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Modeling of screening currents in superconducting non-insulated REBCO magnets: fast and accurate 2D approach

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Non-insulated (NI) coils in superconducting REBCO high-field magnets provide electro-thermal stability. However, current transfer between turns through the metal causes transient currents and magnetic fields, increasing the AC loss and requiring longer times to charge the magnet. Therefore, magnet design and optimization requires numerical modeling. Although 3D modeling provides the full description, it is highly time consuming. In this contribution, we propose an effective cross-sectional 2D modeling method to model the screening currents and turn-to-turn currents in non-insulated coils within high-field magnets. This technique is based on the Minimum Electro-Magnetic Entropy Production method [1,2], which is programmed in C++ and enables parallel computing [2,3]. With this method, we analyze the screening currents, instantaneous AC loss and generated magnetic field in tentative designs of high-field superconducting magnets generating more than 32 T. The fast numerical method enables to evaluate the magnet performance considering either a homogenized approach or by taking the details of each turn into account. This method can also be applied to power devices, such as rotor windings in motors and generators. In the future, we expect to extend this method in order to take multi-physics modeling into account.

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