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M2Po2B-04: Simulations for the fault current limiting operation of a long-length YBCO CORC® superconducting cable cooled by Helium gas

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The CORC® superconducting cables composed of YBCO coated conductors are of great interest for power transmission applications due to many advantages such as high power density, lightweight and low loss. The flowing cold Helium gas can be used to cool HTS cables down to 50 K to significantly improve their current carrying capacity. Coupled electromagnetic-thermal finite element (FE) simulations implemented in COMSOL Multiphysics package were developed to predict the fault current limiting performance and the cooling after the fault of a YBCO cable cooled in flowing He gas. In the simulations, temperature dependence of electrical and thermal properties of all component materials are considered for better accuracy. In order to overcome computational challenges caused by the considerable difference in geometric scale (a few μm for the HTS tape thickness and 10 m for the length of the cable), the model is divided into two separate simulations. The first simulation is performed on the cross-section of the cable to calculate the electric field, power heating and temperature rise in every component of a CORC® cable when a pulse of current higher than cable critical current is applied for about 30 ms, which would be long enough for electrical breaker to shut off the fault. The heating power calculated in the first simulation will be transferred to the second model to simulate the cooling of a 10 m long cable after the fault. Effect of the flow rate of coolants and the thickness of dielectric insulation layers will also be investigated to suggest strategic approaches for optimizing the design of the cable and cooling system for fault current limiting performance.

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