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The influence of metal plates on quench protection of high temperature superconducting pancake coils

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Metal plates are applied in high-temperature superconducting (HTS) magnet to provide a mechanical support and conduction cooling. The electromagnetic coupling between the metal plates and HTS coils has a considerable influence on the discharge operation of HTS coils during quench protection. In this paper, a multi-physics model is developed using circuit- field coupling method to study the effect of the metal plates on the quench protection operation of the HTS coil. An experimental platform is built to verify the simulation model, which includes dump resistors, HTS double-pancake coil, switch and DC power supply. The central magnetic field, coil voltage and current are measured and analyzed during a series of discharging operations. The HTS coil is carried out at 77K (in liquid nitrogen). The effects of initial transport current, size of metal plates, martials on the discharging process during quench protection are studied by experiments and simulations. Using the simulation model, the temperature of the HTS coil and metal plates is analyzed, and the effect of the initial temperature o is studied. The results show that the metal plates can lead to a sharp current drop in the early stage of coil discharging process, the thickness and quantity of metal plates can significantly accelerate current dropping. Furthermore, the metal plates can keep the temperature evenly distributed in the HTS coil during quench protection, which can significantly reduce the risk of coil damage.

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