Proof-of-Concept Testing for Integrating a Stationary Cryocooler into the Rotor of a Superconducting Motor

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Superconducting motors are seen as a route to electrification of large aircraft for emission reduction. In a synchronous superconducting motor, a popular configuration is to have the rotor with DC field coils and the stator with AC coils. This configuration makes the rotor cooling easier as DC superconducting coils have few losses. Most of the rotor heat to be lifted to ambient comes from shaft conduction, especially if the DC coils are energised with a flux pump. However, the heat from the rotor still needs to be transferred across a rotating interface to a stationary world. This work proposes using a stationary cryocooler's cold heat exchanger as part of a pump to circulate gaseous helium inside the rotor and to use the rotor's spinning action to complete the pumping. In this way the rotating interface for heat transfer becomes the pump. A rotating gas seal is still necessary but this can be at ambient temperature and pressure. CFD analysis has indicated that the system will work with acceptable losses and require less than 20 W of cooling to keep the rotor of a 100 kW motor at 50 K. This paper presents the results from the design, construction and testing of a proof-of-concept prototype of the pumped rotor.