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Thermal and Electromagnetic Simulation of Multi-stacked No-Insulation REBCO Pancake Coils on Normal-state Transition by PEEC model

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Many researchers have a great interest in applying no-insulation (NI) REBCO pancake coils to high field magnets used for NMR, MRI, and accelerator applications, because NI REBCO pancake coils have a high thermal stability. When a local normal hot spot appears in an NI REBCO pancake coil, the operating current can flow from the turn to the adjacent turns so as to avoid the hot spot. In other words, an NI REBCO pancake coil has a self-protection against a burnout. The high thermal stability of NI REBCO pancake coils has been demonstrated in experiments, and it is recognized as very stable HTS coils. However, it does not mean that an NI REBCO magnet never quenches. In fact, the quench of NI REBCO magnet has been identified in several experiments. Based on the above background, we have developed a numerical simulation to confirm the current and thermal behavior of a single NI REBCO pancake coil during a normal-state transition using a partial element equivalent circuit (PEEC) model. However, in practical applications, multi NI REBCO pancake coils are usually stacked. If one of pancake coils transitioned into a normal state, it would deteriorate the stability of the other pancake coils. Actually, in experiments, it was confirmed that a quench in one pancake coil invoked sequential quenches in the other pancake coils. To develop further valuable applications, the stability of multi-stacked NI REBCO pancake coils should be verified in detail. Therefore, we developed a numerical simulation for multi-stacked NI REBCO pancake coils to confirm a quench process. In this paper, we present the simulation results of multi-stacked NI pancake coils on a normal-state transition by the PEEC model. A sequential-quench phenomenon is reproduced in the numerical simulation, and its mechanism is observable.

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