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Improvement of excitation delay by multiple high temperature superconducting tapes in no-insulation coil

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One of the problems with the practical application of high-temperature superconducting coils is burnout due to the heat generated by a local low critical current density. At the current level of manufacturing technology for a high-temperature superconducting tape, it is not possible to manufacture long high-temperature superconducting tapes that do not completely include deterioration of local critical current density. To overcome this problem of high-temperature superconducting coils, a no-insulation coil, which is wound with uninsulated conductor, has been proposed as a coil structure. Previous studies have shown that this structure can prevent burnout even if there is a local critical current density degradation in the winding. However, a big problem is that the no-insulation coil has a long excitation delay time. Therefore, we propose a no-insulation coil wound with multiple high-temperature superconducting tapes without insulation between tapes in order to improve the excitation delay. In addition, multiple tapes are possible to reduce the critical current drop rate of the entire multiple tapes even if one tape in multiple tapes has a deteriorated part of the critical current density.
In this study, the transient electromagnetic phenomena in the no-insulation coil wound with multiple high-temperature superconducting tapes was calculated by the partial element equivalent circuit (PEEC) method. The calculated results showed that the excitation delay time could be shorted by multiple tapes. Furthermore, the current distribution in a no-insulation coil has local deterioration of the critical density in one tape of multiple tapes was examined. The calculated results showed that even if one of the multiple tapes has a local critical current density degradation, the current that greatly exceeded the critical current did not flow in each tape, and the current flew quickly to the adjacent tapes.

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