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AC loss simulation in HTS coil windings coupled with an iron core

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Rapid-cycling synchrotrons (RCSs) are desired as the main component of radiotherapy facilities for cancer treatment in order to meet growing patient numbers. Superferric magnets consisting of high temperature superconducting (HTS) coil windings and iron cores are considered to be an effective solution for reducing construction cost and electricity consumption for RCSs. However, superferric magnets generate AC loss in their HTS coil windings when carrying AC current. The leakage magnetic field from the iron core also directly affects the AC loss of HTS windings. It is desirable to develop design methodologies for superferric magnets with minimized AC loss. FEM (Finite element method) is a powerful tool to develop the design methodologies for RSC magnets.

In this work, we carry out 3D FEM AC loss simulations in HTS coil assemblies coupled with an iron core using the T-A formulation. The dimensions of the iron core are based on our earlier published work. The HTS coil assemblies comprise double pancake coils (DPCs) wound with coated conductors manufactured by Shanghai Superconductor Co. with an average self-field Ic of 193 A. The number of DPCs and the distance between the iron core and the inner-turn of the DPCs are varied to investigate AC loss dependence on coil geometry and the influence of leakage magnetic field from the iron core on AC loss of the HTS windings, respectively. It is worth noting that the iron core geometry kept the same for all the simulated cases. The magnetic field and current density distributions of different parts of the HTS coil assemblies are compared to help understand the AC loss generation mechanism of the HTS coils coupled with the iron core.

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