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Wed-Af-Or15-07: Analytical and Experimental Study on a Low-Speed and High-Efficiency 1 kW Class Fully High-Temperature Superconducting Induction/Synchronous Generator

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Low speed direct drive generator has been widely used in the renewable energy power generation, due to the advantage of no gearbox. Our group has studied so-called high-temperature superconducting induction/synchronous motor (HTS-ISM), which has the advantages of high efficiency, high torque density and robustness against overload. Especially, its highly efficient generation characteristics at low speed would realize the above-mentioned renewable energy system.
In this paper, a low-speed and high-efficiency fully high-temperature superconducting induction/synchronous generator (HTS-ISG) is designed and fabricated. REBCO tape is adopted for the stator winding and the squirrel-cage rotor winding. Firstly, the current transport characteristics of an YBCO tape are precisely measured and characterized as a function of temperature and magnetic field vector. Then, the open circuit characteristics and load characteristics against the rotational speed of HTS-ISG are analyzed by using the above characteristics. The results show that, when the rotational speed of the HTS-ISG is set to 500 rpm, the induced electromotive force, output power, and efficiency are, respectively, 106 V (peak), 1 kW, and 96.1%. Further, the influence of stator parameters on the current transport characteristics of HTS winding is analyzed and optimized. It is demonstrated that the stator's toroidal winding can reduce the perpendicular components of magnetic flux density with respect to the HTS tape's wide surface. Finally, to verify the performance of the HTS-ISG, a 1kW class HTS-ISG prototype is fabricated, and various experiments are conducted. More detailed simulation and experimental studies will be shown and discussed.

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