Magnetic Flux and Density

In simple matter, the magnetic flux density $\vec{B}$, related to the magnetic $\vec{H}$

$\vec{B} = \mu\vec{H}$

field intensity as where μ called the permeability. In particular when

we consider the free space

$\vec{B} = \mu_0\vec{H}$ where $\mu_0 = 4\pi \times 10^{-7}$ H/m is the permeability of the free space. Magnetic flux density is measured in terms of Wb/m ^{2} .

The magnetic flux density through a surface is given by:

$$\psi = \int_s \vec{B}.d\vec{s} \quad \text{Wb} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3.18)$$

In the case of electrostatic field, we have seen that if the surface is a closed surface, the net flux passing through the surface is equal to the charge enclosed by the surface. In case of magnetic field isolated magnetic charge (i. e. pole) does not exist. Magnetic poles always occur in pair (as N-S). For example, if we desire to have an isolated magnetic pole by dividing the magnetic bar successively into two, we end up with pieces each having north (N) and south (S) pole as shown in Fig. 3.1 (a). This process could be continued until the magnets are of atomic dimensions; still we will have N-S pair occurring together. This means that the magnetic poles cannot be isolated.

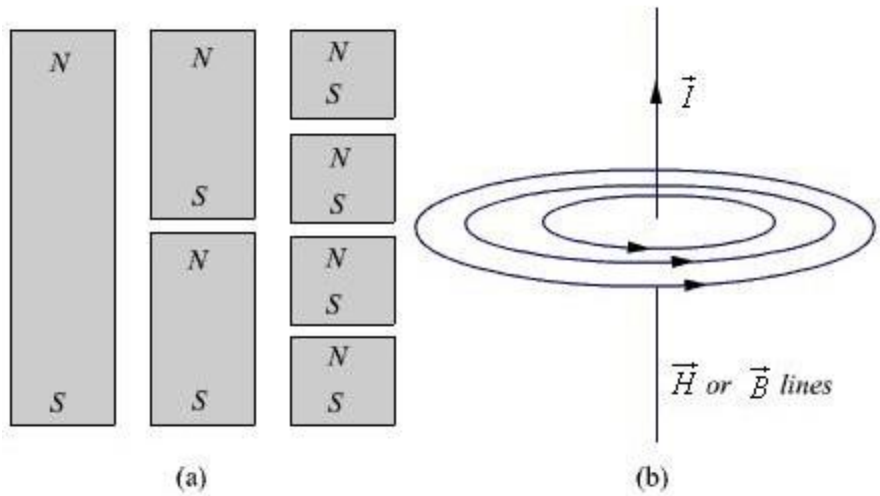

Fig. 3.1: (a) Subdivision of a magnet (b) Magnetic field/ flux lines of a straightcurrent carrying conductor
(www.brainkart.com/subject/Electromagnetic-Theory_206/)

Similarly if we consider the field/flux lines of a current carrying conductor as shown in Fig. 3.1 (b), we find that these lines are closed lines, that is, if we consider a closed surface, the number of flux lines that would leave the surface would be same as the number of flux lines that would enter the surface.

From our discussions above, it is evident that for magnetic field,

$$\oint_S \vec{B}.d\vec{s} = 0 \qquad \text{.......................................(3.19)}$$

which is the Gauss's law

for the magnetic field. By

$$\oint_S \vec{B}.d\vec{s} = \int_V \nabla.\vec{B}dv = 0$$

applying divergence theorem, we can write:

Hence, $\nabla . \vec{B} = 0$ ....(3.20)

which is the Gauss's law for the magnetic field in point form.

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