27th International Conference on Magnet Technology (MT27)
Fukuoka, Japan / 2021

Contribution ID: **609** Contribution code: **TUE-PO1-705-08** Type: **Poster**

Simulation and Experiments on an AC-Injection Active Protection Scheme for a Conduction Cooled, React-and-Wind, MgB2 MRI Coil Segment

Tuesday, November 16, 2021 1:15 PM (20 minutes)

Here we have studied the performance and quench properties of a large (outer diameter: 901 mm; winding pack: 44 mm thick × 50.6 mm high) conduction-cooled, react-and-wind, MgB2 superconducting coil. Minimum quench energy (MQE) values were measured at several coil operating DC currents (Iop), and distinguished from the minimum energy needed to generate a normal zone (MGE). During these measurements, normal zone propagation velocities (NZPV) were also determined using multiple voltage taps placed around the heater zone. The conduction cooled coil obtained a critical current (Ic) of 186 A at 15 K. Two kinds of heater were involved in this study: (1) a localized heater ('test heater') used to initiate the quench, and (2) a larger 'protection heater' used to protect the coil by distributing the normal zone after a quench was detected. The protection heater was placed on the outside surface of the coil winding. We explored two different protection modes via both experiment and simulation. In the first, a DC power supply was used to energize the protection heater (attached to the coil surface) once a quench was detected. In the second, AC was injected into the windings once a quench was detected, quenching the coil with AC heating generated by hysteretic and coupling losses in the conductors. Simulations of the energy needed from the AC power supply and thermal heating from AC excitation are performed. Different heating mechanisms and protection rates were compared for the two modes (i) pulse provided to external heater, and (ii) AC injection into the windings. The implications of this comparison are then discussed.

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Session Classification: TUE-PO1-705 Quench Detection I