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AC loss reduction on a 6.5 MVA/25 kV HTS traction transformer by exploiting asymmetric conductor critical current

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A 6.5 MVA/25 kV high temperature superconducting (HTS) traction transformer for the Chinese high-speed train was proposed in earlier works aiming to replace the oil-based transformers while achieve higher efficiency, lighter weight, and minimized volume. The high targeted efficiency of the transformer (> 99%) makes AC loss reduction a vital issue. HTS coated conductors generally exhibit asymmetric Ic (B, θ), where θ is the angle between the magnetic field and normal component of the conductor face, leading to a non-trivial influence on the AC loss of coil windings. Meanwhile, commercial HTS conductors from different manufacturers may have distinctive characteristics in their critical currents. AC loss reduction of the 6.5 MVA transformer windings by exploiting asymmetric conductor critical current is essential to achieve the efficiency target.
In this work, we carried out AC loss simulations on the HV and LV windings of the 6.5 MVA transformer through combination of two-dimensional axisymmetric T-A formulation and homogenization method. The HV windings are wound with HTS coated conductors, whereas the LV windings are wound with Roebel cables. In our simulation, the measured Ic (B, θ) curves of HTS conductors from different manufacturers are used as the input for the simulation. The simulated AC loss values in HTS transformers wound with coated conductors from different manufacturers are compared. The simulation results clearly show that AC loss reduction can be achieved by exploiting the asymmetric conductor critical current, and this can be used to improve the efficiency of the 6.5 MVA traction transformer.

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