Definitions of Terminology in Magnetics

Ag Area of the air gap, or the cross sectional area of the air gap perpendicular to the flux path, is the average cross sectional area of that portion of the air gap within which the application interaction occurs, Area is measured in sq. cm. in a plane normal to the central flux line of the air gap.

Am Area of the magnet, is the cross sectional area of the magnet perpendicular to the central flux line, measured in sq. cm. at any point along its length. In design, Am is usually considered the area at the neutral section of the magnet.

B Magnetic induction, is the magnetic field induced by a field strength, H, at a given point. It is the vector sum, at each point within the substance, of the magnetic field strength and resultant intrinsic induction. Magnetic induction is the flux per unit area normal to the direction of the magnetic path.

Bd Remanent induction, is any magnetic induction that remains in a magnetic material after removal of an applied saturating magnetic field, Hs. (Bd is the magnetic induction at any point on the demagnetization curve; measured in gauss.)

Bd/Hd Slope of the operating line, is the ratio of the remanent induction, Bd, to a demagnetizing force, Hd. It is also referred to as the permeance coefficient, shear line, load line and unit permeance.

BdHd Energy product, indicates the energy that a magnetic material can supply to an external magnetic circuit when operating at any point on its demagnetization curve; measured in megagauss-oersteds.

(BH)max Maximum energy product, is the maximum product of (BdHd) which can be obtained on the demagnetization curve.

Bis (or J) Saturation intrinsic induction, is the maximum intrinsic induction possible in a material.

Bg Magnetic induction in the air gap, is the average value of magnetic induction over the area of the air gap, Ag; or it is the magnetic induction measured at a specific point within the air gap; measured in gauss.

Bi (or J) Intrinsic induction, is the contribution of the magnetic material to the total magnetic induction, B. It is the vector difference between the magnetic induction in the material and the magnetic induction that would exist in a vacuum under the same field strength, H. This relation is expressed by the equation:

$$Bi = B - H$$

Bi = intrinsic induction in gauss
B = magnetic induction in gauss
H = field strength in oersteds.

Bm Recoil induction, is the magnetic induction that remains in a magnetic material after magnetizing and conditioning for final use; measured in gauss.

Bo Magnetic induction, at the point of the maximum energy product (BH)max; measured in gauss.

Br Residual induction (or flux density), is the magnetic induction corresponding to zero magnetizing force in a magnetic material after saturation in a closed circuit; measured in gauss.

***f* Reluctance factor**, accounts for the apparent magnetic circuit reluctance. This factor is required due to the treatment of Hm and Hg as constants.

F Leakage factor, accounts for flux leakage from the magnetic circuit. It is the ratio between the magnetic flux at the magnet neutral section and the average flux present in the air gap.

$$F = (BmAm)/(BgAg)$$

F Magnetomotive force, (magnetic potential difference), is the line integral of the field strength, H, between any two points, p_1 and p_2.

$$F = \int_{p_2}^{p_1} H \, dl$$

F = magnetomotive force in gilberts
H = field strength in oersteds
dl = an element of length between the two points, in centimeters.

H Magnetic field strength, (magnetizing or demagnetizing force), is the measure of the vector magnetic quantity that determines the ability of an electric current, or a magnetic body, to induce a magnetic field at a given point; measured in oersteds.

Hc Coercive force of a material, is equal to the demagnetizing force required to reduce residual induction, B, to zero in a magnetic field after magnetizing to saturation; measured in oersteds.

Hci Intrinsic coercive force of a material, indicates its resistance to demagnetization. It is equal to the demagnetizing force which reduces the intrinsic induction, Bi, in the material to zero after magnetizing to saturation; measured in oersteds.

Hd is that value of H corresponding to the remanent induction, Bd; measured in oersteds.

Hm is that value of H corresponding to the recoil induction, Bm; measured in oersteds.

Ho is the magnetic field strength at the point of the maximum energy product (BH)max; measured in oersteds.

Hs Net effective magnetizing force, is the magnetizing force required in the material, to magnetize to saturation measured in oersteds.

J, see Bi, Intrinsic induction.

Js, see Bis Saturation intrinsic induction.

lg Length of the air gap, is the length of the path of the central flux line of the air gap; measured in centimeters.

lm Length of the magnet, is the total length of magnet material traversed in one complete revolution of the center line of the magnetic circuit; measured in centimeters.

lm/D Dimension ratio, is the ratio of the length of a magnet to its diameter, or the diameter of a circle of equivalent cross-sectional area. For simple geometries, such as bars and rods, the dimension ratio is related to the slope of the operating line of the magnet, Bd/Hd.

P Permeance, is the reciprocal of the reluctance, R, measured in maxwells per gilbert.

R Reluctance, is somewhat analogous to electrical resistance. It is the quantity that determines the magnetic flux, ϕ, resulting from a given magnetomotive force, F.

$$R = F/\phi$$

R = reluctance, in gilberts per Maxwell
F = magnetomotive force, in gilberts
ϕ = flux, in Maxwells

Tc, Curie temperature, is the transition temperature above which a material loses its magnet properties.

Tmax Maximum service temperature, is the maximum temperature to which the magnet may be exposed with no significant long range instability or structural changes.

Vg Air gap volume, is the useful volume of air or non-magnetic material between magnetic poles; measured in cubic centimeters.

μ permeability, is the general term used to express various relationships between magnetic induction, B, and the field strength, H.

μre recoil permeability, is the average slope of the recoil hysteresis loop. Also known as a minor loop.

ϕ magnetic flux, is a contrived but measurable concept that has evolved in an attempt to describe the "flow" of a magnetic field. Mathematically, it is the surface integral of the normal component of the magnetic induction, B, over an area, A.

A closed circuit condition exists when the external flux path of a permanent magnet is confined with high permeability material.

The demagnetization curve is the second (or fourth) quadrant of a major hysteresis loop. Points on this curve are designated by the coordinates Bd and Hd

A Fluxmeter is an instrument that measures the change of flux linkage with a search coil.

The Gauss is the unit of magnetic induction, B, in the cgs electromagnetic system. One gauss is equal to one maxwell per square centimeter.

A Gaussmeter is an instrument that measures the instantaneous value of magnetic induction, B. Its principle of operation is usually based on one of the following: the Hall-effect, nuclear magnetic resonance (NMR), or the rotating coil principle.

The Gilbert is the unit of magnetomotive force, F, in the cgs electromagnetic system.

A Hysteresis loop is a closed curve obtained for a material by plotting (usually to rectangular coordinates) corresponding values of magnetic induction, B, for ordinates and magnetizing force, H, for abscissa when the material is passing through a complete cycle between definite limits of either magnetizing force, H, or magnetic induction, B.

Irreversible losses are defined as partial demagnetization of the magnet, caused by exposure to high or low temperatures external fields or other factors. These losses are recoverable by remagnetization. Magnets can be stabilized against irreversible losses by partial demagnetization induced by temperature cycles or by external magnetic fields

A keeper is a piece (or pieces) of soft iron that is placed on or between the pole faces of a permanent magnet to decrease the reluctance of the air gap and thereby reduce the flux leakage from the magnet. It also makes the magnet less susceptible to demagnetizing influences.

Leakage flux is flux, ϕ, whose path is outside the useful or intended magnetic circuit; measured in maxwells.

The major hysteresis loop of a material is the closed loop obtained when the material is cycled between positive and negative saturation.

The Maxwell is the unit of magnetic flux in the cgs electromagnetic system. One maxwell is one line of magnetic flux.

The neutral section of a permanent magnet is defined by a plane passing through the magnet perpendicular to its central flux line at the point of maximum flux.

The Oersted is the unit of magnetic field strength, H, in the cgs electromagnetic system. One oersted equals a magnetomotive force of one gilbert per centimeter of flux path.

An open circuit condition exists when a magnetized magnet is by itself with no external flux path of high permeability material.

The operating line for a given permanent magnet circuit is a straight line passing through the origin of the demagnetization curve with a slope of negative Bd/Hd. (Also known as permeance coefficient line.)

The operating point of a permanent magnet is that point on a demagnetization curve defined by the coordinates (BdHd) or that point within the demagnetization curve defined by the coordinates (BmHm).

An oriented (anisotropic) material is one that has better magnetic properties in a given direction.

A permeameter is an instrument that can measure, and often record, the magnetic characteristics of a specimen.

Reversible temperature coefficients are changes in flux which occur with temperature change. These are spontaneously regained when the temperature is returned to its original point.

Magnetic saturation of a material exists when an increase in magnetizing force, H, does not cause an increase in the intrinsic magnetic induction, B, of the material.

A search coil is a coiled conductor, usually of known area and number of turns, that is used with a fluxmeter to measure the change of flux linkage with the coil.

The temperature coefficient is a factor which describes the reversible change in a magnetic property with a change in temperature. The magnetic property spontaneously returns when the temperature is cycled to its original point. It usually is expressed as the percentage change per unit of temperature.

An unoriented (isotropic) material has equal magnetic properties in all directions.

Conversions

Designation	CGS	SI	Conversion
H	Oersted (Oe)	A/m	1A/m = 12.57 x 10^3 Oe
B	Gauss (G)	Tesla (T)	1 T = 10,000 G
ϕ	Maxwell (M)	Weber (Wb)	1 Wb = 10^8 M
F	Gilbert	Amp-turn	1 A-t = 1.256 Gilbert
BH	MGOe	Joule/m^3	1 J/m^3 = .1257 x 10^6 GOe