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Coupling time constant measurements and analyses of spiral copper-plated multifilament coated conductors

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Striation (multifilament) is an effective way to reduce AC losses in the coated conductors for the applications of magnets or electrical power devices. Considering the robustness of the striated coated conductors, it is preferred to have some transverse conductance like copper between superconductor filaments. In such a conductor, however, the striation works for AC loss reduction only after the decay of the coupling current, which flows between transverse conductance and superconductor filaments and is characterized with the coupling time constant. Since the coupling time constant is proportional to the square of the conductor length for straight coated conductors, we proposed the spiral copper-plated striated coated conductor cable (SCSC cable), where the copper-plated multifilament coated conductors were spirally wound on a core to reduce the loop length of the coupling current. We prepared various models of the SCSC cable, in which copper-plated multifilament coated conductors with different conductor widths, filament numbers or copper thicknesses were wound on GFRP cores with different diameters. As references, we also prepared short straight pieces with different lengths. At 77 K, the frequency dependence of AC loss was measured in transverse magnetic fields with a small amplitude, where the coupling loss dominants the AC loss. The coupling time constants were determined from the frequency dependences of measured AC losses. The determined coupling time constants were smaller than the characteristic times of the magnetic field and/or the transport current changes in practical applications. Furthermore, in order to clarify the electromagnetic behaviors of the coupling current in SCSC cables, we conducted the numerical electromagnetic field analyses of SCSC cables. We compared the theoretical coupling time constants with the measured ones.

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