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Thermal-Electromagnetic Coupled Analysis Considering AC Losses in REBCO Windings at 65 K of 10 MW Fully-Superconducting Synchronous Generators for Electric Aircraft

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To prevent global warming, CO2 emission by aircrafts is required reduction. For that purpose, the electric propulsion system is focused on as a promising technology. That system enables the aircraft to adopt distributed propulsors which have a great advantage from the viewpoint of aerodynamics. That system contains rotating machines; however, the conventional ones cannot satisfy the stringent weight requirement of aircraft applications. The superconducting rotating machines can be designed as compact and lightweight because of no iron core and the shorter windings than conventional ones. Our research group investigated the fully-superconducting synchronous generator with 10 MW output power for electric aircrafts. We reported the result of simple thermal-electromagnetic coupled analysis focusing on only the temperature rise by the losses. In this study, to obtain the detailed property, we will conduct the thermal-electromagnetic coupled analysis considering the interaction between the temperature rise and the temperature dependence of the losses. The superconducting windings are composed of REBa2Cu3Oy (REBCO) superconducting tapes. The AC loss of them depends on the temperature and the amplitude of magnetic field. In case of armature windings, i.e. large field amplitude, such as > 0.1 T, the AC loss decreases as increasing temperature. In contrast, in case of field windings, i.e. small field, such as < 0.1 T, the AC loss increases as increasing temperature. Considering such complicated property of the losses, the analysis using FEM software will be conducted for 2D models. Conducting analysis for various generator models, for instance, its armature windings with ducts for efficient cooling, the optimal winding structure will be proposed from the viewpoint of cooling. The coolant for the armature windings and the field ones are liquid nitrogen and gas helium, respectively, and the temperature of both coolants is 65 K. The detailed results will be reported in MT27.

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