APP7-1

Study of bulk HTS rotating machine using Closed-Circuit Magnetization

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High-temperature superconductor (HTS) provide intensified magnetic flux which makes conventional rotating machine more powerful and higher power density. Target applications of HTS rotating machine will be in large sized transporter as represented by ship electric propulsion. If further miniaturization realized, large sized EVs such as electric cargo trucks is able to be taken into consideration as an application of HTS rotating machine.

In this study, Closed-Circuit Magnetization(CCM) for radial gap rotating machine was designed based on FCM. Combined structure of HTS bulk and 2G HTS winding which are installed in the motor structure achieve higher magnetic flux excitation. To apply 2G wire for combined use for armature and magnetizing winding, modified structure of conventional armature was installed.

Thanks to this structure and CCM method, all the field poles is able to be magnetized in only one routine of the excitation and demagnetization with 2G winding. And trapped magnetic flux distribution of each HTS field pole is expected to be uniformed compare with the one of PFM.

In this study, 2D analysis using FEA was conducted to verify the effectiveness of CCM. The armature of the rotating machine was composed by Bi2223 HTS winding and RE123 bulks were installed into four-pole motor. Two types of HTS rotor structure, which are Salient and cylindrical pole design, for prototype model with kW class design was evaluated and optimized.

The design of bulk HTS field pole with CCM was modified by fitting various operating parameters on FEA. Optimized design of the rotating machine will also be presented and discussed.

Part of this work has been financially supported by KAKENHI 16H06136.
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Keywords: FEA, Synchronous motor, HTS bulk, magnetization

APP7-2

Development and Load Test of a Radial Gap Bulk HTS Synchronous Machine for Marine Applications

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Superconducting rotating machines continue to benefit from considerable research and development and have the potential to significantly improve the performance of industrial machinery or even aerospace applications in the future. The power density they display, and thus, their high power/volume ratio, constitute an authentic technological breakthrough and a critical asset for marine applications.
Since 2001 we have been studying the scientific and technical aspects of the HTS bulk superconducting motor concept. Starting from the fundamental understanding and control of the crystal growth to improve the flux trapping performance [1], going through the elaboration of a stable and efficient thermosiphon cooling system [2], and up to the motor electrical, mechanical and thermal designs. In order to do so, we designed individual components and constructed a prototype for proof of concept.
The structure underwent consequent modifications leading to the radial gap machine of today. Featuring single grain RE-123 HTS bulk magnets (QMG, NSSMC) organized in arrays on its rotor four poles, and a conventional copper stator winding, this motor aims for a 30 kVA power output under 5 T magnetization at 190 RPM [3,4]. This presentation, after introducing the machine electrical and mechanical design, will report the results we obtained after load testing at full rated rotational speed and up to 3 T magnetization for field pole.

Part of this work has been financially supported by KAKENHI 21360425 16H04597 and 09F09305 as well as ABB Corporate Research.

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Keywords: HTS synchronous motor, HTS bulk, Thermosiphon

APP7-4

Evaluation of trapped field characteristic of bulk magnet system using various type refrigerators

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We developed several type superconducting bulk magnets with the goal of their industrial application, and study to improve a magnetic field activated by pulsed field magnetization (PFM). It is important problem to choose a suitable refrigerator to cool a bulk superconductor. This paper investigated trapped field characteristics when using several type refrigerators; one is a Stirling refrigerator, in which an ultimate temperature was up to 50 K and cooling capacity was 11 W at 77 K. The other is a two-stage type GM type refrigerator, in which an ultimate temperature was 13 K and cooling capacity was 5 W at 20 K. When cooling and magnetizing tests were carried out using a GdBCO bulk with dimensions of 60 mm in diameter and 20 mm thick, the maximum trapped field of 3.0 T was achieved at 50 K in the bulk magnet system using a Stirling refrigerator.
This work was supported by JSPS KAKENHI Grant Number JP15K05951.

Keywords: REBCO bulk magnet, refrigerator, pulsed field magnetization, trapped magnetic field