Analysis of Stator-end Region in Large Turbine Generator by Coupling Axi-periodic Analysis on 2D Finite Element Method

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Abstract **— This paper deals with an analysis method of magnetic field, which affects the stator end regions in a large turbine generator. To estimate the saturation in the stator end regions, axi-periodic analysis is coupled on 2-dimensional finite element method (2D FEM), and the process is named 2D coupled method in this paper. In the stator-end regions, the flux density distribution obtained by 2D coupled method is verified by the comparison with the flux distribution by 3D FEM.**

I. INTRODUCTION

The magnetic field analysis of stator-end region is significant to the large turbine generator because time varying flux induces eddy current, which causes thermal damages to machines. Since end windings of stator in electrical machines have 3-dimensional (3D) distributions, it is required to employ 3D analysis. However, 3D finite element method (FEM) requires large computation time and it is difficult to model end windings. Therefore, axi-periodic analysis is introduced to estimate the flux distribution caused by end windings in generator end region [1]. However, with the axi-periodic analysis method, only the effect of end windings, which is caused by peripheral component of current in end windings, can be estimated and the effects of slots are ignored [2], [3].

Therefore, this paper presents a coupled method of axi-periodic analysis on 2D FEM to consider both fields caused by z-axis current in slots and peripheral currents in end-windings with considering saturation in stator end region. 2D FEM is used to estimate the field caused by z-axis component of current in slot and slot effect. Flux distribution from 2D FEM is superposed to that from axi-periodic analysis, considering the saturation of magnetic material. The resultant flux distribution is compared to flux distribution from 3D FEM.

II. ANALYSIS MODEL AND PROCEDURE

The 3D constructions of the end region in a turbine generator and analysis process are shown in Fig.1 and Fig. 2 respectively. Fig.3 presents the axi-periodic and 2D FEM analysis model. As shown in Fig.2, the process considering saturation consists of 3 steps. Firstly, the flux density and field strength from 2D FEM analysis are estimated. Secondly, the flux density and field strength from axi-periodic analysis are estimated. Finally, the resultant field strength, which is estimated from 2D FEM and axi-periodic analysis, is superposed and resultant flux density is found in B-H curve of material of the stator and rotor.

III. CONCLUSIONS

For the analysis of the end region in large turbine generators, 2D coupled method provides easier modeling and requires less computation time than 3D analysis does and can be easily applied to the initial stage of generator design.

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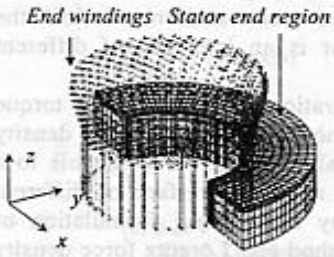


Fig. 1 3D construction of end windings

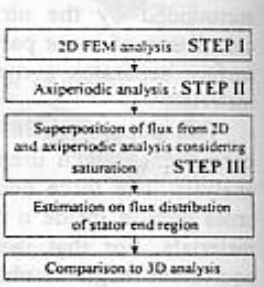
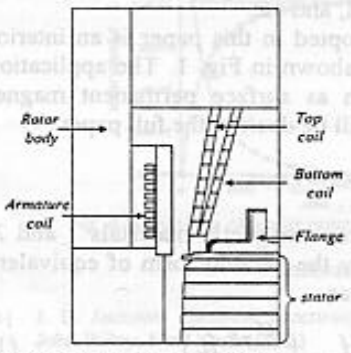
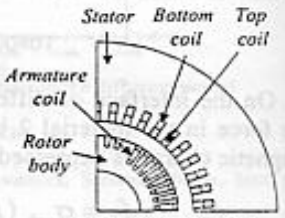


Fig. 2 Analysis process



(a) Axi-periodic analysis model



(b) 2D analysis model

Fig. 3 Analysis models

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