Force-electric coupling characteristics of CORC cables under bending load

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Abstract

Conductor on Round Core (CORC) cables based on REBCO high-temperature superconducting tapes, with their advantages of high critical current density, high critical magnetic field, low AC loss and excellent mechanical properties, have become the core candidate materials for compact nuclear fusion magnets. However, REBCO tapes are brittle ceramic materials, and the strong coupling effect between mechanical properties and electrical properties significantly restricts engineering applications. The critical current performance of CORC cables is rapidly degraded due to the strain limit easily exceeded under bending loads. Therefore, it is very important to study the bending characteristics of CORC cables. The bending characteristics of CORC cables are systematically studied in this paper. The strain-current degradation law is revealed through experiments and multi-physical field modeling. Based on this, CORC cables with different winding angles, different core diameters and different layers are prepared. Then, three groups of CORC cables are tested by three-point bending test on a self-built low-temperature (77 K) electrical test platform. The critical bending radius of different sample cables is obtained. Furthermore, the 3D finite element coupling model of solid mechanics and flow method and magnetic field module is constructed by COMSOL Multiphysics software, and the mechanical-electrical coupling characteristics of CORC cable under bending load are analyzed for the first time.

Keywords: REBCO, CORC cable, bending load, axial strain, force-electric coupling properties, fusion magnets