THERMAL AND ELECTRICAL CHARACTERISTICS OF ADIABATIC SUPERCONDUCTING SOLENOIDS DURING A SPONTANEOUS TRANSITION TO THE RESISTIVE STATE

by

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ABSTRACT

Epoxy impregnated superconducting magnets are subject to localized disturbances which create a region in which the superconductor reverts to the resistive state. The current flowing through the resistive (normal) region causes it to grow resulting in rapid heating of the winding. The growth of the normal zone is accompanied by a decay in the current which can induce high voltages between adjacent turns of the winding. The design of systems which protect the magnet from potential damage requires a quantitative understanding of the mechanism by which the resistive region spreads.

Normal zone growth is measured in small samples of wire which are configured to simulate the magnet winding. A correlation is developed for normal zone growth by thermal wave propagation along the conductor and by thermal conduction through the insulation between adjacent turns. The experiments show that the normal zone growth in an epoxy impregnated winding is dominated by turn-to-turn thermal conduction. The correlation can predict normal zone growth in epoxy impregnated windings made of NbTi with minimal experimental data.

A computer program is developed which simulates the normal zone growth in a solenoidal winding. The resistance of the normal zone is calculated from the size of the normal zone and the temperature distribution. This resistance is then used to integrate the circuit equations to yield time dependent current and terminal voltages. A comparison to experiments show a very good agreement when the heat losses from the winding to the liquid helium are negligible. At currents close to critical, AC loss effects become important.

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