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M2Or3J-05: [Invited] AC Loss in no-insulation ReBCO racetrack coils for high-dynamic applications

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There is growing interest to use superconductors for actuator applications. High-field superconducting electromagnets enable a much higher performance. DC-excited stator coils in such systems are subjected to time-varying magnetic fields of up to several hundred mT, leading to significant AC loss. Inherently stable no-insulation coils make motion systems more reliable, but come at the cost of even higher AC loss. Here we focuss on the AV loss in such NI ReBCO coils, determining them both numerically and experimentally.

We developed a specific test arrangement and measured the AC loss in 200 mm long and 20 mm wide NI ReBCO racetrack coils made of single 4 mm wide tape conductor at 4.2 and 77 K. The combined effect of a parallel AC magnetic field with an amplitude of up to 100 mT and a DC transport current up to 600 A was investigated. The loss was measured simultaneously with magnetic, electric and calorimetric methods. The results largely confirm the numerical model predictions, which were obtained a-priori from only the coil dimensions, its critical current and the effective time constant τ associated with radial current redistribution. For this research, the coils were solder-impregnated resulting in a relatively low turn-to-turn surface resistance of 1 μΩ·cm^2 and a τ-value of approximately 65 s, corresponding to a characteristic frequency f_c of 2.4 mHz.

The AC loss of the coils is determined in the frequency range of 0.5 mHz to 1.25 Hz. For f<f_c, *couplingcurrentsdissipatehomogeneouslyth*
f_c, theeffectofcurrentconcentrationduetotheskin−effect(P_ac √f)thatispredictedbythemodelisalsoclearlyvisibleinthedat
DespitetheinherentthermalstabilityofNIReBCOcoils, thesignificantlyhigherAClosscomparedtoinsulatedcoilsmakesthiste
dynamicapplicationssuchasthemagneticfieldcoilsinalinearmotorsystem.However, anapplication−specificoptimizationofth
to−turnresistance, seekingasmartcompromisebetweencoiloperationalrobustnessandacceptablethermalbudget, canmakesuch
dynamicmotionsystems.

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