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Quantitative Analysis of AC Losses in HTS Coils Below 40K for Advanced Electric Aircraft Propulsion Systems

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Electric or hybrid aviation technologies are increasingly recognized as pivotal for achieving net-zero emissions in the aerospace sector. Superconducting machines, characterized by their high power-to-weight ratio, are poised to fulfill the advancing propulsion requirements of this domain. The design of future cryogenic systems and the attenuation of alternating current (AC) losses in high-temperature superconducting (HTS) machines necessitate experimental data on AC losses across a spectrum of operational temperatures. Consequently, gaseous helium's employment as a cryogen emerges as a versatile solution, catering to the operational demands of HTS power applications.

Building upon our antecedent research, which delineated the fabrication of multi-filamentary HTS coils and corroborated a significant diminution in AC losses, the present study endeavors to quantify additional AC loss reductions across diverse HTS windings within a rotational machine environment, specifically under the cryogenic threshold of 40K. This investigation introduces a novel fully HTS machine, integrated with a cryogenic helium circulation system for cooling, designed to facilitate an environment conducive to measuring the AC losses in HTS stator windings at sub-40K temperatures. Subsequent to the experimental phase, Finite Element Modelling (FEM) will be employed to corroborate the findings, thereby providing a computational framework to augment future system designs. It is anticipated that the cooling strategy, leveraging a cryogenic gas circulation system, will enhance the performance and power density of fully HTS machines, culminating in an optimized machine efficiency.

References

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