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S Design and test of a superconducting generator for aircraft application

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More electric or all-electric aircraft are seen as a viable solution for improving efficiency, reliability, maintenance in compliance with environmental commitments. This is why many concepts have been developed for a progressive electrification of aircraft with generators, motors and secondary functions as flight control. The benefits of electrification are significant and include: noise reduction, greenhouse gas emissions, pollutants and energy consumption.
For the reasons mentioned above, the aircraft manufacturers wish to develop an aircraft using electric or hybrid energy. Progress in the field of electric motors for the propulsion of cars or ships is a first technological approach for aeronautics. In addition, the technology of YBCO superconducting tapes and pellets is now ripe and ready to be used for aeronautical applications.

In this paper, we present a new topology of superconducting machine. The inductor of the actuator is composed with two superconducting and a classical elements. The first one is a large superconducting coil producing an axial magnetizing field. The second element is a set of superconducting pellets placed inside of the superconducting coil. These pellets shields the magnetizing with the diamagnetic response of the superconducting materials. The magnetic flus density is then modulate between a low value near a pellet and a high value elsewhere. The last part of the machine is two classical armature windings made with copper wire. These windings are placed on both sides of the superconducting system. In this way, we built an axial flux machine. The designed nominal power is 50 kW at 5000 rpm and an operating temperature of 30 K. The cryogenic cooling is provided by a circulation of helium under pressure. No-load, short circuit and load tests have been carried out and extrapolation to a 1 MW machine is in progress.

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