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The Potential for the Use of Low AC Losses Hyperconducting Aluminum in Cryogenic Motors

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The demand for high power density motors for electric propulsion aircraft demands conductors capable of withstanding high frequencies (i.e., 300-1kHz), but also capable of high current density. This is because motor power increases with B, J, and w. Superconductors are attractive because of their high J which can lead also to high B, but they are presently limited to f < 300 Hz. One alternative to superconductors is cryogenic hyperconducting Aluminum (HPAL). HPAL has very high RRR, and thus very low ohmic losses at cryogenic temperatures, and if made with very fine filaments, or as Litz cable, can have very low eddy current losses as well. One of the drawbacks of hyperconducting aluminum is an anomalous magnetoresistance. For B< 2 T, this contribution is minor. In addition, certain composite designs can make this contribution small even at high B. In this work we compare the current densities and AC losses of several different designs of HPAL conductors to superconductors at a variety of temperatures, frequencies, and field amplitudes, specifically for T = 20 and T = 120 K, the regimes of liquid hydrogen and LNG. The level of segmentation and the use of composite vs Litz cable is discussed, as well as the matrix/sheath material. The suitability for use in synchronous induction type propulsion motors is then compared in different regimes.

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