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Thu-Mo-Po4.06-06 [44]: Design and property analysis of a performance evaluation system for HTS wind power generators

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Software-based simulations, such as finite element method (FEM), can identify the electromagnetic forces generated by high-temperature superconducting (HTS) coils in a generator, but structural errors can occur in actual manufacturing processes based on the simulation results. Because large wind turbines have high torque, the structural errors in the manufacturing process can cause fatal damage to the system during operation. In this paper, we proposed a performance evaluation system (PES) that can physically test the structural stability of HTS coils with high torque before the generator is manufactured. The PES consists of three HTS coils and corresponding armature windings for use in a 10 MW HTS generator. In the design of the PES, both the HTS coil and the armature are fixed, and the armature is supplied with the same three-phase current as the designed 10 MW HTS generator. The various performance of HTS coils and supports can be effectively evaluated before actual production using the proposed PES. The forces of the HTS coil for the PES were calculated by the Lorentz force equation and analyzed using a 3D FEM software. In the PES, a salient pole was used to have the same force of the generator, since the detent force between the HTS coil and the armature was generated by a linear machine. Through the simulation results, the forces of the PES and the designed HTS generator were compared. As a result, when the same 3-phase current as the HTS generator was supplied to the PES, the force generated by the PES was the same as the generator. This paper is the first step to implement a hardware-based PES, and we confirmed that the output characteristics of the 10MW HTS generator and the proposed PES are the same. The PES can also be used to estimate support stresses and strains of large-scale HTS generators and will be used effectively in future research and manufacturing of large-scale HTS wind turbines.

Authors: Mr KIM, Changhyun (Changwon National University); Ms SUNG, Hae-jin (Chnagwon National University); Prof. YU, In-Keun (Changwon National University)

Co-author: Prof. MINWON, Park (Changwon National University)

Presenter: Mr KIM, Changhyun (Changwon National University)

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