: The properties of a magnet are:

1. The north pole of one magnet attracts the south pole of other magnet and vice-versa.
2. The magnet possesses its own magnetic field lines due to various factors like the flowing of current, orbital spin of an electron, magnetic moment etc
3. The behavior of a magnet is always studied with respect to the earth's magnetic field.