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Boundary Conditions for Two Different Magnetic Mediums

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ABSTRACT: When a magnetic field passes through the boundary of two different magnetic mediums with different normal angles, boundary conditions must be met. This project aims to verify the mathematical expression for the boundary conditions that relate the tangential and normal components of the magnetic field across the boundary. This is illustrated using a numerical problem. By solving the boundary conditions, we can understand how the magnetic field behaves as it passes through the boundary. This is accomplished by developing a program code to verify the same problem. This work has the potential to improve our understanding of magnetic fields and could be useful in the design of various magnetic devices.

KEYWORDS: Magnetic Field Intensity, Magnetic Flux Density, Normal Component, Gauss Law, Magnetic Field

I.INTRODUCTION

Regarding the conduct of magnetic fields, boundary conditions can be utilized to portray how the field behaves at the interface between two different substances, like air and a magnetic material. One of the boundary conditions for the vertical component of the magnetic field is recognized as the continuity of the vertical component. This condition states that the vertical component of the magnetic field must be uninterrupted across the boundary between two distinct media. In simpler terms, the vertical component of the magnetic field at the interface must have the same value on both sides of the boundary. Another boundary condition for the vertical component of the magnetic field is the boundary condition for the magnetic flux density, also known as the magnetic permeability boundary condition. This condition asserts that the vertical component of the magnetic flux density must be uninterrupted across the boundary between two different media, and that the product of the magnetic flux density and the vertical component of the magnetic field must also be uninterrupted across the boundary. Finally, another boundary condition for the vertical component of the magnetic field is the boundary condition for the magnetic field intensity, also known as the magnetic field strength boundary condition. This condition states that the vertical component of the magnetic field intensity must be uninterrupted across the boundary between two different media, and that the product of the magnetic field intensity and the vertical component of the magnetic flux density must also be uninterrupted across the boundary.

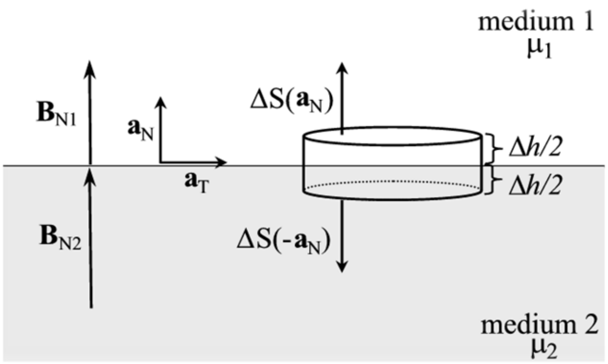

Fig 1 Pictorial Representation of boundary conditions

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II.MATHEMATICAL EXPRESSION

According to Gauss law for magnetostatics

$\oint B.ds = 0$

$\oint B.ds + \oint B.ds + \oint B.ds + \oint B.ds + \oint B.ds + \oint B.ds = 0$

Top bottom left right front back

$B_{N_1}(\Delta S) - B_{N_2}(\Delta S) + 0 + 0 + 0 + 0 = 0$

$B_{N_1} = B_{N_2}$

Normal component of $\vec{B}$ is continuous at boundary

$\mu_1 H_{N1} = \mu_2 H_{N2}$ (B= μH)

$\mu_1 / \mu_2 = H_{N2} / H_{N1}$

Normal component of His discontinuous at boundary
H undergoes some change at interface.

B = Magnetic Flux Density
H = Magnetic Field Intensity
B_{N_1} = Normal Component 1 of Magnetic Flux Density
B_{N_2} = Normal Component 2 of Magnetic Flux Density
H_{N1} = Normal Component 1 of Magnetic Field Intensity
H_{N2} = Normal Component 2 of Magnetic Field Intensity
μ_1 = Permeability of medium 1
μ_2 = Permeability of medium 1

III.NUMERICAL PROBLEM

H1 = 6ax + 2ay + 3az (A/m) magnetic field strength in a material with r1 = 6000 that exists for z 0. For z >0, we wish to locate H2 in a medium with r2 = 3000.

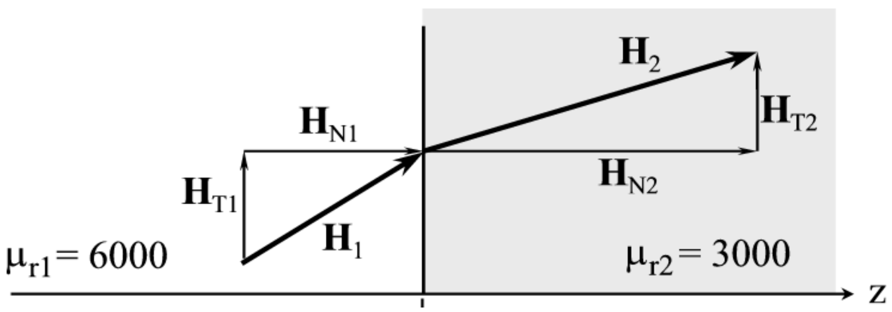

Fig 2 Tangential Component

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aN=[0 0 1]

$H_1 = 6a_x + 2a_y + 3a_z$
$\mu_{r1} = 6000$
$\mu_{r2} = 3000$
$H_2 = ?$

$\boldsymbol{H}_{N1} = (H_1.aN)*aN$

$= (6a_x + 2a_y + 3a_z)(0\ 0\ 1)$

$\boldsymbol{H}T_1 = \boldsymbol{H}1 - \boldsymbol{H}_{N1}$

$= [6a_x + 2a_y + 3\ a_z] - [0\ 0\ 3a_z] = 6a_x + 2a_y$

$\boldsymbol{H}T2 = \boldsymbol{H}T1 = 6a_x + 2a_y$

$\boldsymbol{H}_{N2} = \boldsymbol{H}_{N1} * \mu_{r1}/\mu_{r2}$
$= 3a_z$

$H_2 = \boldsymbol{H}T2 + \boldsymbol{H}_{N2} = 6a_x + 2a_y + 3a_z$

$B_{N1} = \boldsymbol{\mu}_1 * \boldsymbol{H}_{N1} = 18{,}000a_z$

$B_{N2} = \boldsymbol{\mu}_2 * \boldsymbol{H}_{N2} = 18{,}000a_z$

$\mathbf{(B_{N1} - B_{N2}) = 0}$

$$\boxed{(B_{N1} - B_{N2}) = 0}$$

IV. PROGRAM CODE

```
clc;
clear;
aN=[001]/sqrt(1);
disp('Enter the values of H1,u1 and u2')
H1 = input('H1='); u1 = input('ul=');
u2 input('u2='); =
H_N1=(dot (H1, aN))*aN;
H_T1=H1-H_N1;
H_T2=H_T1;
```

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```
H_N2=H_N1*u1/u2;
H2=H_T2-H_N2;
disp('The magnetic field intensity in region 2 is')
H2
B_N1=u1*H_N1
B_N2=u2*H_N2
B_N1-B_N2
```

V. RESULT AND DISCUSSION

Fig 3 shows program code simulated in the Matlab Software

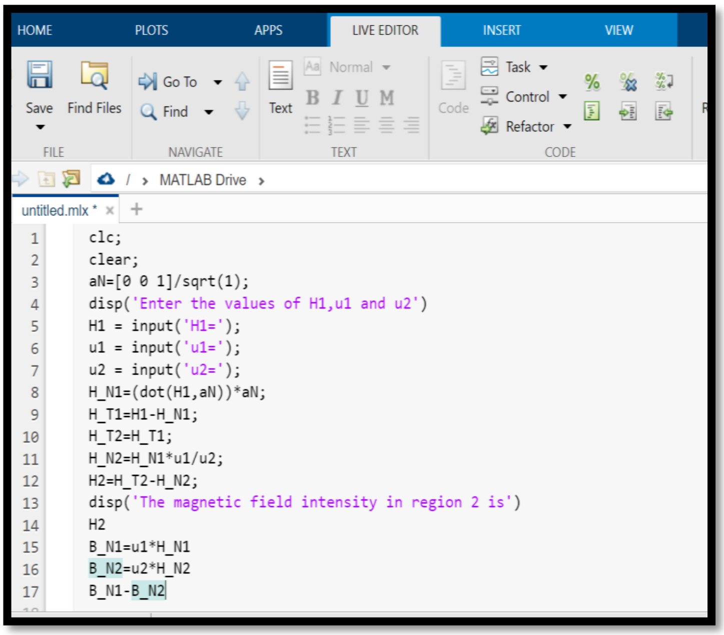

Fig. 3Code Window

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```
Enter the values of H1,u1 and u2


The magnetic field intensity in region 2 is
H2 = 1×3
       6     2    -6

B_N1 = 1×3
             0           0       18000

B_N2 = 1×3
             0           0       18000

ans = 1×3
       0     0     0
```

Fig. 4Output

In the fig 4,The outputs such as the magnetic field intensity in the second medium and the normal components of the magnetic flux densities are obtained

VI.CONCLUSION

The verification of boundary conditions for two different magnetic mediums with different normal angles has been successfully completed. It can be clearly observed from the output of the simulated code that the normal components of the magnetic flux density are equal and cancel of each other. The boundary conditions were derived mathematically,bysolving these boundary conditions, we obtained the expression that describes the behaviour of the magnetic field as it passes through the boundary. The derived expression for boundary conditions can be used in various applications, including the design of magnetic devices such as transformers and motors. The results of this project can also contribute to a better understanding of electromagnetic phenomena and can serve as a reference for future studies in this field.

.REFERENCES

[1] Sadiku, M. N. O. (2011). Elements of Electromagnetics (5th ed.). Oxford University Press.

[2] "Boundary Conditions in Electromagnetics" by D. M. Pozar, Advanced Engineering Electromagnetics, John Wiley& Sons, Inc., 2011.

[3] "Electromagnetic Boundary Value Problems" by J. A. Kong, Wiley-IEEE Press, 2nd ed., 1998.

[4] Wang, S., & Ma, C. (2020). Boundary conditions for electromagnetic fields at the interface between different media. IEEE Transactions on Electromagnetic Compatibility, 62(5), 1425-1437.

[5] Kong, J. A. (1986). Electromagnetic Wave Theory (2nd ed.). Wiley.