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Thu-Mo-Po.03-09: Study of coil end of cos-theta superconducting coil with mini cable

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The saddle-shaped coil with mini round cable is a commonly used type of superconducting magnet coils. The cables are embedded in the slots on the formers for winding. The end shape of the coil affects the winding process and the magnetic field. This article compares several types of end shapes for saddle-shaped coils, including the radical-type end, Walstrom end, circular arc transition end, and B-spline end. The main difference lies in the relationship between the axial position z and the azimuth angle φ . This article provides detailed equations describing the path of the coils for the four types of end shapes, including the path equations for the jumper section. The design and processing methods of the coil formers and slots are introduced for different ends. Two methods for establishing finite element models of the saddle-shaped coil using the opera3d 20-node brick, are proposed in this paper. One is to establish it turn by turn with a circular cross-section, and the other is to establish it layer by layer with a fan-shaped cross-section. The calculation method of the 20-node model are described in detail, and the modeling method is suitable for any end shape. Simulation was used to assess the impact of different end shapes on the maximum field at the end and the integral field. The formers is processed with different end shapes, and a dipole coil and a hexapole snake coils are respectively wound to preliminarily evaluate the winding process of different end-shaped coils. This paper compares different end shapes from the aspects of smoothness, winding process, wire usage, maximum field at the end, and integral field. This study provides valuable insights for selecting and designing end shapes for saddle-shaped superconducting coils.

Authors: XIN, Canjie (The Institute of Modern Physics, Chinese Academy of Sciences); GUAN, Mingzhi (The Institute of Modern Physics, Chinese Academy of Sciences); Mr YANG, Tongjun (Institute of Modern Physics, Chinese Academy of Sciences); WU, Wei (Institute of Modern Physics, Chinese Academy of Sciences); Dr LIANG, Yu; HAN, Zhengnan

Presenter: HAN, Zhengnan

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