A Study on the Deperming of Isotropic Ferromagnetic Material Using Vector M-B Preisach Model

Hyuk Won[1], Hye Sun Ju[2] and Gwan Soo Park[2]
[1]Ulsan Branch Institute, Korea Marine Equipment Research Institute, Technopark, Jung-gu, Ulsan 681-802, Korea
[2]School of Electrical Engineering, Pusan National University, San 30, Jangjeon-dong, Geumjeong-gu, Busan 609-735, Korea
Whyuk98@komeri.re.kr;gspark@pusan.ac.kr

Abstract — It is very important to predict the inside magnetization of ferromagnetic material in the study on deperming. Especially, the study on both ends of the magnetization distribution with a very complex structure necessarily is required. In this paper, inside magnetization of isotropic ferromagnetic material after deperming process is analyzed by using vector M-B Preisach Model and the residual magnetization induced magnetic signal are analyzed. Also, vector M-B model is better than scalar M-B model showed improved results is proved by comparing the experimental and analytical result, under the same conditions.

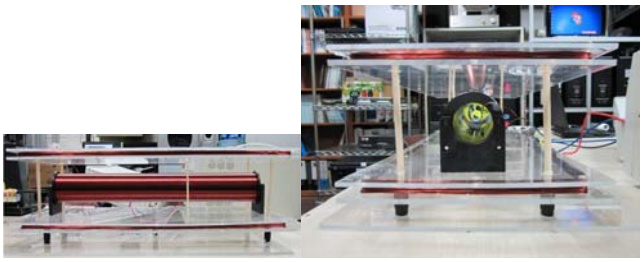
I. Introduction

Deperm is a process of deleting the magnetic flux inside ferromagnetic materials by controlling the magnetic field applied from outside. The magnetization inside ferromagnetic materials has a self-hysteretic property, leading to multi-branch variations. To mimic magnetic characteristics of ferromagnetic materials, hysteresis as well as magnetic saturation should be considered during the analyses. Most widely utilized hysteresis analysis models up to the present are micromagnetics model [1]-[3] and Preisach model [4]-[8]. Micromagnetics model has its limitation in case that it is applied to magnetization on a macroscopic scale and accordingly Preisach modeling technique is more suitable in this case.

In this paper, a study on the deperming of isotropic ferromagnetic materials is conducted based on both experiments with magnetic treatment facility (MTF), which is a miniaturized experimental model, and numerical analysis methods in which the static magnetic finite-element method and Vector Preisach model are combined. Furthermore, the discrepancy was practically negligible between the experimental result from a practical demagnetization process and the numerical analysis result from the proposed Preisach model with M-B variables, under the same conditions.

II. Results and Discussion

The analysis result based on the proposed M-B variable method is compared with the experimental result based on the magnetic treatment facility (MTF) which is displayed in Fig. 1. The measurement model and the analysis model used are shown in Fig. 2 with some dimensions. The material for the demagnetization material is SM45C and the deperm protocol is a current with a 4 [A] maximum value, 606 [turns] of coil, and a total of 12 shots, which is plotted in Fig. 3.



(a) (b)

Fig. 1 Lab MTF System. (a) side view. (b) front view.

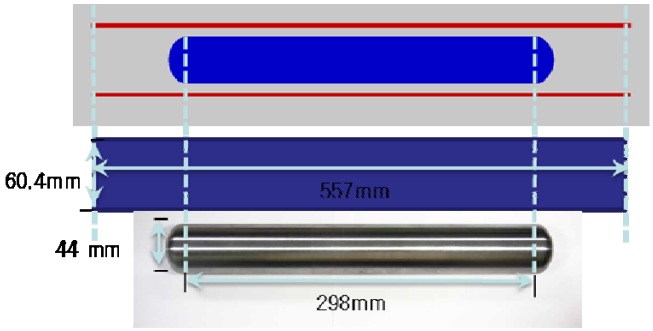


Fig. 2 Analysis and measurement model.

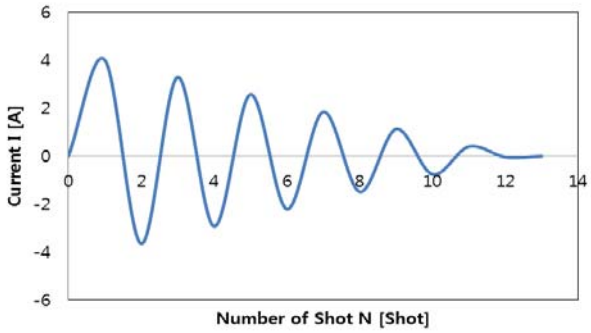


Fig. 3. Deperm protocol.

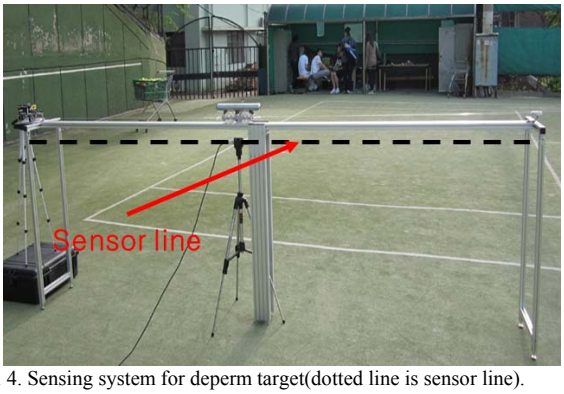
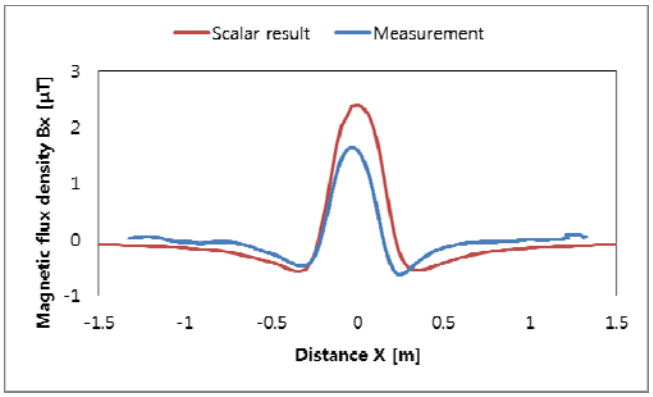
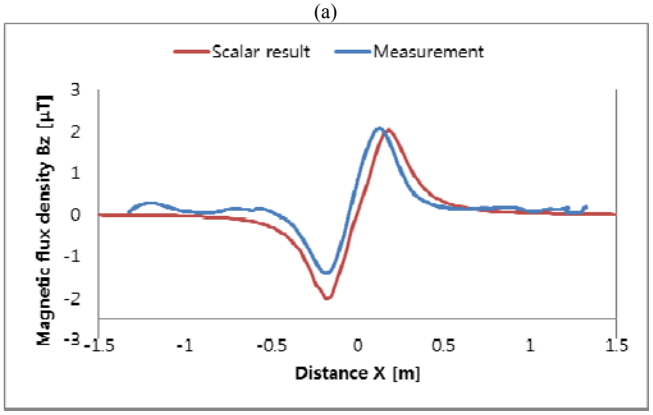


Fig. 4. Sensing system for deperm target(dotted line is sensor line).

8. Material Modeling

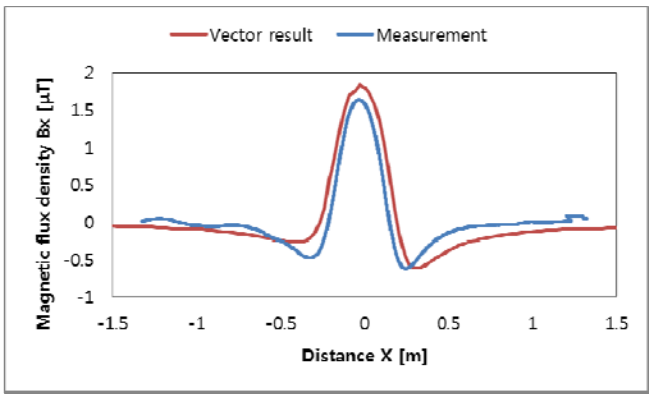


(a)

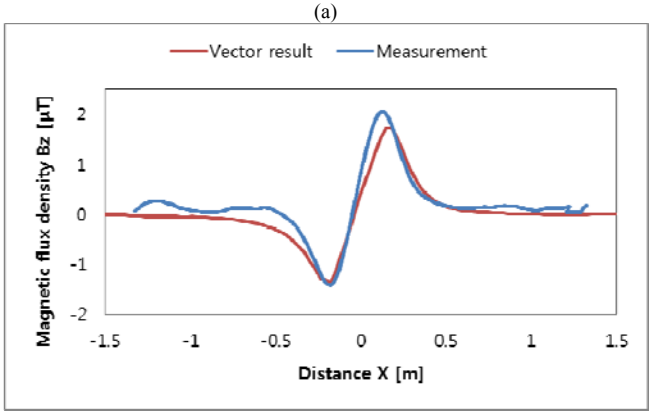


(b)

Fig. 5 Comparison scalar results with measurement. (a) Bx component. (b) Bz component.



(a)



(b)

Fig. 6 Comparison vector results with measurement. (a) Bx component. (b) Bz component.

To compare the result from the proposed analysis method and that from the experiment, we made use of a fluxgate sensor installed 160 [mm] apart from the deperm target, as shown in Fig. 4, and measured the magnetic field while moving the deperm target.

The scalar results are plotted in Fig. 5. Fig. 5(a) shows the Bx component and Fig. 5(b) shows the By component. The disagreement between the result of the scalar analysis method and that of the measurement is 0.2~1 [μT], which validates the feasibility of the proposed method. But, the resulting value is somewhat different as shown in fig. 5. The vector results are plotted in Fig. 6. Fig. 6(a) shows the Bx component and Fig. 6(b) shows the By component. The disagreement between the result of the vector analysis method and that of the measurement is 0.1~0.2 [μT], which validates the feasibility of the proposed method. In summary, vector analysis seems more accurate results from comparison of the analytical results and the experimental results.

III. Conclusion

In this paper, the deperming process is investigated by means of the proposed Preisach modeling technique. In addition, vector M-B model is better than scalar M-B model showed improved results is proved by comparing the experimental and analytical result, under the same conditions. The experimental deperming model and the analyzed result agree well. In the next study, research on the deperming of isotropic ferromagnetic material by changing the deperm protocol will proceed using vector M-B Preisach model.

IV. Acknowledgment

This work has been supported by the Low Observable Technology Research Center program of Defense Acquisition Program Administration and Agency for Defense Development.

V. References

[1] W. F. Brown Jr., “Micromagnetics,” *New York: Interscience*, pp. 46-84, 1963.

[2] J. G. Zhu and H. N. Bertram, “Micromagnetic studies of thin metallic film,” *J. Appl. Phys.*, vol. 63, no. 8, April, 1988.

[3] Werner Scholz and Sharat Batra, “Micromagnetic simulation of head-field and write bubble dynamic in perpendicular recording,” *IEEE Trans. on Mag.*, vol. 41, no. 10, Oct. 2005.

[4] D. L. Atherton, B. Szpunar and J. A. Szpunar, “A new approach to Preisach diagrams,” *IEEE Trans. on Mag.*, vol. 23, no. 3, pp. 1856-1865, May, 1987.

[5] D. L. Atherton and M. Schonbachler, “Measurements of reversible magnetization component,” *IEEE Trans. on Mag.*, vol. 24, no.1, pp. 616-620, Jan. 1988.

[6] I. D. Mayergoyz, “Dynamic Preisach models of hysteresis,” *IEEE Trans. on Mag.*, vol. 24, no. 6, pp. 2925-2927, Nov. 1988.

[7] F. Vajda and E. Della Torre, “Measurements of output-dependent Preisach functions,” *IEEE Trans. on Mag.*, vol. 27, no. 6, pp. 4757-4762, Nov. 1991.

[8] I.D.Mayergoyz and A.A.Adly, "A New Isotropic Vector Preisach-Type Model of Hysteresis and Its Identification", IEEE Trans. on Mag., Vol.29, No.6, pp 2377-2379, Novembewr 1993.