APP2-1

Novel Performance for WLTC Operation Mode of 50kW Fully Superconducting Motor Drive System

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Our group has been developing a high temperature superconducting motor, which has been expected for the applications of next-generation transportation equipment, e.g., train, bus, etc. Our motor is so-called High Temperature Superconducting Induction/Synchronous Motor (HTS-ISM). So far, the 20 kW class prototype, which consists of BSCCO rotor and copper stator, has already been developed and shown its excellent characteristics based on experiments and analysis. Furthermore, the 50 kW class HTS-ISM prototype, in which both the rotor and the stator are made of BSCCO superconducting tapes, has been fabricated, and various characteristics have been evaluated.
In order to realize a practical HTS-ISM drive system, not only the HTS-ISM but also peripheral devices such as an inverter and a refrigerator must be investigated. Furthermore, it is really important to study the cooling characteristics during drive conditions.
In this paper, we developed a multidisciplinary analysis method which combines the nonlinear voltage equation, the motion equation and the thermal equivalent circuit. Then, we carried out the so-called World-wide harmonized Light duty driving Test Cycle (WLTC) rotation test for the 50 kW class fully HTS-ISM. The WLTC is a newly adopted global harmonized driving test cycle which is used to measure the fuel consumption and CO2 emissions. It was shown that the nonlinear resistance of HTS stator winding should be considered in the voltage equation to express the exact performance of the HTS-ISM. It was also clarified that the heat generation of the motor is absorbed into the heat capacity of the motor body after the temperature of the rotor bar as well as the stator coil rise instantaneously, due to the large starting current. Furthermore, we successfully calculated the electric power consumption of the 50 kW class drive system and showed that our system possesses high efficiency even we consider the power consumption of cryocooler.

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Keywords: HTS-ISM, Fully superconducting motor, Multiphysics, WLTC

APP2-2

Optimal Design of Air-Core Superconducting Generator Using Simplex Method

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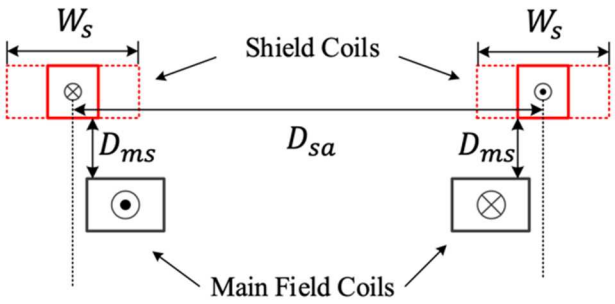
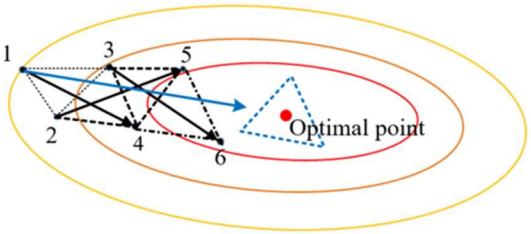
Superconducting(SC) machines have been proposed and demonstrated for several high-power-density applications such as wind turbines, electric aircraft, and ship propulsion by using superconducting wires that can carry more than 100 times the current of conventional copper conductors [1][2]. Especially, fully air-core SC topologies have been considered as an option to achieve very high power density with unit weight of machines. In this paper, 10-MW 3000-rpm class active shield SC-generator which consists of rotating armature is proposed. Fig. 1 shows 1-pole analysis model with key parameters. Simplex method is useful optimization technique for finding the minimum or maximum value of the objective function by using reflection, contraction, and expansion. Fig. 2 shows the simplex method briefly. Initial simplex is formed of point 1, 2, 3. By comparing the objective function values at the points of the simplex, one of them (for example point 1) is reflected to point 4. Now 2nd simplex consists of point 2, 3, 4. It moves to the simplex having the optimal point gradually. In the full paper, the optimal design results by using Simplex method will be presented in detail.





Keywords: Optimal design, Air-core, Simplex method, active shield