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Thu-Mo-Po.05-08: Finite Element Approach for Calculating Stress Distribution in Non-Circular High-Temperature Superconducting Coils

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Complex stress distribution arises in high-temperature superconducting (HTS) coil based on REBCO coated conductors, which is affected by the applied winding tension, thermal stress during cooling down, and electromagnetic forces when energizing the coil. The material and structure of bobbin and overband also play an important role. If the stress exceeds a certain range, it can cause delamination and damage to the tapes, resulting in a significant drop in the performance and lifetime of HTS magnets.
In this study, a finite element (FE) method model was proposed for analyzing the stress distribution of HTS coils with non-circular geometries, especially the stresses arise from winding tension and overband. Compared to traditional analytical methods, this approach is not only applicable to circular coils but also to coils of other shapes, such as racetrack coils for magnetic levitation applications and D-shaped coils in tokamak that could hardly be calculated analytically. Comparison between the traditional analytical model and the proposed FE method model was obtained, which validated the latter one according to the simulation results on the radial and hoop stresses of two circular coils. Next, the proposed approach was used to analyze the winding stress distribution of a racetrack coil and a D-shaped coil. Furthermore, a comprehensive analysis of the stress distributions in the epoxy impregnated racetrack coil and the D-shaped coil was conducted, considering winding stress, thermal stress, electromagnetic stress, and the influence of overband.

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