Electro-Thermal Modeling of HTS Power Lines for Cryogenically-Cooled Electric Aircraft Design

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***Abstract*— Emission reduction goals for the aviation industry have led to new research and development efforts in fully electrified propulsion. In the fully-electric aircraft concept currently under development by the Center for High-Efficiency Electrical Technologies for Aircraft (CHEETA), the envisioned power system is cryogenically cooled with many novel components, including high-temperature superconducting (HTS) cables [1]. Creating a physical prototype for a cryogenic power system is costly and difficult, with limited opportunities for testing. Hence, to understand the potential advantages and requirements when using cryogenically cooled systems of these novel components in a more efficient manner, well-defined simulation models are essential before building physical prototypes. Object-oriented, equation-based modeling and simulation technologies allow for the "virtual" implementation of the novel technologies being developed through CHEETA, e.g. HTS models. This allows us to study system responses under various operating conditions, cooling medium, and fault conditions. The cryogenic component models have been created using the object-oriented modeling language, Modelica, as it offers interoperability and portability for multi-domain modeling in the thermal and electrical domains. The presentation shows how the models developed can represent the functional behavior of an HTS line compared to physical experiments, on how the thermal behavior using liquid hydrogen cooling provides good thermal properties with substantial improvements in current carrying capacity.**

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