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Mon-Mo-Or3-06: Calibration, validation and application of a novel 1D thermal-hydraulic/electric model for the quench analysis of the Al-slotted core HTS conductor for fusion applications

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Numerous high current conductor designs based on High Temperature Superconducting (HTS) materials for fusion magnets have been recently proposed worldwide.
One of the most promising is the Twisted-Slotted-Core Cable-in-Conduit-Conductor comprised of an aluminum core with twisted slots in which REBCO tapes are stacked and with an external metal jacket. The coolant flows in a central hole and in lateral gaps between the stacks and the slots.
A thermal-hydraulic/electric 1D multi-region conductor model is under development to properly address the quench propagation in HTS conductors accounting for their design peculiarities.
Indeed, quench propagation in HTS materials is a well-known issue due to the low normal zone propagation velocity compared to low temperature superconductors (LTS). Since no quench tests have been carried out on HTS conductors, reliable thermal, hydraulic and electric modeling of quench propagation in such conductors is of paramount importance to assess their performance.
The direct applicability of well-known modeling tools for quench analysis in LTS conductors is questionable, due to very different materials, e.g. low and anisotropic thermal conductivity of the HTS tapes with respect to isotropic high thermal conductivity of LTS strands, as well as the different geometry, e.g. a bulky core with few twisted HTS stack compared to the ˜ 1000 (<˜1 mm outer diameter) LTS strands, employed in the HTS conductor design.
In order to properly calibrate the electric model free parameters, e.g., the electrical resistances between the HTS stacks and the slotted core are measured at 77 K.
After the calibration, the model is validated against electrical tests carried out on the HTS conductor equipped with superconductive stacks.
Finally, the 1D multi-region model is applied to the analysis of the quench propagation in the HTS conductor, accounting for the coolant flow in the lateral gaps and in the central hole as well as for the heat conduction in the solids and the current distribution in the current-carrying elements.

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