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Wed-Mo-Po.04-06: Research on transport AC loss characteristics in tenon-mortise modularized conductor (TMMC) with double-layer copper formers

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Evaluation of AC loss is a key issue for high temperature superconducting (HTS) conductor design and optimization, which is critical for the efficient operation of large HTS devices. our research group previously presented a novel HTS conductor named Tenon-Mortise Modularized Conductor (TMMC), composed of multi-layer concentric round sub-conductors arranged in a fully-misaligned configuration. These concentric round sub-conductors are composed of slotted copper formers, which are used for installing stacked REBCO tapes. This research objective is to investigate the transport AC loss characteristics in TMMC, caused by the different amplitudes and frequencies of triangular wave current. Both numerical simulations and experimental methods were employed at 77 K for a comprehensive analysis. A 1-meter-long double-layer TMMC specimen, fabricated from double-layer copper formers, was subjected to electrical testing to measure transport AC loss. It was observed that the transport AC loss of tapes increased with the amplitude of the triangular current, while the frequency of the current had a relatively small impact on the AC loss. Specifically, At current amplitudes of 6 kA and 8 kA, the reduction in current frequency from 1000 kA/s to 500 kA/s corresponded to differences in mean AC loss of 6.5% and 15.5%, respectively, suggesting a low dependence of transport AC loss in TMMC on current frequency. In addition, a 2D double-layer TMMC model was constructed using finite element method (FEM), and the simulation results were compared with experimental results. There was good agreement between the measured and simulated results, with discrepancies likely due to experimental noise. This study investigates the transport AC loss characteristics of the latest proposed TMMC through experimental methods, providing a solid foundation for the development of high-current, low-loss HTS cables for future fusion applications. However, further research is essential to fully understand the factors influencing AC loss and to develop effective strategies for minimizing it.

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