Effective Method of Inductance Calculation in Permanent Magnet Type Transverse Flux Linear Motor

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Abstract - **This paper deals with an effective calculation method of both apparent and incremental inductances for a permanent magnet type transverse flux linear motor. Firstly the analysis model is divided into three parts according to coil shapes and flux paths because the coil is too long to model the whole shape. The inductance calculation method then is explained for each part. This method is compared with the energy perturbation method in terms of time-efficiency, and verified by comparison of the calculated results with test data.**

Introduction

When nonlinear magnetic materials are considered, coil inductance can be accurately calculated from magnetic energy or flux linkage accomplished by finite element method. The typical example of inductance calculation method is energy or current perturbation, which is demonstrated in [1]. It takes, however, a lot of effort and time to get the inductance for current variation although inductance of even multi-phase coils can be computed by the perturbation method. Correspondingly, a simpler and faster inductance calculation method is introduced in [2]. The method, which the software ANSYS also uses, can be useful to calculate the incremental inductances. However, by the method it is impossible to compute the accurate apparent inductance under saturated condition because apparent inductance is greater than incremental inductance. The two inductances can be same in the unsaturated condition.

Even though those inductance calculation methods have both advantages and disadvantages, there are several application examples for transformers or motors with longitudinal flux. However it is difficult to find an inductance calculation method for transverse flux machines. Moreover the methods used for longitudinal flux machines need to be changed and supplemented for transverse flux machines because winding shapes and flux paths are quite different.

Therefore, this paper deals with an effective calculation method of both apparent and incremental inductances for a permanent magnet type transverse flux linear motor (TFLM). Firstly the analysis model is divided into three parts according to coil shapes and flux paths because the coil is too long to model the whole shape. The inductance calculation methods then are explained for each part. The flux or energy used to calculate the inductance is obtained by three-dimensional equivalent magnetic circuit network [3]. This method is compared with the energy perturbation method in terms of time-efficiency, and verified by the comparison of the calculated value with test data of the machine.

Inductance Calculation Results

Fig. 1 is the schematic of the TFLM geometry and partition of one phase coil. Different model for each part is needed for precise analysis. The flux linkage and leakage flux are obtained from each model at first. Then, apparent and incremental inductances for current change are calculated by supplementing the method in [2], and compared with the energy perturbation method in terms of time-efficiency. The method is verified by comparison of the calculated inductances with test data of the machine as shown in Fig. 2.

In the extended paper, the effective method to calculate inductances of TFLM will be introduced in detail. The calculated inductances will be useful as reliable parameter for dynamic simulation.

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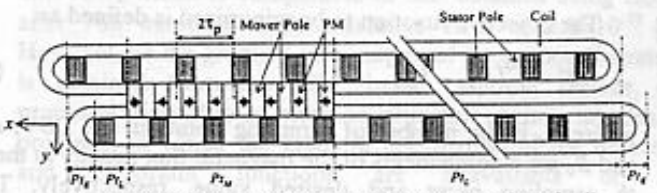

Fig. 1. Schematic of the TFLM geometry and partition of coil

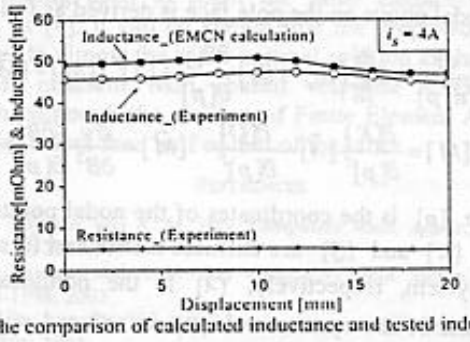

Fig. 2. The comparison of calculated inductance and tested inductance

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