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Estimation method of optimal amount of overshooting current for temporally uniform magnetic field in a conduction-cooled ReBCO coil for MRI applications

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The variation of the magnetic flux density due to shielding current attenuation causes negative influence on temporally stable magnetic flux density required at the center of high-resolution MRI magnets. We have already clarified the relationship between the maximum current in an overshooting process and the shielding magnetic flux density attenuation and established the estimation method of the optimal amount of the overshooting current for suppressing the shielding magnetic flux density attenuation in a ReBCO coil cooled by LN2. This estimation method, however, cannot be applied to MRI applications because the repeated measurements are required for estimating the optimal amount of the overshooting current in the ReBCO coil. In this paper, we investigated an estimation method of the optimal amount of the overshooting current for suppressing the shielding magnetic flux density attenuation by only one-time excitation of the ReBCO coil cooled by a refrigerator. We investigated the operating temperature and current load factor dependency of the variation rate of the shielding magnetic flux density just after the overshooting process. Regardless of the operating temperature and the current load factor, the variation rate of the shielding magnetic flux density decreased with the amount of overshooting current and changed from a positive value to a negative value. The ratio of the optimal overshooting current to the critical current of the ReBCO coil against each current load factor became almost the same independently of the operating temperature. Based on these results, we devised a suitable excitation current waveform in the overshooting process for suppressing the shielding magnetic flux density attenuation in the ReBCO coil cooled by the refrigerator. Using this current waveform, we could suppress the shielding magnetic flux density attenuation by only one-time excitation.

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