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Generalization of Magnetic Field Energy Irrespective To Propagation Using Direct Geometric Method

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***Abstract*—Heat is the lower form of energy and work is the higher one. In every electrical, mechanical or electro-mechanical circuits energy is assumed to be conserved. Similarly in magnetic and electrical circuits charge and potential difference are tried to be conserved. In this paper, we will analyse the different propagations of magnet so that the main component of magnetic energy field (i.e. magnetic dipole moment) can be quantified for the every propagation of magnet. A general formula for bending of the magnet is derived using direct geometric method. In this the magnetic dipole of a solide ferromagnetic within the Curie temperature is represented.**
***Keywords*— plasma, superconductivity, dipole, magnetic field, Curie tempreture.**

I. INTRODUCTION

There are basically five state of matters solid, liquid, gas, plasma and super conducting materials. At the absolute zero temperature, the conductors behave like superconductors and the semiconductors behave like insulators [1]. The plasma is the state of no electron in the matter, only the nucleus exists at very high (10^7 K) temperature [2]. The superconductor is the state of matter at which the energy travels in the form of lumps (i.e. up to 10 K for pure metals). The main element of the interest is solids which are having different magnetic properties [3], which exist till the Curie temperature.

A. *Energy Distribution In A Magnetic Field*

Whenever a magnet is placed in an intense magnetic field, the behavior of it is to move parallel in the field. If a magnet of 2L length is placed at an angle Ɵ with the magnetic field of intensity B then the work done in making it parallel to the field will be equal that energy which is able to make it at Ɵ propagation from along the field. The work done in this process will be equal to the potential energy stored in the magnet.

$$W = - MB\cos\Theta$$

Where Ɵ is the angle between the field and the field of the magnet
In which , Dipole moment M = pole intensity (m) x effective length of the magnet (2L)
Hence the dipole moment is the major parameter for the analysis of energy of a magnet.

II. FORMULATION

A. *Geometric Formulation Of The Dipole Moment For A Bended Magnet*

let a magnet of 2L effective length is bended as a general arc making radius of curvature R and angle of curvature Ɵ with its center. The linear distance between the two poles of the arc is 2x. Then,

Dipole moment before the bending is $M_0 = m.2L$

After bending,

The instantaneous dipole moment of the bended magnet $Mx = m.2x$ ….(1) *Engineering Physics; Publisher: S. Chand*

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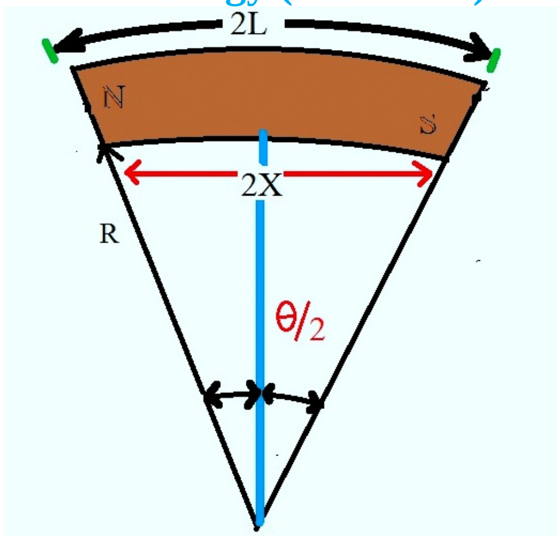

In any arc of the triangle;

$$x = R.\sin\Theta/2 \qquad \ldots\ldots (2)$$

$$\text{and } \Theta/2 = L/R$$

$R = 2L/\Theta$ putting the value in equation in equation (2) gives:-

$x = (2L/\Theta) \sin\Theta/2$ putting the value in equation (1) gives:-

$$M_x = m.2x$$

$$\text{Or } M_x = m.2.\ (2L/\Theta) \sin\Theta/2$$

$$= 2(m.2L.\ \sin\Theta/2)/\ \Theta$$

$$M_x= 2(M_0\sin\Theta/2)/(\Theta)$$

$$M_x = (M_0\sin\Theta/2)/(\Theta/2)$$

This formula is applicable for all the geometric arcs at every angle without integration.

Physical significance at the boundary conditions,

If Θ tends to zero then x will be equal to 2L in case the of no bending:-

$(\sin\Theta/2)/(\Theta/2) = 1$ and $M = m.2L$ (i.e. M_0).

It means if the magnet is not going to be bent then the magnetic and electrical dipole moment remains same.

If Θ tends to infinity, there will not be any magnetic and electrical dipole moment of the field for infinite rotation:-

$M_\infty = M_0/\infty = 0$.

It means if the magnet bended for very large rotation then its field is tends to zero due to reduction in separation between the poles.

If the rotation of the magnet is π radians, the magnetic field will be

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$$M_{\pi} = 2M_0/\pi.$$

It means the magnetic semicircular arc has its magnetic dipole moment 2/ π times of its initial value. The denominator can increase up to nπ times for every odd integer value of n and for even values it will be zero.

If the angle of rotation is 2π; then the dipole moment of a circular magnet will be zero as there is no in plane pole separation.

$M_{2\pi} = (2M_0 \sin \pi)/\pi = 0$. It is true for all even coefficients of π. The magnetic dipole moment is inversely proportional to the number of turns given.

Hence the geometric formulation is most accurate and exact than the traditional integral formulation. Integral has its own limits during the calculation, so geometric method is most sophisticated. The propagation can be tabulated to compare with the integral method. There is no deviation from the all real values got from the integrals.

Applicability of the equation:-

General equation for magnetic arc for energy calculation.

This equation is also applicable for the electric dipoles.

It is applicable for both stable and electro magnets.

TABLE I RESULTS FOR THE DIFFERENT PROPAGATIONS OF THE MAGNET FOR EACH 5 DEGREES

Serial no	Propagation angle (Θ) in radians	Numerical value of dipole moment	Serial no	Propagation angle (Θ) in radians	Numerical value of dipole moment
1.	π/36	0.9987 M_0	19.	19 π/36	0.6008 M_0
2.	2π/36	0.9949 M_0	20.	20 π/36	0.5642 M_0
3.	3π/36	0.9886 M_0	21.	21 π/36	0.5271 M_0
4.	4π/36	0.9798 M_0	22.	22 π/36	0.4894 M_0
5.	5π/36	0.9686 M_0	23.	23 π/36	0.4515 M_0
6.	6π/36	0.9549 M_0	24.	24 π/36	0.4135 M_0
7.	7π/36	0.9389 M_0	25.	25 π/36	0.3754 M_0
8.	8π/36	0.9207 M_0	26.	26 π/36	0.3376 M_0
9.	9π/36	0.9003 M_0	27.	27 π/36	0.3001 M_0
10.	10π/36	0.8778 M_0	28.	28 π/36	0.2630 M_0
11.	11π/36	0.8533 M_0	29.	29 π/36	0.2266 M_0
12.	12π/36	0.8269 M_0	30.	30 π/36	0.1910 M_0
13.	13π/36	0.7988 M_0	31.	31 π/36	0.1562 M_0
14.	14π/36	0.7691 M_0	32.	32 π/36	0.1225 M_0
15.	15π/36	0.7379 M_0	33.	33 π/36	0.0898 M_0
16.	16π/36	0.7053 M_0	34.	34 π/36	0.0585 M_0
17.	17π/36	0.6715 M_0	35.	35 π/36	0.0285 M_0
18.	18π/36	0.6366 M_0	36.	36 π/36	0 M_0

The above results can be represented in the form of graph as shown below:

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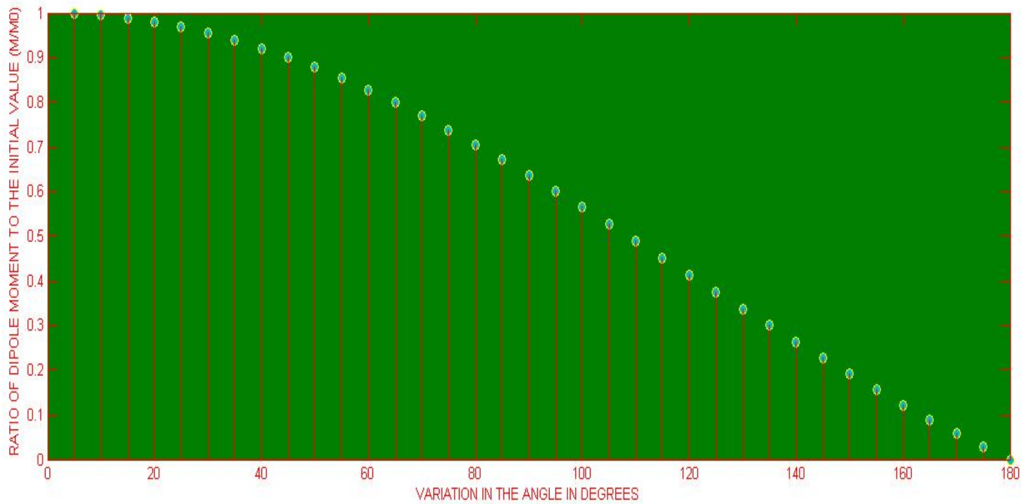

III. CONCLUSION

The variation of dipole moment is directly proportional to the effective length of magnet. The dipole moment reduces with the increase in the curvature (ϴ) of the magnet. The dipole moment is zero at the multiple values of angle π because the distance between two poles become zero at that instant. Geometric method is applicable for the all propagations of the magnet.

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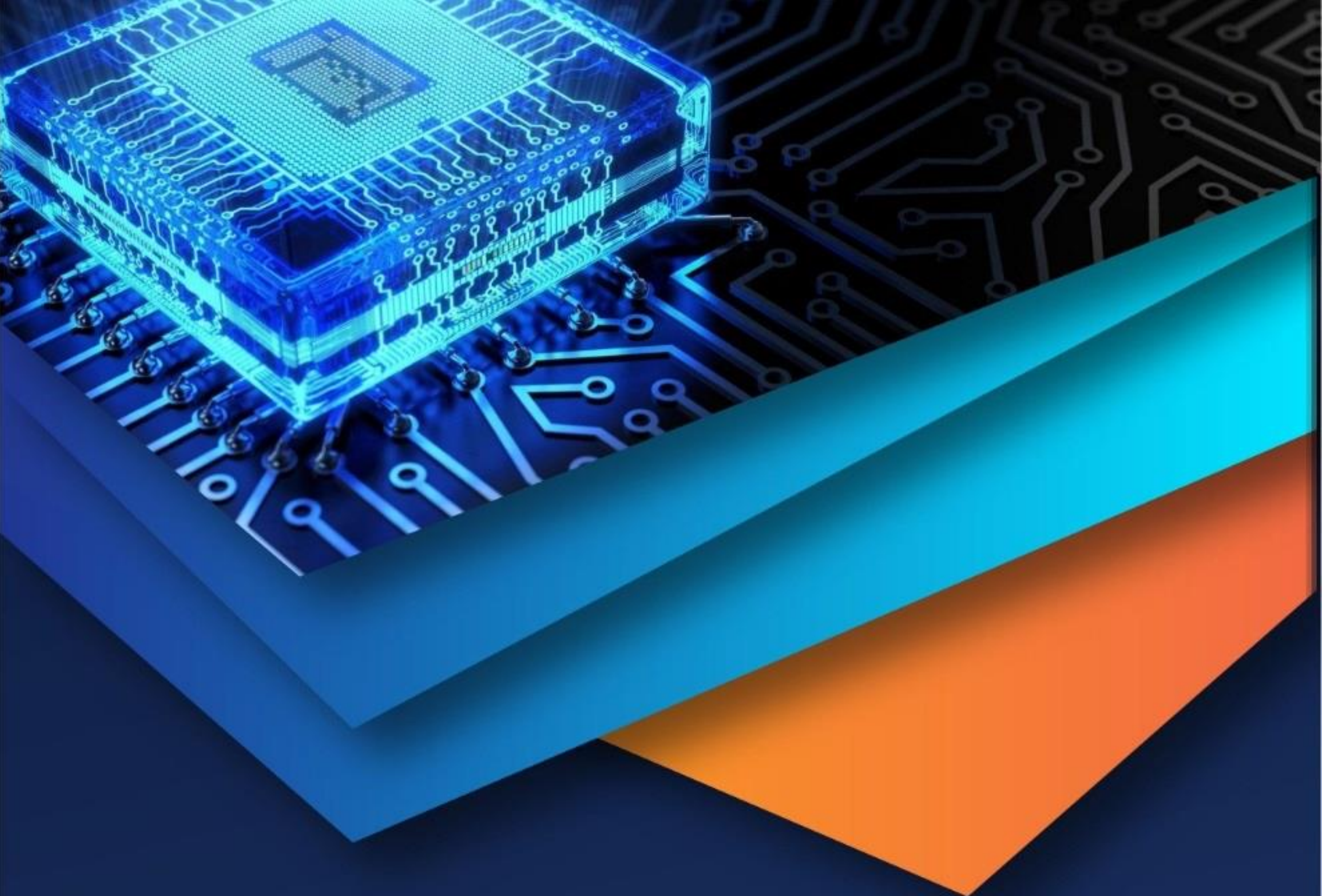

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