Flux Density, B = The amount of magnetic flux passing through a unit area

Date:

MAGNETIC HYSTERESIS

The phenomenon of flux density B lagging behind the magnetizing force H in a magnetic material is known as magnetic hysteresis

EXPLANATION

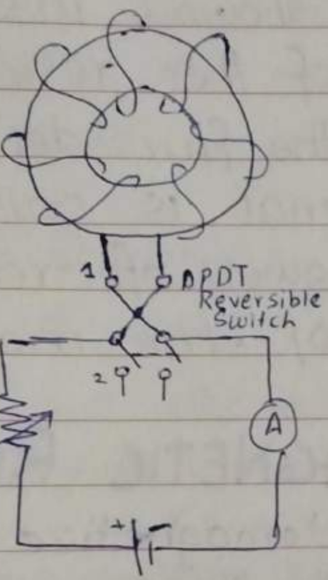
In other words, when the magnetic material is magnetized first in one direction and then in the other direction, completing one cycle of magnetization, it is found that the flux density B lags behind the applied magnetization force H.

FERROMAGNETIC MATERIALS

Ferromagnetic materials are mainly responsible for the generation of the hysteresis loop

When the magnetic field is not applied the ferromagnetic material behaves like a paramagnetic material. This means that at the initial stage the dipole of the ferromagnetic material is not aligned, they are randomly placed. As soon as the magnetic field is applied to the ferromagnetic material, its dipole moments align themselves in one particular direction resulting in a much stronger magnetic field.

For understanding the phenomenon of the magnetic hysteresis, consider a ring of magnetic material wound uniformly with solenoid. The Solenoid is connected to a DC source through a Double pole double throw (DPDT) reversible switch.



Magnetizing Force (H): Magnetic intensity applied to points within a magnetizable substance - also called magnetic force

Refer to fig in book

SATURATION POINT (oa)

Initially the switch is in position 1. By decreasing the value of R the value of the current in the solenoid increases gradually resulting in a gradual increase in ~~flux~~ field intensity H, the flux density also increases till it reaches the saturation point 'a' and the curve obtained is oa.

Saturation occurs when on increasing the current the dipole moment or the molecules of the magnetic material align itself in one direction.

Date:

Residual Magnetism

Now by decreasing the current in the solenoid to zero the magnetizing force is gradually reduced to zero, but the value of flux density will not be zero as it still has the value 'ob' when $H=0$, so the curve obtained is 'ab' as shown. This value ob of flux density is bcz of the residual magnetism.

The value of the flux density 'ob' retained by the magnetic material is called residual magnetism, and the power of retaining it is known as Retentivity of the material.

DEMAGNETIZING MAGNETIC RING

Now to demagnetize the magnetic ring, the position of the DPDT reversible switch is changed to position 2 and thus, the direction of flow of the current in the solenoid is reversed resulting in reverse magnetizing force H.

When H is increased in reverse direction, the flux density starts decreasing and becomes zero ($B=0$) and the curve shown in fig follows the path bc. The residual magnetism of the material is removed by applying the magnetizing force known as Coercive force in the opposite direction

COERCIVE FORCE

The value of the magnetizing force oc

required to wipe out the residual magnetism 'ob' is called coercive force.

NEGATIVE SATURATION POINT

Now to complete the hysteresis loop the magnetizing force H is further increased in the reverse direction till it reaches the saturation point 'd' but in the negative direction, the curve traces the path cd.

NEGATIVE RESIDUAL MAGNETISM

The value of H is reduced to zero H=0 and the curve obtains the path de, where oe is residual magnetism when the curve is in negative direction

COMPLETION OF HYSTERESIS LOOP

The position of the switch is changed to 1 again from the position 2 and the current in the solenoid is again increased as done in the magnetization process and due to this H is increased in the positive direction tracing the path as efa, and finally The hysteresis loop is comple. In the curve again 'of' is the magnetization force, also known as the coercive force required to remove the residual magnetism 'oe'

TOTAL COERCIVE FORCE

Here the total coercive force required to wipe off residual magnetism in one comple cycle is denoted by 'cf'

From the above discussion, it is clear that the flux density B always lags behind the magnetizing force H. Hence the loop 'abcdefa' is called the magnetic hysteresis loop or hysteresis curve.

DISSIPATION OF ENERGY

Magnetic hysteresis results in the dissipation of wasted energy in the form of heat. The energy wasted is proportional to the area of the magnetic hysteresis loop.

SOFT MAGNETIC MATERIAL

The soft magnetic material has a narrow magnetic hysteresis loop and has a small amount of dissipated energy. They are made of material like iron, silicon, steel etc.

* It is used in devices that require alternating magnetic field
* It has low coercivity * Low magnetization * Low retentivity

HARD MAGNETIC MATERIAL

The hard magnetic material has a wider hysteresis loop and results in a large amount of energy dissipation and the demagnetization process is more difficult to achieve

* It has high retentivity * High coercivity * High saturation