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, electro-dynamic 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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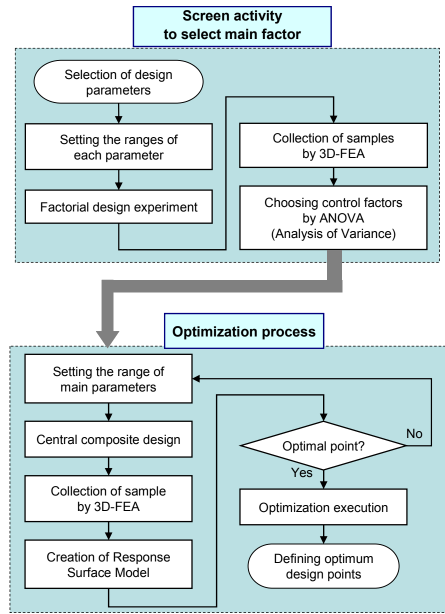

Fig.1. Proposed design process using DOE and RSM

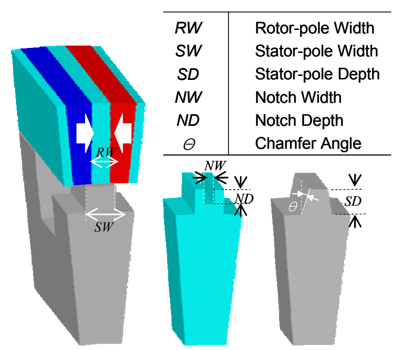

Fig.2. The analysis model and the six design variables for DOE

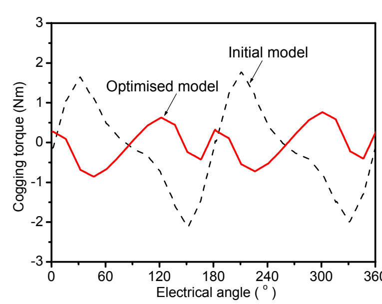

Fig.3. The comparison of cogging torques of prototype and optimized model

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