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Thu-Mo-Po4.13-03 [99]: Semi-Analytical Calculation of Levitation and Guidance Forces in a Superconducting EDS Train

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Electrodynamic suspension (EDS) train is one of the most important ways to develop high-speed or ultra-high-speed rail transit. In order to explore the dynamic characteristics of EDS system with figure-eight-shaped coil, this paper transforms the complex electromagnetic field coupling relationship between vehicle coils and ground coils into a simplified circuit relationship, and introduces the motion characteristics to establish the field-circuit-motion coupled model based on the dynamic circuit theory. Firstly, the dynamic circuit model of the single-sided EDS system is established. The magnetic coupling calculation is carried out between vehicle coils and ground coils. The time-step iteration method is used to solve the induced current control equation of the figure-eight-shaped coil, and the induced current distribution curves under different operating conditions are obtained at the same time. Energy method is employed in transient solution of levitation force, guidance force and drag force. The field-circuit-motion coupled model is verified by three-dimensional finite element model and the experimental data in Japanese Yamanashi test line. After that, a cross-connected EDS train dynamic circuit model is built, as compared with the single sided model, the difference of system performance in suspension and guidance can be investigated. Finally, based on the cross-connected structure, the essential parameters affecting the stability of the system are explored, and the characteristics of vertical, lateral displacement and angular offset of the system are calculated and analyzed. The results of above research can provide a reference for the designing and experimental testing of the EDS train.
Key words: Superconducting electrodynamic suspension (EDS); Dynamic circuit theory; Mutual inductance calculation; Electromagnetic force

Primary author: Mr CAI, Yao (Southwest Jiaotong University)

Co-authors: Mr WANG, Yiyu; YANG, Wenjiao (Southwest Jiaotong University); LI, Gang (Southwest Jiaotong University); Mr WANG, Chao (School of Electrical Engineering, Southwest Jiaotong University); MA, Guangtong (Southwest Jiaotong University)

Presenter: Mr CAI, Yao (Southwest Jiaotong University)

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