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Quench protection study of a large scale REBCO magnet with additional copper tapes

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REBCO coated conductors (CCs) are expected to be applied to high field magnets due to their high longitudinal tensile strength and excellent critical current characteristics in high fields. For large scale magnets with large stored energy, the coil design is determined by the feasibility of quench protection. Although various quench protection methods have been proposed for REBCO magnets, the most traditional and straight forward approach is to increase the copper stabilizer and reduce the current density. This approach leads to a significant increase in conductor length to generate a required magnetic field in case a small bore diameter magnet, while the conductor increase would not be serious in case a large bore diameter one. Based on this approach, we have successfully fabricated a practical cryogen-free magnet with a large bore of 200 mm-diameter and a central field of 5 T using REBCO CCs laminated with 0.3 mm-thick copper tapes [1]. For further study, we investigated the feasibility of quench protection through quench tests and analysis in this study. We conducted quench tests on samples of copper-plated REBCO CCs with additional copper tape to assume an energy recovery method with external resistance. In the quench tests, the decay time constant after shutdown was varied to find the conditions that can protect the magnet with high stored energy. In the analysis, we estimated the normal voltage and hot-spot temperature in the quench tests by coupled thermal-electrical analysis. We confirmed that the experiment and analysis were in good agreement and that quench protection was feasible under practical conditions.

[1] M. Daibo *et. al.*, *IEEE Trans. Appl. Supercond.*, 23 (2013) 4602004.

Primary author: Mr MUTO, Shogo (Fujikura Ltd.)

Co-authors: Dr FUJITA, Shinji (Fujikura Ltd.); Mr TSUCHIYA, Koki (Fujikura Ltd.); Mr TAKEMOTO, Tetsuo (Fujikura Ltd.); Mr MASAOKI, Ishii (Fujikura Ltd.); Dr IJIMA, Yasuhiro (Fujikura Ltd.); Mr DAIBO, Masanori (Fujikura Ltd.)

Presenter: Mr MUTO, Shogo (Fujikura Ltd.)

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