Contribution ID: **521** Contribution code: **TUE-PO1-506-05** Type: **Poster**

Design and Analysis of a Revolving Armature type Axial Flux High-Temperature Superconducting Motor

Tuesday 16 November 2021 13:15 (20 minutes)

Recently, as interest in high-efficiency motors has increased, motors of various structures have been developed. In particular, the axial flux motor has a relatively low leakage flux, so the power density, output torque, and efficiency are high. High-temperature superconducting (HTS) coils have a higher magnetic flux density than permanent magnets. Therefore, by applying HTS coil to the existing axial type motor, the advantages of weight reduction, miniaturization and high efficiency can be maximized.
This paper deals with a revolving armature type axial flux HTS motor design, fabrication, and its performance analysis.
Using HTS wire, a 2 kW axial flux motor was designed that operates at a temperature of 77 K and a rotational speed of 400 rpm at a rated voltage of 100 V. This axial flux HTS motor, a revolving armature was selected because a solid vacuum condition must be maintained for stable cooling of the HTS field coil.
A 3D finite element method (FEM) simulation was performed to analyze the electromagnetic properties and the thermal characteristics of this motor.
The critical current of the field coil made for the HTS axial flux motor was 65 A at the operating temperature, and the operating current taking into account the cooling margin was 35 A. The output torque and the mechanical power of the motor were 55 Nm and 2 kW, respectively. The magnetic field at the air-gap was 0.4 T. The measured data of the critical currents and the inductances agreed well with the results calculated in the simulation. The results of this study can be effectively used to design various types of HTS axial flux motors in the future.

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Session Classification: TUE-PO1-506 Superconducting Rotating Machines, Linear Machines, and Related Subjects I