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Design Study of 3 ϕ -10 MVA-6.9/1.0 kV REBCO Superconducting Transformers with Lightweight and Current-Limiting Function for an E-aircraft Propulsion System

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We propose the electric propulsion system which are composed of 10 MW superconducting generators, superconducting transformers, superconducting cables, and 2 MW superconducting motors. The design study of 2 MW fully superconducting motors with a rated voltage of 1 kV is being conducted. On the other hand, the 10 MW fully superconducting synchronous generators were designed so as to operate at a rated voltage of 6.9 kV from the viewpoint of a current capacity of the armature windings. Therefore, 6.9/1.0 kV-10 MVA transformers with lightweight are required. We have already designed a 66/6.9 kV-20 MVA superconducting transformer cooled with subcooled liquid nitrogen at 65 to 70K and successfully fabricated the 1/10 model. Here transposed parallel conductors which were composed of laser-scribed multifilamentary REBCO tapes were adopted to realize a high current capacity and low AC loss. In this paper, we designed a lightweight 6.9/1.0 kV-10 MVA superconducting transformer with REBCO tapes for e-aircrafts so that the transformer had a current-limiting function for early recovery from the quench due to fault excess current. By making a numerical simulation of sudden short-circuit, the current limiting behavior of the superconducting windings was investigated quantitatively. In this paper, it is demonstrated that the temperature rise of the superconducting windings can be suppressed by designing the current limiting function properly.

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