4LF HTS ROTATING MACHINES

Poster Session 1:00 p.m. – 3:00 p.m.
Thursday, August 8, 2002

4LF01 Calculation of AC Loss in an HTS Wind Turbine Generator

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We have developed a design for a lightweight direct drive transverse flux generator with a rating of 2 MW for application in large wind turbine generators. The design features a multi-pole permanent magnet rotor with a single global HTS stator coil of between 4 and 6 m diameter for each phase. The stator design seeks to minimise exposure of the HTS tape to alternating magnetic fields perpendicular to the face of the tape in order to reduce the AC loss in the stator coils to an acceptable level.

For a coil operating at 50 Hz, the total AC loss is calculated as 15 W/m. Thus, AC losses within each of the three 6 m diameter HTS global coils of a 2 MW generator would be 285 W. The thermal load for the cryogenic system of the 2 MW generator is estimated to total 936 W, with the majority (90%) due to AC loss. Assuming a cryogenic specific power of 20, the energy required to cool the 2 MW generator represents less than 1% of total output.

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4LF02 Design and Electrical Characteristics Analysis of 100 HP HTS Synchronous Motor in 21st Century Frontier Project, Korea

***H.M. Jang**, I. Muta, T. Hoshino, T. Nakamura, Kyoto University; S.W. Kim, M.H. Sohn, Y.K. Kwon, K.S. Ryu, Korea Electrotechnology Research Institute.*

Using two-dimensional electromagnetic field analysis a 100 HP high temperature superconducting (HTS) synchronous motor as part of the 21st Century Frontier Project, Korea, was designed, and its electrical characteristics were evaluated. The motor has a conventional rotating field structure operating at 1800 RPM and an air-gap armature winding. The racetrack field windings are made from Bi-2223 HTS tapes and operate at 30 K. The operating current of the HTS tape was decided for magnetic field analysis of the HTS field winding and the I_c-B characteristics of the HTS tapes. The equivalent circuits with the appropriate machine parameters have been obtained for the fabrication of 100 HP HTS motor.

4LF03 Characteristics of Axial-Type HTS Motor Under Different Magnetic and Temperature Conditions

***H.J. Jung**, T. Nakamura, I. Muta, T. Hoshino, Kyoto University.*

We have replaced a conventional rotor of an axial-type motor with a bulk Bi-2223 rotor, with the object of investigating the possibility of motor application using bulk Bi-2223, and tested the motor to evaluate the performance. The testing results showed that the motor was driven with a large slip and the torque decreased with increasing speed. In this study, to investigate the causes of slip driving and torque decreasing, we measured the motor characteristics under different magnetic and temperature conditions. The motor was tested with different air-gap lengths and exciting methods applied to the armature windings, in order to examine the effects of the magnetic flux density distribution in the air-gap on the motor characteristics. For the purpose of studying the influence of temperature on the torque generation of the motor, torque-current characteristic was measured at different temperatures.

4LF04 Influences of Superconducting Fault Current Limitter (SFCL) on Superconducting Generator in One-Machine Double-Line Power System

I. Muta, T. Dohshita, T. Hoshino, T. Nakamura, T. Egi, Kyoto University.

A superconducting generator in a one-machine double-line infinite-bus system was analyzed. In the model system, superconducitng fault current limitters (SFCLs) are installed in both transmission lines. When a fault happens in one line, the SFCL in the fault line operates and then fault current is limited by the SFCL. However, in some cases, the SFCL in the other line has also been proved to operate due to interference between the transmission lines. The problem of installation of SFCLs in the model system was pointed out by simulation analysis.

4LF05 Torque Characteristics of a Motor Using Bulk Superconductors in the Rotor in the Transient Phase

Y. Tsuboi, H. Ohsaki, The University of Tokyo.

A motor using bulk superconductors in the rotor (bulk superconducting motor) is one possible application. When the bulk superconducting motor is operated with slip, for example during starting point and overload operations, traveling electrical fields are applied to the bulk superconductors. In slip operation, the characteristics of the motor are complex because, under the traveling field, flux flow occurs in the bulk superconductors, which causes an increase in the current but at the same time generates heat, which decreases the critical current density of the bulk superconductors.

In order to analyze the characteristics of a bulk superconducting motor in the transient state and those of a bulk superconductor in traveling fields, pull out tests and locked rotor tests are performed using an experimental apparatus for a hysteresis motor with a bulk superconductor for the rotor. Numerical analysis of the tests are also performed.

4LF07 Design of Field Coil for 100 HP Class HTS Motor Considering Operating Current

J.J. Lee, Y.S. Jo, J.P. Hong, Changwon National University; Y.K. Kwon, Korea Electrotechnology Research Institute.

The value of I_c(critical current) in an HTS (high temperature superconducting) tape is easily influenced by B_n (magnetic field amplitude applied perpendicular to the tape surface). Therefore, the I_c of an HTS magnet as a field coil is determined not only by operating temperature but also by B_n. The magnetic circuit design of HTS motor is important to achieve any operating current under given load conditions, and it is essential to the thermal design of HTS motor rotors. To determine the result of thermal design, the magnetic field distribution has to be known exactly. On the basis of 2D (dimensional) magnetic field analysis, the magnetic field distributions due to several cases were calculated by using the Biot-Savart equation and the magnetic image method. The operating current of the HTS motor was calculated by using I_c-B_n curve and 3D FEA (Finite Element Analysis), and it was verified by the experimental results.

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4LF08 Experimental Investigation of the Heat Transfer Characteristics in a Rotating Cryogenic System

*M.G. Seo, S.W. Kim, Y.S. Jo, S.K. Baik, **Y.K. Kwon**, Korea Electrotechnology Research Institute; M.H. Sohn, Korea Electrotecnology Research Institute.*

A rotating cryogenic system is designed to simulate the cooling system for the rotor of a superconducting motor. The heat transfer characteristics in the rotating cryogenic system at speeds up to 1800 RPM has been investigated experimentally. To examine the total heat leak into the experimental rotor, temperature was measured at each part of the system at various rotating speeds from 0 RPM to 1800 RPM. Total heat leak into the rotor was calculated by the measured mass flow rate and temperature