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Influence of E-J characteristics of coated conductors and field ramp-up rates on the shielding-current-induced fields of magnets

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The shielding-current-induced field (SCIF) of coated-conductor magnets has been studied mainly for dc magnets. In dc magnets, E-J characteristics of coated conductors can influence their field stabilities, because shielding currents should decay by the finite resistivity, i.e. E divided by J. In magnets generating time-variant magnetic fields, the field ramp-up/down rates as well as E-J characteristics can influence SCIF. J at an arbitrary point in a coated conductor is associated with E due to the E-J characteristic. Because E is determined by the electromagnetic induction during the field ramp-up/down phase of a magnet, J, as well as the shielding current, should be influenced by the ramp-up or ramp-down rate and E-J characteristics. We carry out numerical electromagnetic field analyses on the SCIF of coated-conductor magnets while varying the field ramp-up/down rates as well as the E-J characteristics of coated conductors. The analyses are conducted on simple axisymmetric coils and the cross-sectional model of a cosine-theta magnet designed for a rotating gantry for carbon cancer therapy. As for the excitation pattern of the magnets, we use simple temporal profiles with repeating ramping-up, flat top, and ramping-down phases for the axisymmetric coils, and temporal profiles simulating the excitation of a magnet for a rotating gantry for the cosine-theta magnet. We look at the influence of the ramp-up/down rates and the E-J characteristics on the current distributions in coated conductors in various phases, i.e. ramp-up/down phases, the flat top phase, and steps of the repeating ramp-up/down phases. Then we discuss their influences on the shielding-current-induced fields.
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