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Comparative Study of MW class Superconducting Machines according to Shielding and Electromagnetic Structures Based on Analytical Method

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The concept of an electric aircraft and ship implies the development of an entirely new electric propulsion system. Among the key technologies of these systems, electric motors and generators are required for high performances such as high efficiency and high specific power. In this paper, a study on the electromagnetic design of the MW class superconducting (SC) machine according to electromagnetic structure was carried out. The structure of a partially SC machine has a three-phase copper coil on the inner rotor and a shield coil or magnetic core in the outermost structure for magnetic shielding. To improve the power density, the weight of the system, and the shielding capability, the electromagnetic field analysis of SC machine is very important in the design stage. To establish the design process of the SC machine, an analytical method considering shielding conditions and type of armature core was proposed. The proposed analytical method is to calculate the analytical solution by deriving the governing equation and general solution for each domain based on Maxwell's equation and electromagnetic field theory and applying appropriate boundary conditions. The magnetic permeability of the air core is the same as that of the vacuum, and the magnetic permeability of the electrical steel core can be calculated using the iteration method based on magnetic field analysis. In addition, the active shield and the passive shield were selected to have the same magnetic field at the outermost shell. The electromagnetic performances obtained using the analytical method were compared with those obtained using finite element (FE) analysis, and the validity of the analytical method presented in this paper was verified through comparison of the analysis results. The analytical modeling, analysis results, performance rating, and discussion according to the core type and shielding conditions of SC machines will be presented in the full paper.

Primary authors: SHIN, Kyung-Hun (Chonnam National University); BANG, Tae-Kyoung (Republic of Korea /Chungnam National University)

Co-authors: Prof. CHOI, Jang-Young (Chungnam National University); Prof. CHO, Han-Wook (Chungnam National University)

Presenters: SHIN, Kyung-Hun (Chonnam National University); BANG, Tae-Kyoung (Republic of Korea /Chungnam National University)

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