3D Time-Stepping Analysis of Induction Motor by New 3-D Equivalent Magnetic Circuit Network Method

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Abstract **– The paper presents a new time stepping 3-D numerical analysis method for analyzing induction motors. It is method that the analysis model is divided into element and then equivalent magnetic network is constructed by connecting the node of element's center. Also, the MMF by induced current combine passive source into the network. So, by using only scalar potential at each node, it is capable of modeling the induction motor and analyzing the characteristics, 3-dimensionally**

I. Introduction

To estimate time harmonic electromagnetic fields in the electric motors have become important to the motor design [1]. Therefore, the 2-D time stepping finite element method (FEM) is widely applied to the analysis of the motor. But, some error occurs in case that the leakage flux from the side of the core is not correctly modeled by 2-D analysis. Although 3-D FEM used to estimate these effects accurately, very long computation times necessary.

In this paper, new time stepping equivalent magnetic circuit network (EMCN) method that can be analyzed the induction motor 3 dimensionally without additional variable like current vector potential is proposed.

II. Proposed 3 Dimensional Numerical Analysis Method

The proposed method is that the analysis model is divided into hexahedral element like Fig. 1 and then equivalent magnetic network is constructed by connecting the node of element's center. Also, the MMF by induced current combine passive source into the network. Therefore, by using only scalar potential at each node, it is capable of modeling the induction motor and analyzing the characteristics, 3-dimensionally. The proposed method considered the induced current by electromagnetive force (EMF) express the MMF as passive source in the conventional network. Therefore, we can obtain the new reluctance and MMF considering the induced current applying the time diffence method (TDM) as

$$\phi'\left(R_{Forced} + R_{Induced}\right) = \left(F'_{Forced} + F'_{Induced}\right) \qquad (1)$$

where, $R_{Induced}$ and $F_{Induced}$ are the added terms by eddy current in conventional magnetic circuit.

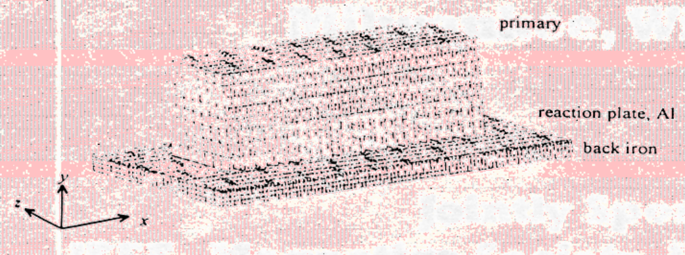

Fig.1. Mesh shape of Analysis model for EMCN.

From (1), we can construct algebra equation to solve the network using the magnetic continuous condition that the sum of inflow and outflow of magnetic flux at all nodes.

III. Results and Discussion

In this paper, in order to verify effectiveness and accuracy of the proposed method, a linear induction motor (LIM) is analyzed. Figuare 2 shows spatial magnetic flux density distribution of each direction in the middle plane of the air gap. Comparing the proposed method and 2D FEM on the thrust in Fig. 3, the 2D analysis overestimate the thrust because it is assumed the eddy current constants under the analysis region and the MMF by endring can not considered. In the final paper, these points plus further results and a detail of the EMCN method will be given.

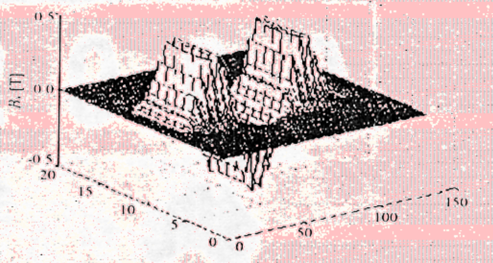

Fig.2. Spatial distribution of magnetic flux density, B_y

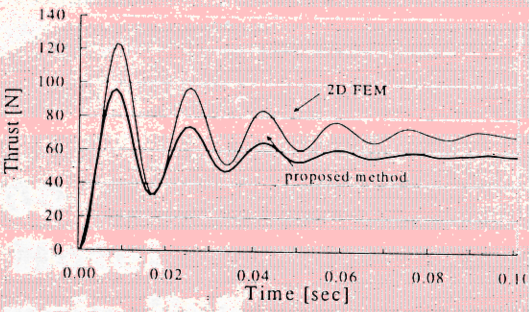

Fig.3. Thrust (comparison of EMCN and FEM)

Reference

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[2] J. Hur, I. S. Jung and D. S. Hyun, "Lateral Characteristic Analysis of PMLSM Considering Overhang Effect by 3 D Equivalent Magnetic Circuit Network Method," *IEEE Trans. on Magnetics*, Vol. 34, No. 5, pp. 3142-3145, Sep. 1998.

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