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Magnet Note

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Topic: Common Coil Design

Title: Testing HTS common coils at intermediate temperatures

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Testing HTS common coils at intermediate temperatures

As part of the ongoing research into common coils and High Temperature Superconductors, a method has been established for testing common coils at temperatures between 4.5K and 70K. Ic measurements were performed on two coil cassettes at 5K increments, from 5K to 60K.

Design

To measure the current dependence on temperature, several technical issues required addressing.

- A method for heating and stabilizing the coil/magnet assembly at any arbitrary temperature between 4.5K and 70K.
- The ability to use high currents outside the temperature range of the NbTi wire commonly used for magnet power lead connections.
- Measurement of the coil temperature.

Coil temperature stabilization

A structure of two HTS coil cassettes was fabricated, allowing excitation in the dipole configuration. Mounted on the side edges of the holding structure were several 25 watt resistive heaters. These heaters were used to increase the temperature of the coils over ambient. For this test, ambient is the environment which remains in the dewar after the magnet assembly has been cooled to 4.5K using liquid helium. The dewar is not filled with liquid, but allowed to drift once the magnet has reached 4.5K. The remaining helium gas, with the cold dewar walls, is used as a heat sink. The combination of heat sink and heaters allows for stable, active temperature control. At full power, 50 watts, the entire magnet structure warms at a rate of .1K per minute. Full power was capable of sustaining a magnet temperature 15K over the dewar ambient. By reducing heater power, it is possible to hold the magnet temperature at an arbitrary temperature over ambient. The warm magnet shed heat to the dewar and gas, and as the test progressed, the dewar ambient steadily rose, allowing testing at the full range of temperatures desired.

High current leads

Since most of the test is performed well over the critical temperature of NbTi, a HTS lead assembly was developed. This assembly is constructed using two HTS Rutherford type cables soldered between two NbTi cables. The cable assemblies are then epoxy potted into a micarda cavity using emerson and cuming 2850 FT filled epoxy. The NbTi outer cables are present for applications at 4.5K, the HTS cables allowing use up to 60K.

Temperature measurements

To assess the coil temperatures, four temp sensing diodes were used. All four were placed in contact with the impregnated coil surface by the use of a spring. A slot was milled out of the side plates in four locations, and the sensors were slid into the cavity formed. This assured good contact to the coil surface, and protected the sensors from the ambient gas around the magnet. In operation, the typical difference between sensors on the magnet was .3 to .5 K. For the particular tests performed on this HTS coil assembly, the small errors of the sensors were insignificant.