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Modeling an HTS Cable with a Superconducting Fault Current Limiter in MATLAB/SIMULINK for Integrating in Electric Aircraft

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Aviation electrification is at the center of attention in reducing CO2 emissions. Aircraft are responsible for around 2.4 % of the annual global carbon emissions. This is the motivation behind the development of fully electric, zero-emission aircraft. The advantages of superconductivity, including compactness, lightweight, and high efficiency, make this technology a promising choice to accelerate the transition to electric aviation. A large electric aircraft's powertrain includes motors, converters, DC and AC cables, batteries, fuel cells, fault current limiters, power generators, and fuel storage. This work focuses on modeling two components: resistive superconducting fault current limiter (RSFCL) and HTS DC cable. The adiabatic and non-adiabatic, electrical-thermal lumped-parameter models of the RSFCL are developed in MATLAB. In addition, a configurable MATLAB SIMULINK model of the fault limiter is designed for integration with wider systems models. Moreover, three electrical-thermal models of the HTS DC cable are explained and compared: lumped parameter (0-D), one-dimensional (1-D), and two-dimensional (2-D). Considering the 2-D model as the most credible, the comparison results show that in the case of events (e.g., fault), the lumped-parameter is a suitable and fast short-term solution (during fault). In contrast, in the long-term (after fault), the 1-D and 2-D models are preferred solutions. The results also show that the longer the cable, the higher the credibility of the 2-D model over the 1-D model. A SIMULINK cable model is designed using the lumped-parameter method to simulate its behavior during fault. The designed SIMULINK models of RSFCL and cable give users a high advantage of adjustability and adaptability. Finally, the simulation of a network consisting of these two components in SIMULINK is discussed. The results show the successful performance of the RSFCL to limit the fault current and protect the cable from quench.

Topic

Innovative methods and tools for modelling large-scale HTS systems

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