

Characteristic Analysis of Permanent Magnet Assisted Synchronous Reluctance Motor for High Power Application

Jung Ho Lee¹, Young Jin Jang¹ 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 - In this paper, finite element analysis for a permanent magnet assisted synchronous reluctance motor (PMASynRM) is presented and the inductance, torque characteristics analysis is performed under the effect of saturation. Comparisons are given with inductance and torque characteristics of normal Synchronous reluctance motor (SynRM) and those according to quantity of residual flux density (0.1T - 0.4T) in PMASynRM, respectively. Comparisons are given with output characteristics of normal Synchronous reluctance motor (SynRM) and those according to the load in PMASynRM, respectively. And It is confirmed that the proposed model result in high output power performance.

I. INTRODUCTION

The performance of a synchronous reluctance motor (SynRM) in terms of torque and power factor depends on the two-axis inductance L_d and L_q of the machine. The large difference of ($L_d - L_q$) and L_d/L_q ratio are good for the machine's properties. Therefore, Considerable attention has been paid in the past to improve rotor design of SynRM [1] - [3].

By adding a proper quantity of permanent magnets the torque density and power factor of SynRM can be greatly increased. It is called Permanent Magnet Assisted Synchronous Reluctance Motor (PMASynRM).

Finite element methods have the abilities to model the complicated internal structure within a PMASynRM and to model magnetic saturation to a high degree of accuracy.

In this paper, finite element analysis for a permanent magnet assisted synchronous reluctance motor (PMASynRM) is presented and the inductance, torque characteristics analysis is performed under the effect of saturation. Comparisons are given with inductance and torque characteristics of normal Synchronous reluctance motor (SynRM) and those according to quantity of residual flux density (0.1T - 0.4T) in PMASynRM, respectively.

The focus of this paper is characteristics analysis of d, q axis inductance and output power according to magnetizing quantity of interior permanent magnet for PMASynRM.

TMS320C31 DSP installed experimental devices and test machine are equipped and performance characteristics according to load are investigated. The d, q current component ratio, load angles of a PMASynRM are investigated

quantitatively on the basis of the proposed analysis method and the experimental test.

Experimental Comparisons according to load are given with output characteristics curves of normal Synchronous reluctance motor (SynRM) and those according to the load in PMASynRM as shown in Fig. 3, 4, respectively. And It is confirmed that the proposed model result in high output power performance.

II. ANALYSIS MODEL

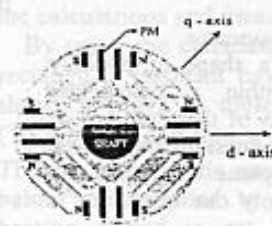


Fig. 1 Rotor cross-section of PMASynRM

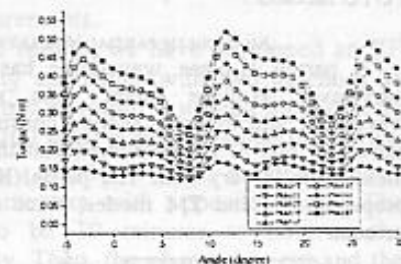


Fig. 2 Torque characteristics according to residual flux density of PMASynRM

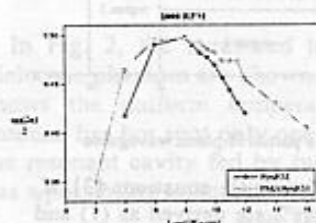


Fig. 3 output characteristic at 2000rpm

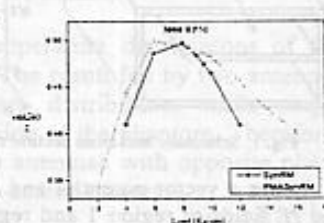


Fig. 4 output characteristic at 3000rpm

REFERENCES

- [1] J. H. Lee, J. C. Kim, D. S. Hyun, "Effect of Magnet on L_d and L_q Inductance of Permanent Magnet Assisted Synchronous Reluctance Motor", *IEEE Transaction on Magnetics*, Vol. 35, No. 5, pp. 1199-1202, May 1999.
- [2] J. H. Lee, "Design Solutions to Minimize Iron Core Loss in Synchronous Reluctance Motor using Preisach Model and FEM", *IEEE Transaction on Magnetics*, Vol. 38, No. 5, pp. 3276-3278, September, 2002.
- [3] J. H. Lee, J. C. Kim, D. S. Hyun, "Dynamic Characteristic Analysis of Synchronous Reluctance Motor Considering Saturation and Iron Loss by FEM", *IEEE Transaction on Magnetics*, Vol. 34, No. 5, pp. 2629-2632, Sep. 1998.

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)



PD3-21	Development of the Magnetic Inductance Tomography System <i>Gwan Soo Park, Kang Seo, and Dong Seok Kim (Pusan Nat'l Univ., KOREA)</i>	316
PD3-22	Design of New Medium Voltage Detecting Systems by Means of 3D Electric Field Analysis <i>Peter Kitak, Igor Tigar, Joze Pihler (Univ. of Maribor, SLOVENIA), Oszkar Biró, and Kurt Preis (Technical Univ. of Graz, AUSTRIA)</i>	317
PD3-23	Classify the Multiplicity of the EEG Sources Using Support Vector Machines <i>Qing Wu, Xueqin Shen, Weili Yan, and Qingxin Yang (Hebei Univ. of Tech., CHINA)</i>	318
PD3-24	The 50Hz Homogeneous Magnetic Field Generators and the Biological Effects <i>Hongyong Guo, Manling Ge (Hebei Univ. of Tech., CHINA), Lingxiao Xing (Hebei Medical Univ., CHINA), Changzai Fan, Qingxin Yang, and Weili Yan (Hebei Univ. of Tech., CHINA)</i>	319
PD3-25	An Alternative Mode Stirred Chamber Modelled by the TLM Method <i>Djonny Weinzierl, Adroaldo Raizer (Universidade Federal de Santa Catarina, BRAZIL), and Arnulf Kost (Brandenburgische Technische Universität Cottbus, GERMANY)</i>	320
PD3-26	Investigation of FDTD Method for Radiated Emission from Differential Transmission Line in LCD TV <i>Hirotsugu Fusayasu, Seiji Hamada, Hiroto Inoue (Matsushita Electric Industrial Co., Ltd., JAPAN), Taro Morii, and Yoshiyuki Ishihara (Doshisha Univ., JAPAN)</i>	321
PD3-27	Analysis and Development of a Radio Frequency Rectangular Resonant Cavity Applicator with Multiple Antennas for a Hyperthermic Treatment <i>Yutaka Tange (Niigata Univ., JAPAN), Yasushi Kanai (Niigata Inst. of Tech., JAPAN), and Yoshiaki Saitoh (Niigata Univ., JAPAN)</i>	322
PD3-28	Mode Characteristic of a Partial H-plane Waveguide <i>Dong-Won Kim and Jeong-Hae Lee (Hongik Univ., KOREA)</i>	323
PD3-29	Characteristic Analysis of Permanent Magnet Assisted Synchronous Reluctance Motor for High Power Application <i>Jung Ho Lee, Young Jin Jang (Hanbat Nat'l Univ., KOREA), and Jung-Pyo Hong (Changwon Nat'l Univ., KOREA)</i>	324
PD3-30	Design and Analysis of PBG Structures on Coplanar Waveguide Using FDTD Method <i>Ming-Sze Tong, Yilong Lu (Nanyang Technological Univ., SINGAPORE), and Yinchao Chen (Univ. of South Carolina, USA)</i>	325
PD3-31	Optimal Design of a Permanent Magnetic Actuator for Vacuum Circuit Breaker Using FEM <i>Yong Min You and Byung Il Kwon (Hanyang Univ., KOREA)</i>	326
PD3-32	Adaptive Mesh Refinement for High Accuracy Wall Loss Determination in Accelerating Cavity Design <i>Lixin Ge, Lie-Quan Lee, Zenghai Li, Cho Ng, Kwok Ko (Stanford Univ., USA), Yunhua Luo, and Mark Shephard (Rensselaer Polytechnic Inst., USA)</i>	327