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# Bending Energy of Electric Dipole using Geometric Orientation Method

Mr. Sudheshwar Singh[1], Avinash Gavel[2], Dr. H. R. Suryawanshi[3]
[1, 2, 3]*Assistant Professor, VEC Ambikapur -497001*

***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 electro-static charges so that the main component of electric energy field (i.e. electric dipole moment) can be quantified for every orientation & trajectory of electric charge couple. 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 temperature, Orientation.***

## 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 (107 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 variation In A Electric field Whenever a magnet is placed in an intense magnetic field, the behavior of it is to move parallel in the field. If a Dipole of 2L length is placed at an angle ϴ 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 ϴ propagation from along the field. The work done in this process will be equal to the potential energy stored in the electric dipole.

$W = - PE \cos\Theta$ Where ϴ is the angle between the field and the field of the dipole

In which , Dipole moment P = Charge intensity (Q) x effective length of the electric couple (2L) Hence the dipole moment is the major parameter for the analysis of energy of an electric couple.

## II. FORMULATION

A. Geometric Formulation Of The Dipole Moment For A Bended electric field let a magnet of 2L effective length is bended as a general arc making radius of curvature R and angle of curvature ϴ with its center. The linear distance between the two poles of the arc is 2x. Then, Dipole moment before the bending is $P0 = Q.2L$ After bending, The instantaneous dipole moment of the bended magnet $Px = Q.2x$

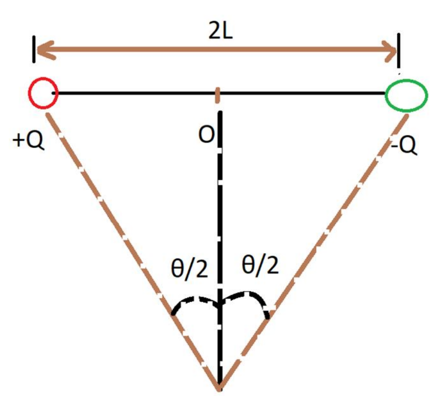



Fig:1 Electric Dipole Moment P = Q . 2L

In any arc of the triangle;
$x = R.\sin\Theta/2$ ….. (2)
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:- $P_x = Q.2x$
Or $P_x = Q.2.(2L/\Theta)\sin\Theta/2$
$= 2(Q.2L.\sin\Theta/2)/\Theta$ $P_x = 2(P_0\sin\Theta/2)/(\Theta)$ $P_x = (P_0\sin\Theta/2)/(\Theta/2)$

This formula is applicable for all the geometric arcs at every angle without integration. Physical significance at the boundary conditions,

If $\Theta$ tends to zero then x will be equal to 2L in case the of no bending:-$(\sin\Theta/2)/(\Theta/2) = 1$ and $P = Q.2L$ (i.e. $P_0$).

It means if the +Q & -Q remains unchanged not going to be bent then the magnetic and electrical dipole moment remains same.

If $\Theta$ tends to infinity, there will not be any magnetic and electrical dipole moment of the field for infinite rotation: - $P_\infty = P_0/\infty = 0$. All charges will be neutralized at one point. Because they are equal and opposite.

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

If the rotation of the electric couple is $\pi$ radians, the electric couple field will be
$P_\pi = 2P_0/\pi$.

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

If the angle of rotation is $2\pi$; then the dipole moment of a circular pole (neutral wire) will be zero as there is no in plane pole separation.

$P_{2\pi} = (2P_0\sin\pi)/\pi = 0$. It is true for all even coefficients of $\pi$. The electric dipole moment is inversely proportional to the number of turns given.

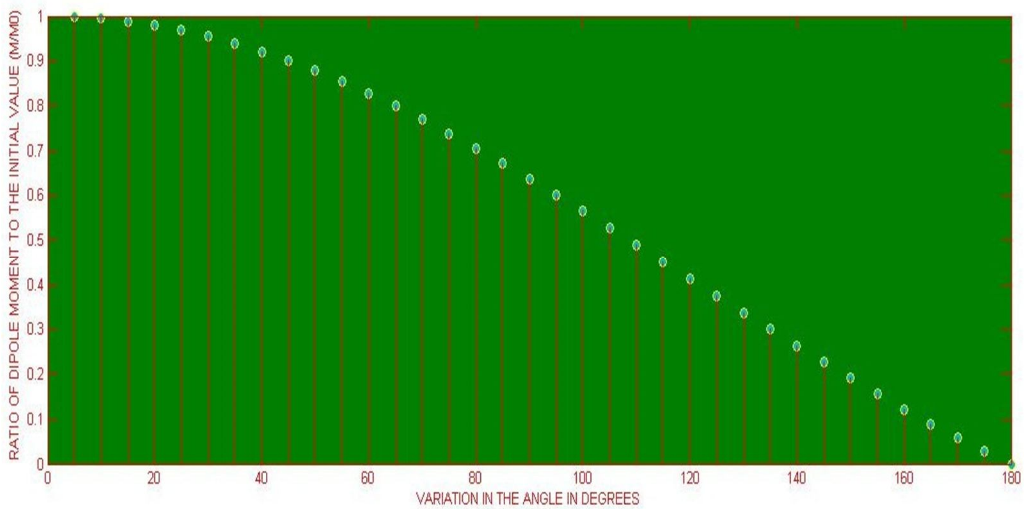
Hence the geometric formulation is most accurate and exact than the traditional integral formulation. Integral has its own limits during the calculation, so geometric method is most sophisticated. The propagation can be tabulated to compare with the integral method. There is no deviation from the all 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: Electric Dipole Orientations And Their Numerical Fractional Values (Effeciencies)

| Serial no | Propagation angle ($\Theta$) in radians | Numerical value of dipole moment | Serial no | Propagation angle ($\Theta$) in radians | Numerical value of dipole moment |
|---|---|---|---|---|---|
| 1. | $\pi/36$ | 0.9987 $P_0$ | 19. | 19 $\pi/36$ | 0.6008 $P_0$ |
| 2. | $2\pi/36$ | 0.9949 $P_0$ | 20. | 20 $\pi/36$ | 0.5642 $P_0$ |
| 3. | $3\pi/36$ | 0.9886 $P_0$ | 21. | 21 $\pi/36$ | 0.5271 $P_0$ |
| 4. | $4\pi/36$ | 0.9798 $P_0$ | 22. | 22 $\pi/36$ | 0.4894 $P_0$ |
| 5. | $5\pi/36$ | 0.9686 $P_0$ | 23. | 23 $\pi/36$ | 0.4515 $P_0$ |
| 6. | $6\pi/36$ | 0.9549 $P_0$ | 24. | 24 $\pi/36$ | 0.4135 $P_0$ |
| 7. | $7\pi/36$ | 0.9389 $P_0$ | 25. | 25 $\pi/36$ | 0.3754 $P_0$ |
| 8. | $8\pi/36$ | 0.9207 $P_0$ | 26. | 26 $\pi/36$ | 0.3376 $P_0$ |
| 9. | $9\pi/36$ | 0.9003 $P_0$ | 27. | 27 $\pi/36$ | 0.3001 $P_0$ |
| 10. | $10\pi/36$ | 0.8778 $P_0$ | 28. | 28 $\pi/36$ | 0.2630 $P_0$ |
| 11. | $11\pi/36$ | 0.8533 $P_0$ | 29. | 29 $\pi/36$ | 0.2266 $P_0$ |
| 12. | $12\pi/36$ | 0.8269 $P_0$ | 30. | 30 $\pi/36$ | 0.1910 $P_0$ |
| 13. | $13\pi/36$ | 0.7988 $P_0$ | 31. | 31 $\pi/36$ | 0.1562 $P_0$ |
| 14. | $14\pi/36$ | 0.7691 $P_0$ | 32. | 32 $\pi/36$ | 0.1225 $P_0$ |
| 15. | $15\pi/36$ | 0.7379 $P_0$ | 33. | 33 $\pi/36$ | 0.0898 $P_0$ |
| 16. | $16\pi/36$ | 0.7053 $P_0$ | 34. | 34 $\pi/36$ | 0.0585 $P_0$ |
| 17. | $17\pi/36$ | 0.6715 $P_0$ | 35. | 35 $\pi/36$ | 0.0285 $P_0$ |
| 18. | $18\pi/36$ | 0.6366 $P_0$ | 36. | 36 $\pi/36$ | 0 $P_0$ |

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

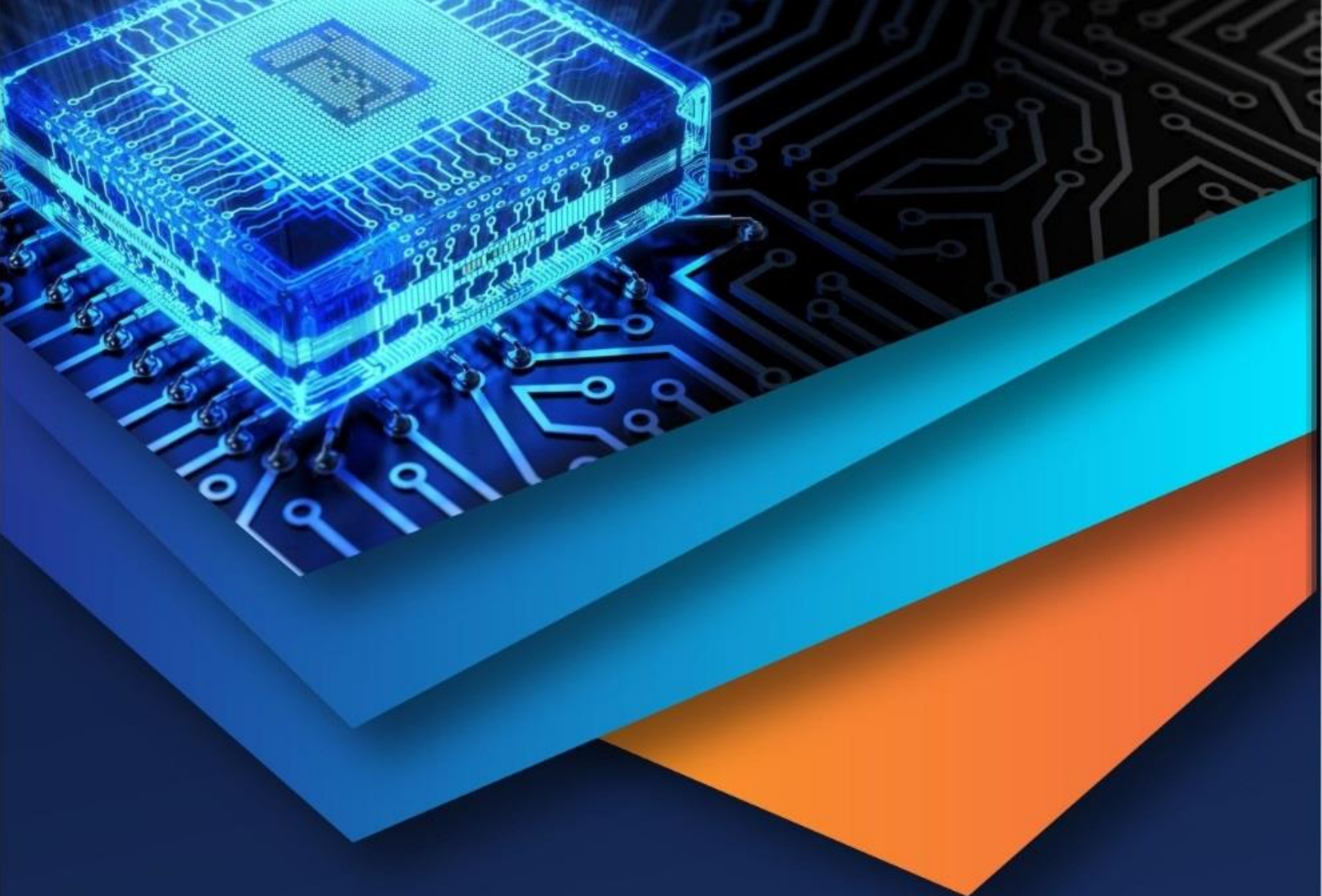



## III. CONCLUSION

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

## REFERENCES

[1] A. Gavel, Dr. R K Bhushan (2015) , "Generalization of Magnetic Field Energy Irrespective to Propagation using direct geometric method, IJRASET pp 263-266
[2] Aharoni, A. ( 1976), "Traction force on paramagnetic particles in magnetic separators", IEEE T Magn, Vol. MAG-12, pp. 234-235.
[3] J. B. Pendry, A. J. Holden, D. J. Robbins, and W. J. Stewart (1999.), "Magnetism from conductors and enhanced nonlinear phenomena," IEEE Trans. Microwave Theory Tech. vol.47, pp. 2075–2084.
[4] Cebers, A. (2005), "Dynamics of elongated magnetic droplets and elastic rods in magnetic field", J Magn Magn Mater, Vol. 289, pp. 335-338.
[5] Moon, F.C., Yih-Hsing Pao (1968), "Magneto elastic buckling of a thin plate", J Appl Mech, vol.35, pp. 53-8.
[6] K. T. A. L. Burm (2012), "Plasma: The Fourth State of Matter", Plasma Chemistry and Plasma Processing, vol.32, pp.401-407.
[7] Moon, F.C. (1978), "Problems in magneto



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