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Thu-Mo-Po4.13-06 [101]: 3-D Analysis of High-Tc Superconductor for Magnetic levitation under High-Speed Movement

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The superconducting magnetic levitation(Maglev), realized by high-Tc superconductor subject to high magnetic field generated by permanent magnet of NdFeB, has attracted special interests for applications such as transit and superconducting magnetic bearing(SMB). In the last two decades, several prototypes of HTS Maglev or SMB have been proposed and developed by different groups. Furthermore, the evacuated-tube-transport(ETT) applied HTS Maglev was developed in Southwest Jiaotong University, China, 2014. However, the ETT Maglev maximal speed is 50 km/h, which is much lower than the high-speed of commercial application, because of the finite length of track and budget. To demonstrate the feasibility of ETT HTS Maglev, numerical analysis on the dynamic and thermal stabilities of levitated superconductor subject to high magnetic field, under high-speed operation over 1000 km/s, are indispensable, as the relevant experiments are expensive and hard to perform. In the present work, we will develop a full 3-D finite-element model based on the T-formulation and nonlinear E-J constitutive relationship. The constitutive law considers the influence of magnetic and thermal fields on the critical current density of superconductor. Especially, being different from the existing related models, the effect of thermal is taken into account by the strong coupling multiphysics of electromagnetic and thermal in temporal and spatial domains. Furthermore, the induced electric field induced by the high-speed movement of superconductor is also introduced in our model. We discussed the dynamics and thermal stabilities of HTS Maglev operated under the high-speed from 600 to 1200 km/h. The results attained by this numerical prognostic work, mostly being inaccessible from the present experimental apparatus, are aimed to promote the HTS Maglev in transit and analogous applications.

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