Numerical simulations in REBCO coils under rotating magnetic fields

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Abstract body:

AC loss presents a significant challenge for high-temperature superconducting (HTS) rotating machines. Understanding the loss behaviour of HTS coils in rotating fields and exploring methods for loss reduction is essential. This study numerically investigates the total AC loss (Q_{tol}) (with current) and magnetization loss (Q_m) (without current) in HTS coils under non-uniform rotating magnetic field. The losses of three 4-turn HTS coils are compared, which are wound with a 4 mm wide tape, a striated tape with two 2 mm filaments, and a striated tape with four 1 mm filaments, respectively. Additionally, AC loss in the coils at 77 K and 65 K are explored. The loss behaviour with back iron, which acts as a flux diverter, is also discussed. It is worth noting that, under rotating magnetic fields, the striated structure of the coils significantly reduces both Q_{tol} and Q_m. At high fields (e.g., above 200 mT for Q_m at 77K), compared to the loss in the un-striated coil, the loss in the coil wound with the two-filament striated tape decreased by almost half, and the loss in the coil wound with the four-filament striated tape was reduced to nearly a quarter. Interestingly, we also show, that under rotating magnetic fields, Q_m and Q_{tot} can be effectively scaled with the critical current of either the coil or the tape. This suggests that losses at different temperatures potentially can be estimated using their respective critical currents.

Key words:

HTS coils, rotating magnetic field; magnetization loss; total AC loss; finite element method (FEM)

