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Design and Preliminary Experiments of Rotating Armature Partial Superconducting Air Core Generator

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Since the late 2000s, research on electric turbo engine propulsion aircraft is being actively conducted in the aircraft industry to reduce environmental pollution and increase energy use efficiency. The electric propulsion aircraft will be equipped with a large-capacity, high-power density electric motor and generator with superconducting technology. In order to develop superconducting electric machines with high specific power, research on the development of partial superconducting (only field coils use superconductors) and fully superconducting (both fields and armatures use superconductors) electric machines are being actively studied. According to previous studies, when a fully superconducting electric machine is applied, it is possible to develop a device that is 3.5 times lighter than a partial superconducting electric machine, and when calculating the specific power including all the cooling devices, it is possible to achieve 30 kW/kg or more. It is explained that a fully superconducting electric machine is the most appropriate concept applicable to the electric propulsion aircraft of the N3-X (NASA) concept [1]. In this paper, as another candidate model applicable to electric propulsion aircraft, a rotating armature partial superconducting air core generator is proposed, and a conceptual design of a 10MW 3000rpm class generator is performed. The validity of the design was verified through finite element analysis (FEA). As a result of the analysis, it was confirmed that the design target 10MW output power was satisfied, and the specific output was about 11.4kW/kg. The actual performances are verified through a static superconducting magnet force measurement and a lab-scale rotating armature superconducting generator experiment.
[1] M. Corduan, M. Boll, R. Bause, M. P. Oomen, M. Filpenko, and M. Noe, "Topology comparison of superconducting AC machines for hybrid electric aircraft,"IEEE Trans. Appl. Supercond., vol.30, no.2, March 2020.

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