High-Voltage Testing of the Series-Connected Hybrid Superconducting Outsert Coil for the Helmholtz Zentrum Berlin

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Introduction

A 13-T, 600-mm-bore Nb_3Sn CICC coil has recently been fabricated in the NHMFL's Large Coil Fabrication Bay and will be part of the Series-Connected Hybrid magnet for neutron scattering experiments at the Helmholtz-Zentrum Berlin. During the fabrication, two types of high voltage tests were conducted to qualify the conductor insulation: a surge test and a Paschen test.

The surge test loads interior insulation (between turns) simulating 150% of the anticipated quench voltage. The Paschen test loads the ground insulation (outer surface) by placing a potential across the windings and a temporary ground plane enveloping the coil with the assembly in a rarefied gas.

Results and Discussion

In the surge test, a pulsed voltage was applied across the coil terminations up to 3.05 kV. The terminal voltage during quench is 2 kV. It was applied in a series of steps, starting at a low voltage and increasing to the final voltage. In each pulse the ringing voltage should have similar damping and frequency characteristics but different amplitudes. If a short develops at a particular voltage, a shift in the time domain of the ringing voltage due to a change in the coil impedance would occur. The results from the test on the coil shown in Fig. 1 do not have the shift showing that internal insulation breakdown did not occur.

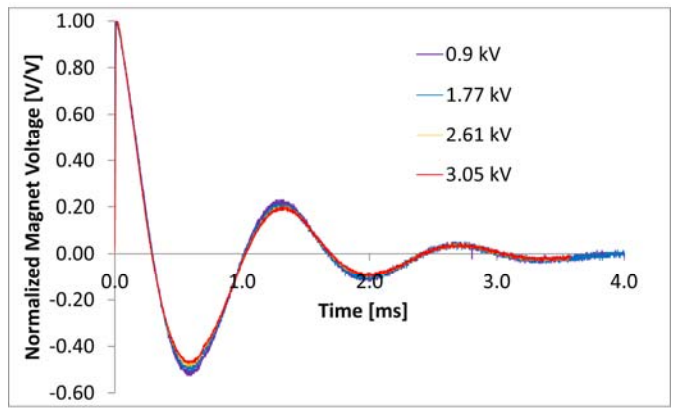

Fig. 1. Normalized ringing voltage from the surge test.

The Paschen test [1] was conducted in a vacuum chamber with air as the medium. The ground plane consisted of copper screen that was wrapped closely around the winding pack, plumbing, leads, joints, and voltage taps. One voltage tap provided a connection to the high voltage source. The test was performed at pressures in the 10 mTorr range up to 100 Torr and every decade in between. Electrical discharges were visible through the three vacuum chamber viewports and an internal camera. After repair of a few thin insulation regions, resistances of 0.8 GΩ at 2.5 kV and 0.5 GΩ at 4.0 kV were achieved. The difference in resistance is attributed to leakage current across the 18 voltage isolators.

Fig. 2. The Outsert coil with the temporary copper ground plane for the Paschen test, with assistance from an FSU Engineering student.

Conclusions

The consistent nature of the ringing voltage in the surge test and high resistance during Paschen test shows that the insulation quality is sufficient.

Acknowledgements

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References

[1] Knaster J., Penco, R, IEEE Trans. Appl. Supercond., **22**, 9002904, (2012)