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Simulation for the Polygonal Coil Magnetic Field

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Abstract: Based on the study of Helmholtz coils, the intensity distribution of polygons coil magnetic field and characteristics of intensity of that magnetic field is given, this lay the foundation for some industrial application is showed here.

Key words: Helmholtz coils; Polygon current carrying coils; Simulation

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1. INTRODUCTION

Helmholtz coils is widely used in the industrial fields. the feature of that magnetic field produced by two current-carrying coils is approximately uniform near the center region, some researcher give a quantitatively analysis on the spatial distribution of the field Helmholtz coils [1-3]; based on the study of two current carry coils which has the same axis , Zhang Jike set the parameter about three current carrying coils in a rational way [4-5], giving the conclusion that the magnetic field produced by three coils have better character over the standard Helmholtz coils both in strength and uniformity. However, in the actual process of manufacturing and production, polygon current-carrying coil is more easy to manufacturing, so the simulation of intensity distribution feature of the magnetic field produced by polygonal coil is given here .it provides a comparison for the magnetic field produced by both circular loop and polygons coil and also give a reference for the manufacturing for industrial polygons carrying coils.

2. THEORETICAL ANALYSIS

The geometrical structure of the Helmholtz coils is shown in Figure 1.

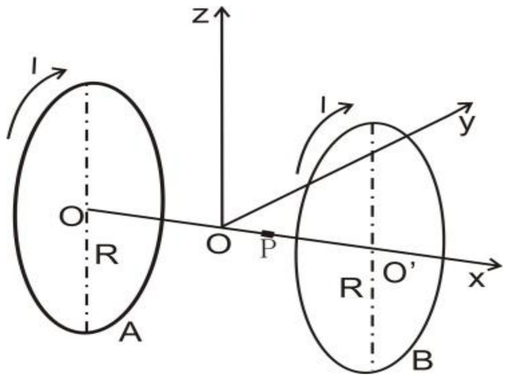

Figure 1
Coaxial Circular Current Loops Model

According to Biot-Savart Law, the strength at P of the magnetic field produced by A is:

$$B_A = \frac{\mu_0 I R^2 N}{2[R^2 + (\frac{R}{2} - x)^2]^{\frac{3}{2}}} \tag{1}$$

The strength at P of the magnetic field produced by A is:

$$B_B = \frac{\mu_0 I R^2 N}{2[R^2 + (\frac{R}{2} + x)^2]^{\frac{3}{2}}} \tag{2}$$

According to the principle of superposition [7], the total magnetic field at P produced by A, B is:

$$B = B_A + B_A = \frac{\mu_0 I R^2 N}{2[R^2 + (\frac{R}{2} - x)^2]^{\frac{3}{2}}} + \frac{\mu_0 I R^2 N}{2[R^2 + (\frac{R}{2} + x)^2]^{\frac{3}{2}}} \tag{3}$$

But when P is not on the axis, we can implement integration by MATLAB in order to simulate plane magnetization.

3. THE DISTRIBUTION OF MAGNETIC FIELD SIMULATION MODEL

We can get the result by using the powerful simulation too MATLAB [8].

3.1. Circular Coil

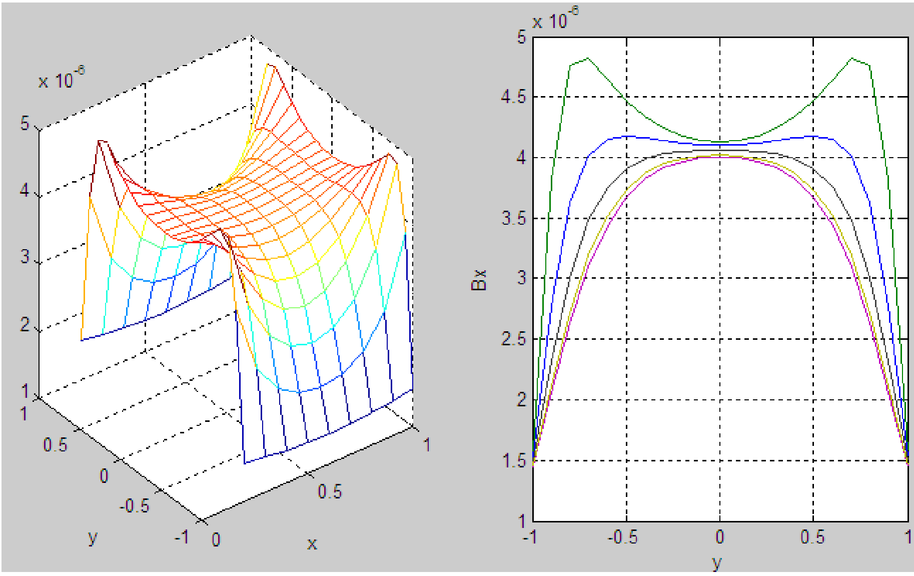

Figure 2
Circular Coil: The *xOy* Plane of the Magnetic Flux Density Distribution and the Trend of the y-Axis

These are the results of simulated circular coil. From above we can see that the intensity of magnetic field distribution is very uniform near the center region.

3.2 Triangle Coil

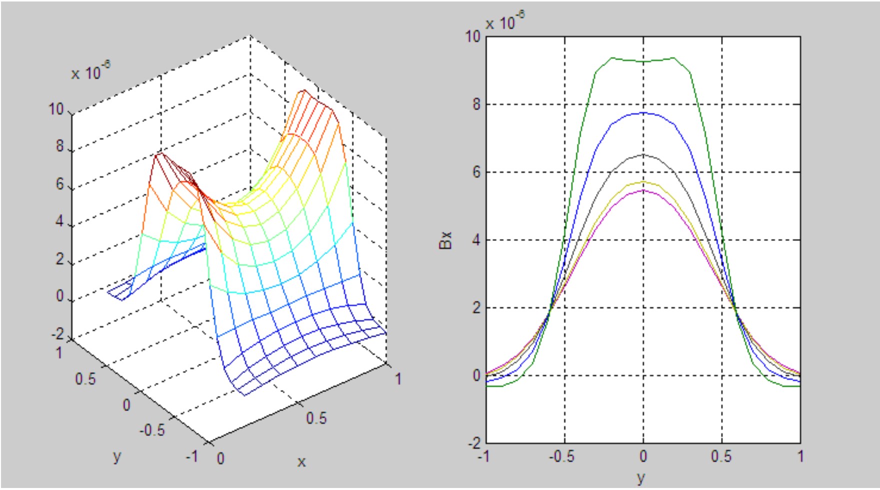

Figure 3
Regular Triangle Coil: The *xOy* Plane of the Magnetic Flux Density Distribution an d the Trend of the y-Axis

These are the results of simulated regular triangle coil. We can see that the intensity of magnetic field produced by quadrilateral coil is strong than that of triangle coil on the middle plane. But the edge effect of the magnetic field produced by the triangle coil is smaller than that of the quadrilateral one.

3.3. *Quadrilateral Coil*

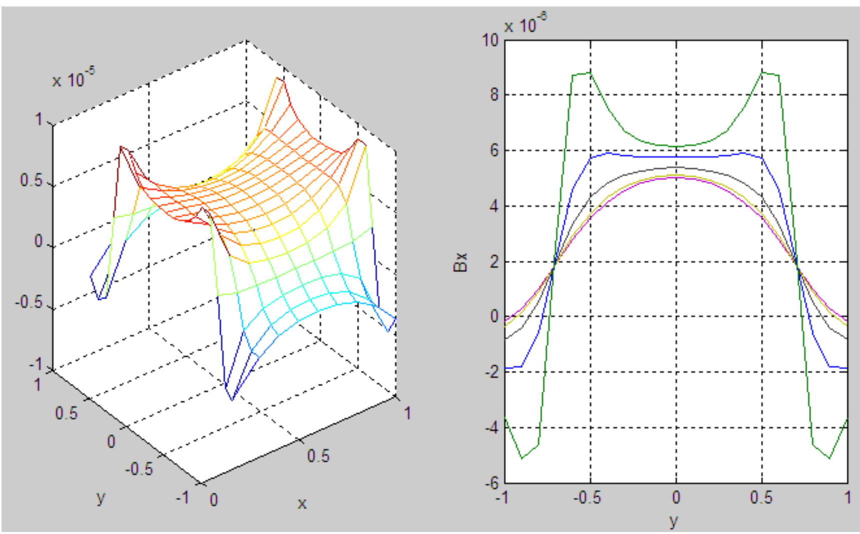

Figure 4
Regular Quadrilateral Coil: The *xOy* Plane of the Magnetic Flux Density Distribution and the Trend of the y-Axis

These are the results of quadrilateral coil. We can see that the magnetic field produced by quadrilateral coil is strong than that of the triangle coil, but weaker than that of the pentagon coil. Also, the edge effect of the magnetic field produced by the triangle coil is small.

3.4. Regular Pentagon Coil

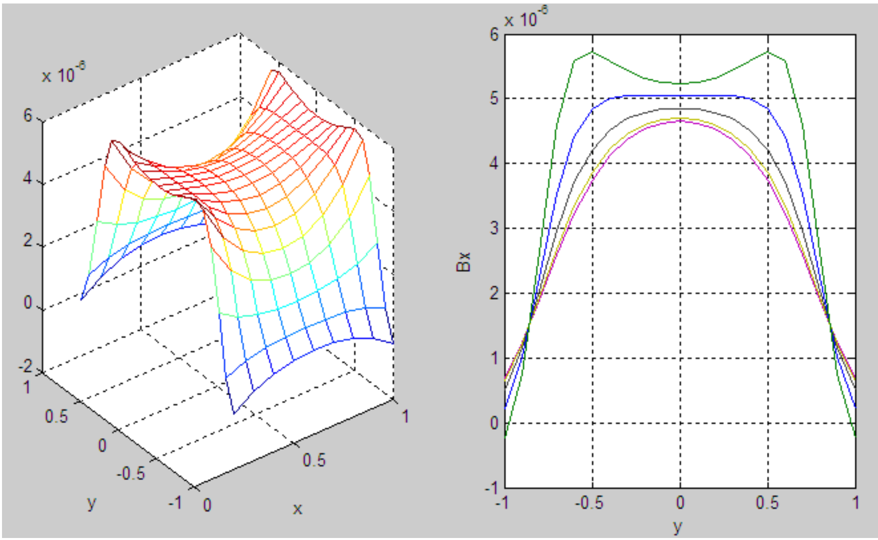

Figure 5
Regular Quadrilateral Coil: The *xOy* Plane of the Magnetic Flux Density Distribution and the Trend of the y-Axis

Above is the result of the quadrilateral simulating coil. We can see that the uniform regions of magnetic field of pentagon coil are wider than that of square coil.

3.5 *Hexagonal Coil*

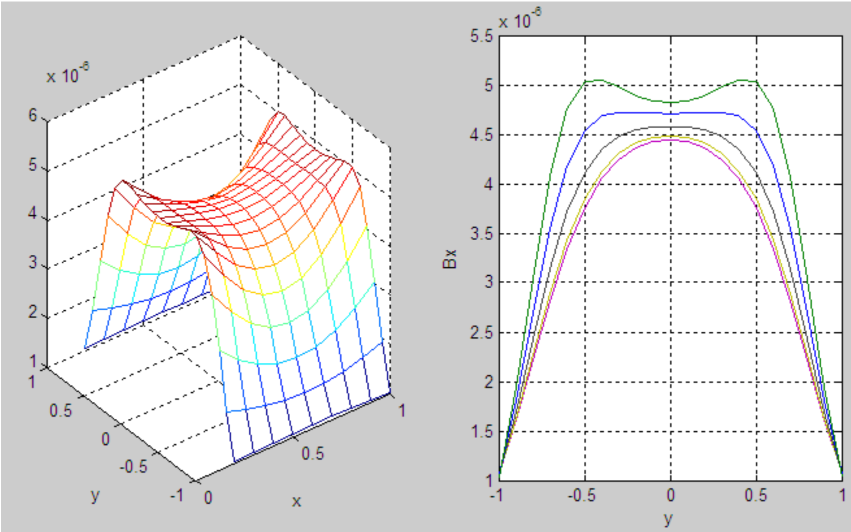

Figure 6
Hexagonal Coil: The xOy **Plane of the Magnetic Flux Density Distri-bution and the Trend of the y-Axis**

Above is the magnetic intensity simulation for hexagonal coil. We can see the intensity of magnetic field in the middle of the plane is slightly stronger than that of the pentagon coil; the edge effect of magnetic field produced by hexagonal coil is larger.

3. CONCLUSION

From above we can see that increase the side number of polygon coil, the intensity distribution of magnetic field is more uniform, and edge effect of magnetic field is more obvious. Based on simulation of the magnetic field of polygon coil, we can design the right polygon coil for industry application.

REFERENCES

[1] Cheng L. L., Li, B., & Xiang, H. R. (2008). Use of helmholtz coils in the measurement of permanent magnets. *Journal of Magnetic Materials and Devices*, (8).

[2] Cai, G. W., Gu, L. X., Jia, Q. K., & Fan, Z. Q. (2007). Principle and design of helmholtz coil for permanent magnetic measurement system. *Journal of Magnetic Materials and Devices*, (8).

[3] Zhu, Y. J., Tao, X. P., & Sun, L. Z. (2010). Discussion of magnetic field of helmholtz coil. *Physics Experimentation*, (3).

[4] Zeng, X. Y. (2000). Helmholtz coil magnetic field homogeneity analysis and error estimation. *Physics Experimentation*, (5).

[5] Zhang, Y. K., & Zan, H. P. (2003). 3 coaxial circular coils formed a uniform magnetic field. *Physics Experimentation*, (10).

[6] Deng, F. B., Jiang, L. H., & Wu, M., F. (2002). Matlab in scientific visualization application. *Shangrao Normal College*, (6), 65.

[7] Zhao, L. Q., & Liang, Z. X. (2008). Analysis of the field distribution between two rectangular helmhotz coils. *Physics and Engineering*, (12), 15.

[8] Zhang, D. F. etc. MATLAB simulation of engineering applica.