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M3Or2G-01: [Invited] Airplane motors employing superconducting DC field windings and conventional conductor AC windings

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Many organizations are developing compact lightweight highly efficient rotating machines for airplane applications. These machines include permanent magnets for excitation and iron-core with and without superconducting windings. Air-core (no magnetic iron) machines have the potential to be most lightweight and efficient. Such machines can use superconductors for both DC excitation field coils and AC armature coils, which need conductors under development, like MgB2 and Bi2212. Since Liquid-hydrogen (LH2) available on a plane is being considered as a coolant, it becomes feasible to develop machines with AC armature coils made off conventional conductors like copper, aluminum, and high-conductivity aluminum.
This paper describes conceptual designs for a 3 MW, 4,500 RPM motor employing REBCO CORC conductor for the DC field coils and conventional conductor Litz cable for the AC armature coils cooled with available LH2 on the plane. Both rotor and stator coils are contained in separate cryostats. The DC excitation coils on the rotor are operated at 40 K to work successfully with brushless flux pump exciter. Likewise, stator AC coils are cooled with available LH2 for taking advantage of conventional conductors at cryogenic temperatures. Motor size, mass and losses are compared for stator windings employing copper, aluminum, and high-conductivity aluminum (Hyper-AL). Compared with copper and aluminum machines, the machine employing Hyper-AL has smaller size, mass and total losses.

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