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One-dimensional quench analyses combined with quench experiments of conduction-cooled RE-123 coated conductors

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We have been accumulating data of quench experiments using short-pieces of conduction-cooled coated conductors. We aim to clarify the conditions for successful quench detection and protection of conduction-cooled magnets. The short turnaround time of such an experiment allows us to accumulate data at various operating conditions, but it cannot completely simulate circumstances in real magnets. The transverse thermal conduction cannot be simulated, because one side of our sample is attached to a GFRP sample holder, and another side is exposed to vacuum. A limited length of a short sample may affect quench propagation, because both ends are attached to current terminals, which are copper blocks with large heat capacity. We combined one-dimensional quench analyses with quench experiments to study the influence of such restrictions of short-sample experiments.

Our quench analysis model was formulated with the one-dimension heat conduction equation, in which the following factors were considered: the local and transient thermal disturbance inducing quench; the heat conduction along the conductor; Joule heat generation based on the current-sharing model; the transverse cooling (heat conduction to adjacent turns etc.) by using a simplified model. To consider the transverse cooling, we attached a GFRP piece with a certain thickness, which increased entire heat capacity and conducted heat through its thickness, to the sample coated conductor. The temperature of the outer side of this GFRP piece was assumed to be the operating (initial) temperature. The thickness of this GFRP piece was used as a parameter to fit the calculated longitudinal voltage distribution to the measured one. To consider the limited length of the short sample, the length of coated conductor in the model is limited, and the temperature at two ends is constant, same as operating (initial) temperature.

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