Design Technique of Magnetic Suspension for Vibration Free Table

Jae-Woo Jung[1], Sung-Il Kim[1], Jung-Pyo Hong[1], Senior Member IEEE,
Ji-Young Lee[2], and Ju-Hoon Lee[3]
[1]Department of Electrical Engineering, Changwon National University
#9 Sarimdong, Changwon, Gyeongnam, 641-773, Korea, E-mail: saltacello@changwon.ac.kr
[2]Transverse Flux Machine Research Group, Korea Electrotechnology Research Institue
[3]Department of Power Facility Diagnosis Research group, Korea Electrotechnology Research Institue
#28-1, Seongjudong, Changwon, gyeongnam, 641-120, Korea, E-mail: jhlee@keri.re.kr

Abstract— This paper proposes the design method of a magnetic suspension that is controlled actively on the exterior vibrations by low frequencies. The magnetic suspension is able to compensate the vibrations with individual controls unlike a mechanical suspension. In the magnetic suspension, two characteristics are required. That is, firstly, magnetic motive force (MMF) by armature winding must be increased linearly. Lastly, the other is same output force as direction of MMF. In this paper, response surface method combined with experimental design is applied to invested the characteristics and optimize the magnetic suspension for vibration free table

I. Introduction

Fig. 1 shows the principle of compensation and cross section of a inserted permanent magnet (PM) type magnetic suspension that composed of armature winding, PM and steel. Reference force, F_{REF} is produced by PM, and that always exists between two steel bodies. When exterior vibration, $F_{EXT}(-)$, happens during t_1, input MMF that flows into each magnetization direction creates resultant force, F_{INC}, in the air gap. In the same manner, as exterior vibration, $F_{EXT}(+)$ is generated during t_2, input MMF that flows into each demagnetization direction brings about resultant force, F_{DEC}, in the air-gap. Thus, in order to operate the suspension, F_{INC} and F_{DEC} should have linearity according to the change of MMF and F_{INC} and F_{DEC} should be same, according to each opposite directions of MMF produced by same current.

The characteristics of the above mentioned magnetic suspension is designed by response surface method (RSM) combined with design of experiment (DOE). The results of the optimal designed magnetic suspension will be verified by comparison with experimental result.

II. Analysis Method

Full factorial design (FFD), one of the experimental designs, is performed to investigate the effect with respect to the amplitude of the force and the balance of the force, the ratio between F_{INC} and F_{DEC}, according to variation of design factors. And then, the important factors greatly influenced on the response are selected. The design factors considered in this paper were as follows; A(return path air-gap), B(PM length), C(main path) and D(upper&lower path length). In the end, RSM is applied to optimize magnetic suspension with the factors [1], [2].

III. Analysis Result

Fig. 2 shows the characteristic of optimal model designed by proposed method in this paper. According to variation of MMF, output force is changed linearly, and the value of Balance approximates almost 1.

IV. References

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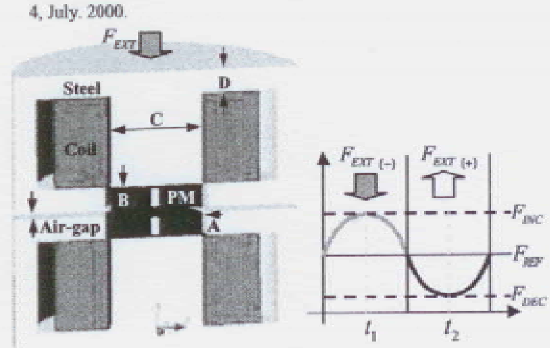

Fig. 1. Cross section of Magnetic suspension and Principle of compensation

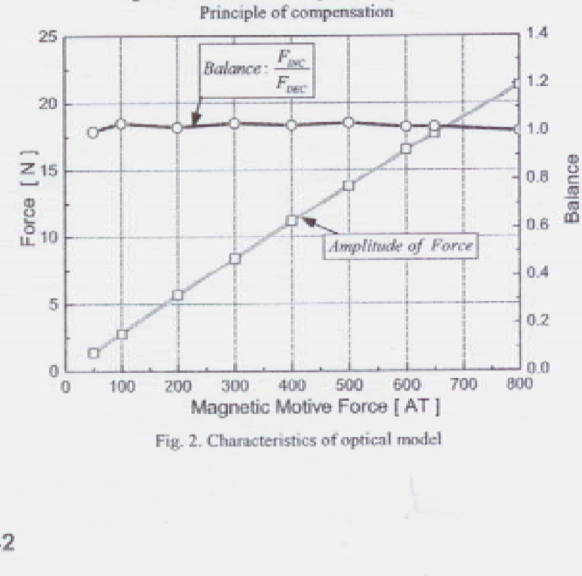

Fig. 2. Characteristics of optical model

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