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Thu-Mo-Po4.12-03 [90]: Development of a 1-T Class Force-Balanced Helical Coils Using REBCO Tapes

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Applying high-temperature superconducting (HTS) tapes to superconducting magnetic energy storage (SMES) is expected to improve small sized high magnetic field coils. In developing high field coils using HTS tapes, however, large electromagnetic forces caused by a large current and high field can degrade the critical current of HTS in the winding. To decrease the electromagnetic forces, the authors proposed the force-balanced coils (FBC) concept as a feasible option for SMES. The authors design and develop a 1-T class model helical coils (HTS-FBC) based on the FBC concept using REBCO tapes. Although the FBC can minimize the mechanical stresses induced by the electromagnetic forces, the FBC may cause the decrease in the critical current due to three-dimensional complex shapes of the helical windings. In other words, since the tensile strain, the bending strain and the torsional strain simultaneously apply to the REBCO tapes, the critical current of the HTS-FBC decrease. The objective of this work is to clarify the critical current property of REBCO tapes depending on the applying complex mechanical strain due to the winding process, the winding configuration and the electromagnetic forces through the development of the HTS-FBC. In this work, the authors are carrying out to develop the HTS-FBC which has 0.3-meter diameter using REBCO tapes. The winding of the HTS-FBC will be carrying out by using a prototype helical winding machine whose motion is optimized to prevent from decreasing in the critical current during winding process. The authors are planning to carry out the excitation test of the HTS-FBC with liquid nitrogen cooling and liquid helium. This work discusses the allowable mechanical strain which prevent degradation in the critical current of the HTS-FBC thorough the helical coil development process and the excitation test with liquid nitrogen cooling and liquid helium cooling.
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