

Re-Demagnetization Characteristics Analysis of a variable-flux Memory Motor Using Coupled Preisach Modeling and FEM

Jung Ho Lee¹, Gi Bok Kim¹ and Jung Pyo Hong²

¹Dept. of Electrical Engineering, Hanbat National University, Dukmyung-Dong, Yuseong-Gu, Daejeon, 305-719, KOREA, E-mail: limotor@hanbat.ac.kr).

²Dept. of Electrical Eng., Changwon Nat'l Univ., Changwon, 641-773, Korea, E-mail: jphong@sarim.changwon.ac.kr

Abstract - This paper deals with the PM performance evaluations in a variable-flux memory motor (VFMM) using a coupled finite element method (FEM) and Preisach modeling, which is presented to analyze the magnetic characteristics of permanent magnets. The focus of this paper is the operation characteristics evaluation relative to magnetizing direction and quantity of permanent magnets on re-, demagnetization condition in a VFMM.

I. INTRODUCTION

Memory motors combine the flux controllability of a PM machine with the high power density of conventional electric machines [1], [2]. They utilize the flux concentration principle that allows the generation of air-gap flux densities that are typical for high-efficiency machines. Memory motors can be built either as variable-flux or pole-changing machines. In both machine types, the magnetization of PMs can be simply varied by a short current pulse, with no need for permanent demagnetizing current as in conventional internal PM machines at flux weakening mode. The distinguishing features of a variable-flux memory motor (VFMM) are the air-gap flux created by rotor magnets can be continuously varied within a fraction of the period of stator current and the re-magnetization current is smaller than rated machine current. The load current i_q cannot demagnetize the magnets. The effects of re- and demagnetization are important issues in the performance of variable-flux memory motor. Therefore, whereas in other kind of machines a rough estimation of magnetization of PMs is acceptable, their importance in variable-flux memory motors justifies a greater effort in calculating them more precisely. Finite element methods have the abilities to model the complicated internal structure within a memory motor and to model magnetizing characteristics to a high degree of accuracy. Preisach's model, which allows accurate prediction of magnetization of PMs, is adopted for this procedure to provide a nonlinear solution [3], [4]. In this paper, a coupled finite element analysis and Preisach's modeling for a variable-flux memory motor (VFMM) is presented and the characteristics analysis is performed under continuous re- and demagnetization.

II. ANALYSIS MODEL

A cross-sectional view of a four-pole variable-flux memory motor is shown in Fig. 1.



Fig. 1 Cross-sectional view of a partially magnetized VFMM



Fig. 2 Flux distribution at magnet 1.05 T and d-axis current 0



Fig. 3 Flux distribution after d-axis current -5A apply



Fig. 4 Flux distribution after d-axis current -10A apply

Fig. 5 shows the flow chart for the proposed analysis method. The flux pattern in PMs of rotor and stator at full, half and magnetization situation etc. are shown in Figs. 2-4, respectively.

In these three figures, the PM magnetizing quantity decreases after demagnetization ampere (d-axis current = from 0 to -10 A) turns were applied, resulting in air gap flux density values.

The magnetization of rotor Alnico magnets was varied in Figs. 2-4 in such a manner that the distance r_0 (negative magnetization) was geometrically increased at a given value to the stator MMF.

This procedure made investigation of the influence of d-axis stator current components on overall magnetization.

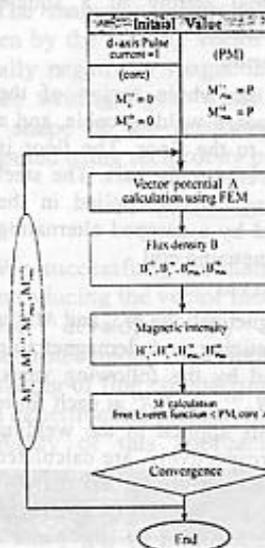


Fig. 5 Flow chart of FEM using Preisach's model

REFERENCES

- [1] V. Ostovic, "Pole changing permanent magnet machines," *IEEE Trans. on Industry Applications*, Vol. 38, No. 6, pp. 1493-1499 Dec. 2002
- [2] V. Ostovic, "Memory motor-A new class of controllable flux PM machines for a true wide speed operation," in Conf. Rec. IEEE-IAS Annu. Meeting, 2001, pp. 2577-2584.
- [3] A. Ivanyi, *Hysteresis Models in Electromagnetic Computation*, AKADEMIAI KIADO, BUDAPEST
- [4] J. H. Lee, D. S. Hyun, "Hysteresis Characteristics Computation on PWM Fed Synchronous Reluctance Motor Using Coupled FEM & Preisach Modeling", *IEEE Transaction on Magnetics*, Vol. 36, No. 7, pp 1209-1213, July 2000.

The Eleventh Biennial IEEE Conference
on Electromagnetic Field Computation



CEFC 2004

Digest Book

June 6 - 9, 2004

Sheraton Grande Walkerhill, Seoul, Korea

Sponsored by



IEEE Magnetic Society



Seoul National University

In Corporation with



Electrical Engineering and Science Research Institute (EESRI)



Korea Electromagnetic Engineering Society (KEES)



Korea Institute of Information & Telecommunication Facilities Engineering (ITFE)



The Institute of Electronics Engineers of Korea (IEEK)



The Korean Institute of Electrical Engineers (KIEE)



The Korean Magnetics Society (KMS)

Supported by



Korea Science and Engineering Foundation (KOSEF)



Korea Research Foundation (KRF)



Korea National Tourism Organization (KNTTO)



| | | |
|---------------|---|------------|
| PE2-24 | Application of Taguchi Method to Robust Design of Acoustic Performance in IMT-2000 Mobile Phones <i>Gun Yong Hwang, Won Yeoul Lee (Yongsan Univ., KOREA), Sang Moon Hwang, Ji Hoon Kim (Pusan Nat'l Univ., KOREA), and Seung Kyu Jeung (Changwon Nat'l Univ., KOREA).....</i> | 375 |
| PE2-25 | New Development of Combined PM Type Microspeakers Used for Cellular Phones <i>Sang Moon Hwang, Hong Joo Lee, Ji Hoon Kim, Beom Soo Kang (Pusan Nat'l Univ., KOREA), and Seung Kyu Jeung (Changwon Nat'l Univ., KOREA).....</i> | 376 |
| PE2-26 | Study and Design of Incline Sensor with Magnetic Fluid <i>Qingxin Yang, Wenrong Yang, Wentao Zhang, Jingfeng Sun (Hebei Univ. of Tech., CHINA), and Decai Li (Beijing Jiaotong Univ., CHINA).....</i> | 377 |
| PE2-27 | Finite Element Simulation of Magnetic Recording with Vector Preisach Hysteresis Model <i>Bastien Orlando (CNRS, FRANCE), Gérard Meunier (CNRS INPG/UJF, FRANCE), Jean-Baptiste Albertini (CEA/GRE, FRANCE), Christophe Guérin (CEDRAT S. A., FRANCE), and Patrice Labie (CNRS INPG/UJF, FRANCE).....</i> | 378 |
| PE2-29 | Investigation on Demagnetization of Residual Magnetization in Architectural Components Using 3-D Magnetic Field Analysis <i>Keita Yamazaki, Kazuo Kato, Shigetaka Hirotsato (Takenaka Corp., JAPAN), Kazuhiro Muramatsu, Tsuyuki Shimizu (Saga Univ., JAPAN), Tomoya Sato, Akira Haga (Tohoku Gakuin Univ., JAPAN), and Koji Fujiwara (Okayama Univ., JAPAN).....</i> | 379 |
| PE2-30 | Re-demagnetization Characteristics Analysis of a Variable-flux Memory Motor Using Coupled Preisach Modeling and FEM <i>Jung Ho Lee, Gi Bok Kim (Hanbat Nat'l Univ., KOREA), and Jung Pyo Hong (Changwon Nat'l Univ., KOREA).....</i> | 380 |
| PE2-31 | Dynamic Characteristics Analysis in a Pole Changing Memory Motor Using Coupled FEM & Preisach Modeling <i>Jung Ho Lee, Gi Bok Kim (Hanbat Nat'l Univ., KOREA), and Jung-Pyo Hong (Changwon Nat'l Univ., KOREA).....</i> | 381 |
| PE2-32 | Application of Design Sensitivity Analysis to Shape Optimization of Conductor Contour in Charge Transfer System <i>Dong-Ik Lee, Il-Han Park (Sungkyunkwan Univ., KOREA), and Young-Ki Chung (Uijae Electrical Research Inst., KOREA).....</i> | 382 |
| PE2-33 | Induction Heating Modeling of Cylindrical Magnetic Load Using Analytical Solution for Magnetic and Thermal Problems <i>M. Namoune, M. Feliachi (GE-44-CRIT, FRANCE), and A. H. Belbachir (Univ. of Tech. of Oran, ALGERIA).....</i> | 383 |
| PE2-34 | A Novel Induction Heating System by Finite Element Analysis <i>W. Jeon (Dongwonroll Co., Ltd., KOREA), S. Ryu, C. Won, D. Han (Konkuk Univ., KOREA), H. Jeon (LG Electronics Inst. of Tech., KOREA), Y. Kamiya, and T. Onuki (Waseda Univ., JAPAN).....</i> | 384 |
| PE2-35 | Virtual Laboratory for Electrical Machines and Power Converters <i>K. W. E. Cheng, K. F. Kwok, and W. K. Chak (The Hong Kong Polytechnic Univ., HONG KONG).....</i> | 385 |