

# Tooth shape Optimization for Cogging Torque Reduction of Transverse Flux Rotary Motor using Design of Experiment and Response Surface Methodology

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**Abstract**— The aim of this paper is to present optimal design process and optimized model of Transverse Flux Rotary motor. Especially the stator and rotor tooth shapes are optimized to reduce cogging torque. Design of Experiment and Response Surface Methodology are used as an optimization method and all the experimental samples are gotten from 3-Dimensional Finite Element Analysis. After having a series of process, validity of this method is verified by comparing optimized model to initial model.

## I. INTRODUCTION

Permanent Magnet (PM) Transverse Flux Machines have been developed to apply to high power system, and the linear types have been introduced in many cases such as railway traction, electrodynamic vibrator, free-piston generator, etc. [1, 2].

This paper introduces novel shaped Transverse Flux Rotary Motor (TFRM) which has advantages such as high power density, robustness and simple structure. Even though TFRM has such advantages, it has relatively high cogging torque. Therefore this paper gives an optimization process to reduce cogging torque without decrease of total flux.

By performing Design of Experiment (DOE), variables which have mainly effects on cogging torque are selected. Then using Response Surface Methodology (RSM) with the selected variables, optimal design is performed. The cogging torque and flux of sample models are obtained by 3-Dimensional Finite Element Analysis (3D FEA).

The utility of this method is verified through the comparison between initial model and optimized one.

## II. DESIGN PROCESS

The whole design process of this paper is shown in Fig1. With six design variables shown in Fig 2 execute screening activity to choose the critical variable. Then the optimal design of TFRM is executed to improve  $F_{obj}$  by using RSM based on the statistical fitting method. An optimal design is performed considering unique characteristic of TFRM such as 3D flux path.

## III. DESIGN RESULT

Fig 3 shows the comparison of the cogging torque characteristics of initial model and the optimal one. The optimal design results satisfy the requirement very well.

## IV. REFERENCES

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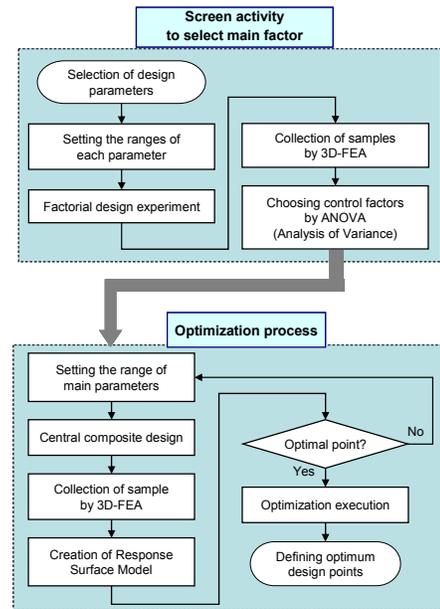


Fig.1. Proposed design process using DOE and RSM

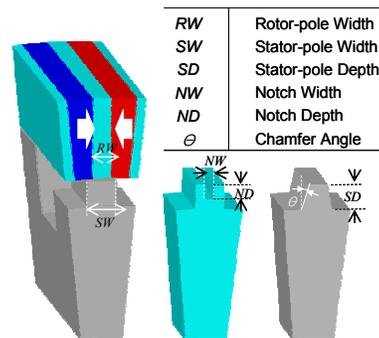


Fig.2. The analysis model and the six design variables for DOE

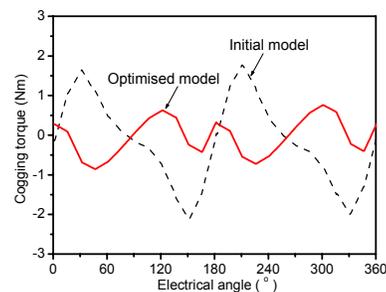


Fig.3. The comparison of cogging torques of prototype and optimized model



April 30th - May 3rd, 2006



[Chair's Welcome](#)

[Committee Members](#)

[Table of Contents](#)

[Author Index](#)

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[Search CD-ROM](#)

[Help](#)

|       |  |     |
|-------|--|-----|
| PF6-7 | <b>Reconstruction of Continuous and Focalized Brain Functional Source Images From Electroencephalography</b> .....   | 486 |
|       | <i>Chang-Hwan Im<sup>1</sup>, Kwang-Ok An<sup>2</sup>, Hyun-Kyo Jung<sup>2</sup>, Ki-Young Jung<sup>3</sup>, and Soo Yeol Lee<sup>4</sup></i>                              |     |
|       | <sup>1</sup> Yonsei University, Korea, <sup>2</sup> Seoul National University, Korea, <sup>3</sup> SungKyunwan University, Korea, <sup>4</sup> Kyung Hee University, Korea |     |

**POSTER SESSION PF7**  
**Devices and Applications XII**  
**May 3, 2006, Wednesday**  
**13:30 - 15:10**

|       |  |     |
|-------|--|-----|
| PF7-1 | <b>Stray Losses Computation in Power Transformer</b> .....   | 487 |
|       | <i>L. Susnjic<sup>1</sup>, Z. Haznadar<sup>2</sup>, and Z. Valkovic<sup>3</sup></i>  |     |
|       | <sup>1</sup> University of Rijeka, Croatia, <sup>2</sup> University of Zagreb, Croatia, <sup>3</sup> Polytechnic of Zagreb, Croatia  |     |
| PF7-2 | <b>Swarm Optimization for Imaging of Corrosion by Impedance Measurements in Eddy Current Test</b> .....  | 488 |
|       | <i>M. Cacciola, S. Calcagno, F. Morabito, and M. Versaci</i>   |     |
|       | University of Reggio Calabria, Italy   |     |
| PF7-3 | <b>Synchronous Machine Parameters Estimation Considering the Field Flux Leakage Saturation</b> .....   | 489 |
|       | <i>Xinli Zhang, Yingli Luo, and Liang Meng</i>   |     |
|       | North China Electric Power University, China   |     |
| PF7-4 | <b>The Characteristics of Noise and Vibration by Asymmetrical Overhang Effect of Permanent Magnet in BLDC Motor</b> .....  | 490 |
|       | <i>Gyu-Hong Kang<sup>1</sup>, Young-Gyu An<sup>2</sup>, and Gyu-Tak Kim<sup>2</sup></i>  |     |
|       | <sup>1</sup> Motor-Net Int. Co. Limited, Korea, <sup>2</sup> Changwon National University, Korea   |     |
| PF7-5 | <b>The Comparison Study of Distributed and Concentrated Winding Types in Interior Permanent Magnet Motor for Integrated Starter Generator</b> .....                        | 491 |
|       | <i>Ji-Young Lee<sup>1</sup>, Soon-O Kwon<sup>2</sup>, Jae-Woo Jung<sup>2</sup>, Jung-Pyo Hong<sup>2</sup>, Yang-Su Lim<sup>3</sup>, and Yoon Hur<sup>3</sup></i>           |     |
|       | <sup>1</sup> Korea Electrotechnology Research Institute, Korea, <sup>2</sup> Changwon National University, Korea, <sup>3</sup> Daewoo Precision Industries Co. Ltd., Korea |     |
| PF7-6 | <b>A FE Tool for the Electromagnetic Analysis of Slow-Wave Helicoidal Structures in Traveling Wave Tubes</b> .....   | 492 |
|       | <i>S. Coco<sup>1</sup>, A. Laudani<sup>1</sup>, G. Pollicino<sup>1</sup>, R. Dionisio<sup>2</sup>, and R. Martorana<sup>2</sup></i>  |     |
|       | <sup>1</sup> University of Catania, Italy, <sup>2</sup> Galileo Avionica, Italy  |     |
| PF7-7 | <b>The Influence of Pressure on SF6 Arc With Contact Evaporation</b> .....   | 493 |
|       | <i>Vui Liau, Byeong Lee, Ki Song, and Kyung Park</i>   |     |
|       | Korean Electrotechnology Research Institute, Korea   |     |

- PF7-8 Theoretical and Experimental Demonstration of the Feasibility of Metallic Surface Cracks Detection Using Microwaves Techniques** ..... 494  
*J. Kerouedan<sup>1</sup>, P. Quéffélec<sup>1</sup>, S. De Blasi<sup>1</sup>, A. Le Brun<sup>2</sup>, and P. Talbot<sup>1</sup>*  
<sup>1</sup>Université de Bretagne Occidentale, France, <sup>2</sup>EDF-R&D/OPP, France
- PF7-9 Thin Crack Modeling in ECT With Combined Potential Formulations**..... 495  
*Y. Choua, L. Santandrea, Y. Le Bihan, and C. Marchand*  
 Laboratoire de Génie Electrique de Paris, France

**POSTER SESSION PF8**  
**Devices and Applications XIII**  
**May 3, 2006, Wednesday**  
**13:30 - 15:10**

- PF8-1 Three-Dimensional Loss Distribution Analysis of an Interior Permanent Magnet Motor Driven by PWM Inverter** ..... 496  
*Yoshihiro Kawase<sup>1</sup>, Tadashi Yamaguchi<sup>1</sup>, Toshiyuki Yano<sup>1</sup>, Satoshi Suzuki<sup>1</sup>, Kazuo Ida<sup>2</sup>, Yoshihiro Kataoka<sup>2</sup>, and Akio Yamagiwa<sup>3</sup>*  
<sup>1</sup>Gifu University, Japan, <sup>2</sup>Daikin Industries Limited, Japan, <sup>3</sup>Daikin Air-Conditioning And Environmental Laboratory Limited, Japan
- PF8-2 Tooth Shape Optimization for Cogging Torque Reduction of Transverse Flux Rotary Motor Using Design of Experiment and Response Surface Methodology** ..... 497  
*Ji-Young Lee<sup>1</sup>, Jung-Hwan Chang<sup>1</sup>, Do-Hyun Kang<sup>1</sup>, Sung-Il Kim<sup>2</sup>, and Jung-Pyo Hong<sup>2</sup>*  
<sup>1</sup>Korea Electrotechnology Research Institute, Korea, <sup>2</sup>Changwon National University, Korea
- PF8-3 Topology Optimization of an Interior Permanent Magnet Synchronous Machine Using a Coupled Finite Elements – Genetic Algorithms Technique**..... 498  
*Dorin Iles-Klumpner<sup>1</sup>, Milorad Risticvic<sup>2</sup>, Ioan Serban<sup>2</sup>, and Ion Boldea<sup>3</sup>*  
<sup>1</sup>MACCON GmbH, Germany, <sup>2</sup>ebm-papst, Germany, <sup>3</sup>University Politehnica of Timisoara, Romania
- PF8-4 Torque Calculation Method of Spherical Robotic Wrist Motor** ..... 499  
*Sung Won and Ju Lee*  
 Hanyang University, South Korea
- PF8-5 Transient Simulation and Analysis for Saturated Core High Temperature Superconducting Fault Current Limiter** ..... 500  
*Cuixia Zhao<sup>1</sup>, Shuhong Wang<sup>1</sup>, Jie Qiu<sup>1</sup>, Jianguo Zhu<sup>2</sup>, Youguang Guo<sup>2</sup>, Weizhi Gong<sup>3</sup>, and Zhengjian Cao<sup>3</sup>*  
<sup>1</sup>Xi'an Jiaotong University, China, <sup>2</sup>University of Technology, Australia, <sup>3</sup>Innopower Superconductor Cable Co. Ltd, China
- PF8-6 Trigonometry-Based Numerical Method to Compute Nonlinear Magnetic Characteristics in Switched Reluctance Motors**..... 501  
*Xiangdang Xue, Ka-Wai-Eric Cheng, Siu-Lau Ho, and K.F. Kwok*  
 The Hong Kong Polytechnic University, China