The Design and Test of the Conical Model Coil

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Introduction

In the autumn of 2006 a grant was awarded by the NSF for a Conceptual and Engineering Design (CED) of conical bore hybrid magnet suitable for neutron scattering experiments at the Spallation Neutron Source (SNS) in Oak Ridge, TN. The Conical Florida-Bitter (CFB) technology (pat. pend.) is the novel technology enabling for the design of this magnet. We have built a CFB model coil that has been tested to high current-density, power density, stress and field at the MagLab.

The Design of the Conical Model Coil

The basic design requirements include: 32mm bore, 15° half angle, 5mm sample diameter and dc power less than 8MW. The disks of a 30T magnet $A$ coil are used to build the model coil. The unique feature in CFB technology is that the inner radii of the disks in different zones are different, as shown in Fig.1. Therefore the distribution of the current density, temperature and stresses are different for each zone and need to be calculated zone by zone. The main design parameters and the detailed zone parameters are listed in reference [1].

Experimental

The conical model coil was installed in the housing, which was especially designed for the testing of varied coils, and the whole assembly was inserted in the existing 20-T 200-mm bore resistive magnet (large bore in cell 4). Four different tests were carried out, including high power testing (insert only), high stress testing (insert + outsert), cyclic testing and destructive testing. Water temperature at three different positions (close to zone2, zone 9 and coil outer radius respectively) was measured in order to evaluate cooling performance.

Results and Discussion

In general, the model coil worked very well. It generated 11.5T at 15 kA and 14.1T at 18 kA current. The power consumed was very close to the design value, implying that the cooling effect system performed as intended. While designed for 15 kA, the coil worked at 18 kA current. In addition, the clamping force on the coil proved to be large enough to handle the electro-magnetic torque. The whole structure was very stable.

Conclusions

The design of the conical model coil is complete. It was reviewed by an international committee in November 2007. The model coil was tested in Dec. 20, 2007. It generated 14.1T in a background field of 19.4T for a total of 33.5T. The CFB technology, therefore, is proved to be suitable for the high-field neutron and photon scattering experiments. It will enable such experiments at higher fields than presently available.

References