Heat transfer monitoring between HTS-CCs and LN_2

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High-temperature superconducting coated conductors (HTS-CCs) are good candidates for resistive superconducting fault current limiter (RSFCL) applications. However, the high current density they can carry and their low thermal diffusivity expose them to the risk of thermal instability. In order to find the best compromise for stability against cost, it is important to study the heat transfer between HTS-CCs and the liquid nitrogen (LN_2) bath. This paper presents an experimental method to monitor in real-time the temperature of a quenched HTS-CC. Current and voltage are recorded too, giving a precise knowledge of the amount of energy dissipated in the tape. These values are compared with an adiabatic numerical thermal model which takes into account heat capacity temperature dependence. The result is a precise estimation of the heat transfer to the liquid nitrogen bath at each time step. Measurements were done on a bare tape as well as insulated ones with several increasing Kapton® thicknesses. The different heat exchange regimes can be clearly identified. This experimental method also allows characterizing re-cooling process after a quench. Finally suggestions are done for an optimal thermal insulation thickness of the HTS-CC in order to reduce the temperature increase of the tape at a rated current and for a given limitation time.

Keywords: Resistive superconducting fault current limiter, High-temperature superconductor coated conductors, Heat-transfer, Thermal stability